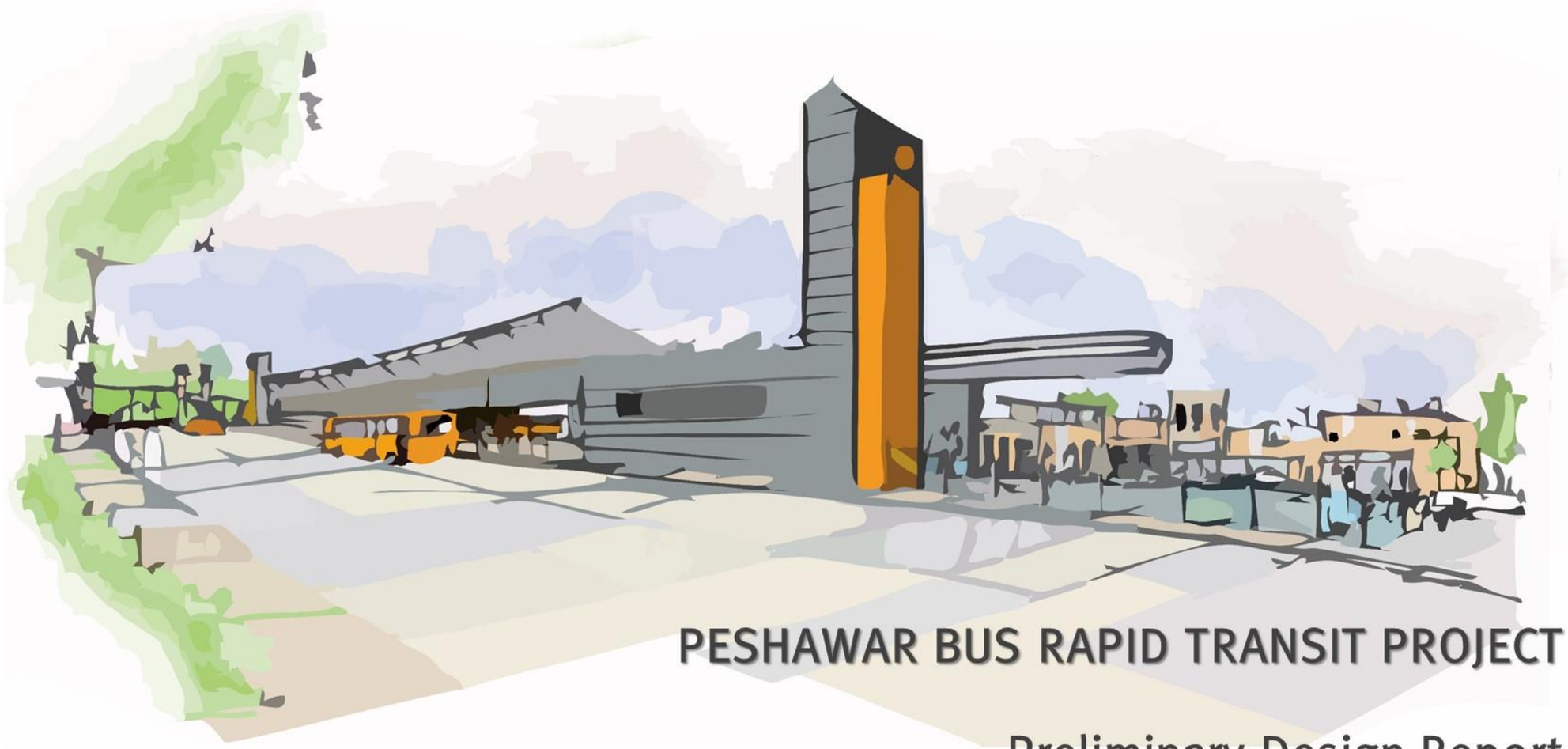

PESHAWAR BUS RAPID TRANSIT PROJECT

Preliminary Design Report

Final (December 2016)

desMobi

Project Control Form

Reference/Project Name	Written by	Version	Date	Description	Checked by	Date
Peshawar BRT Preliminary Design	Yoga Adiwinarto	v.1	June, 2016	Initial Draft Version	Ferdinand Marterer	June, 2016
Peshawar BRT Preliminary Design	Aditya Tafta & Ria Roida	v.2	September, 2016	Final Version	Yoga Adiwinarto	September, 2016
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FINAL REPORT VERSION

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APPENDIX

Glossary

ADB	Asian Development Bank
AFSC	Automated Fare System Collection
BRT	Bus Rapid Transit
BS	BRT Stop
BO	Bus Operator
CBP	Cantonment Board of Peshawar
CC	Control Centre
CNG	Compressed Natural Gas
CCTV	Closed Circuit Television
DESMOBI	Desain Mobilitas Indonesia
FSC	Fare System Collection
GHG	Green House Gas
GoKPK	Government of Khyber Pakhtunkwa Province
GPS	Global Positioning System
GT	Grand Trunk (Road)
ITDP	Institute for Transportation & Development Policy
ITS	Intelligent Transportation System
KPK	Khyber Pakhtunkhwa
KPUMA	Kyhber Pakhtunkwa Urban Mobility Authority
MCC	Manually Classified Count
MRT	Mass Rapid Transit
NFC	Near Field Communication
NMT	Non-Motorized Transport
OD	Origin & Destination
PBC	Peshawar Bus Company
PDA	Peshawar Development Authority
PFS	Pre-Feasibility Study
PNT	People Near Transit
PpHpD	Passenger per Hour per Direction
PPP	Public Private Partnership
PPTA	Preparatory Project Technical Assistance
PT	Public Transport
PSO	Public Service Obligation
RFID	Radio-frequency Identification
RTA	Regional Transport Authority
SDA	Service Delivery Agreement
SS	Station SubStop
TC	Traffic Count
TOD	Transit-oriented Development
UC	Union Council

1 Introduction

1.1 Project Background

Desain Mobilitas Indonesia (DESMOBI), associated with BRT Plan International and Think Transportation, are commissioned by the Asian Development Bank to develop the Bus Rapid Transit (BRT) preliminary design under the Project Preparatory Technical Assistance (PPTA) on Peshawar BRT.

The project was initiated on 8 February 2016 and was to be completed by 27 January 2017. However, after the initial meeting with the Chief Minister of KPK Province, it was decided to complete preliminary design work by the end of June 2016, thus enabling Detailed Engineering Design work to start, and construction to start as early as January 2017 for completion in December 2017.

Prior to PPTA work, a Pre-Feasibility Study performed under CDIA funding was completed in 2015, and has identified the corridor 2/2A, which goes from Karkhano to Kambo, to be feasible. It was selected for BRT implementation phase 1.

This PPTA work objective is to develop the suitable design to implement the BRT, with reference to the corridor identified in the PFS work.

The PPTA team, in addition to the preliminary design, also has the following major tasks to perform:

- Conceptual Plan & Design for NMT, Parking and TOD
- Develop initial business model and financial model of the BRT operation
- Develop PPP scheme options for BRT and TOD implementation in Peshawar
- Develop the transition plan for existing transporter and start the negotiation process
- Develop project preparatory document
- Develop Economic Analysis for the BRT

Figure 1. 1 Existing Public Transport in Peshawar

Since the project started, to date, several visits to collect data and analysis have been conducted in the following dates:

- 17-19 February 2016
- 6-16 March 2016
- 10-15 April 2016
- 22-28 May 2016

1.2 Objectives

The objective of this work is to provide the preliminary BRT design for Peshawar BRT.

This preliminary design report is the third report produced by the consultant for the PPTA work. Prior to this report, an inception report and interim report were submitted to the ADB.

The inception report was submitted in April 2016 and shows the BRT corridor alignment options, the existing public transport services (routes and frequencies), public transport demand as well as the Transit-Oriented Development (TOD) concept surrounding the BRT project.

Since the inception report, few updates were made on BRT alignment, corridor options, BRT routes and station access. The interim report, which was submitted in mid-June, documented those changes and explains the rationale for each proposal developed for Peshawar BRT.

During the meeting with the government in May 2016, it was decided that the two options for the BRT will be designed and proposed, notably called the ‘modest cost’ and the ‘high cost’ options. In the ‘modest cost’ or preferred option, the BRT will be designed at-grade at Saddar road, minimizing the need for elevated structure along the Saddar area. The ’high cost option’, or second option, will be developed aiming to minimize conflict between BRT and general traffic along Saddar area. For that purpose, an elevated structure is proposed.

1.3 Project Scope

BRT Conceptual Design is the first plan and design to visualize BRT in Peshawar, and the following activities are covered in this report:

- ❑ BRT Corridor confirmation and final alignment
- ❑ BRT Routes selection, demand analysis and estimate
- ❑ BRT Station configuration and Cross section design
- ❑ BRT Vehicle specification design
- ❑ BRT physical Corridor and station design, including costing
- ❑ Traffic management, Intersection analysis and accessibility design along BRT corridor
- ❑ BRT preliminary engineering design
- ❑ BRT Initial business model and bus industry transition strategy

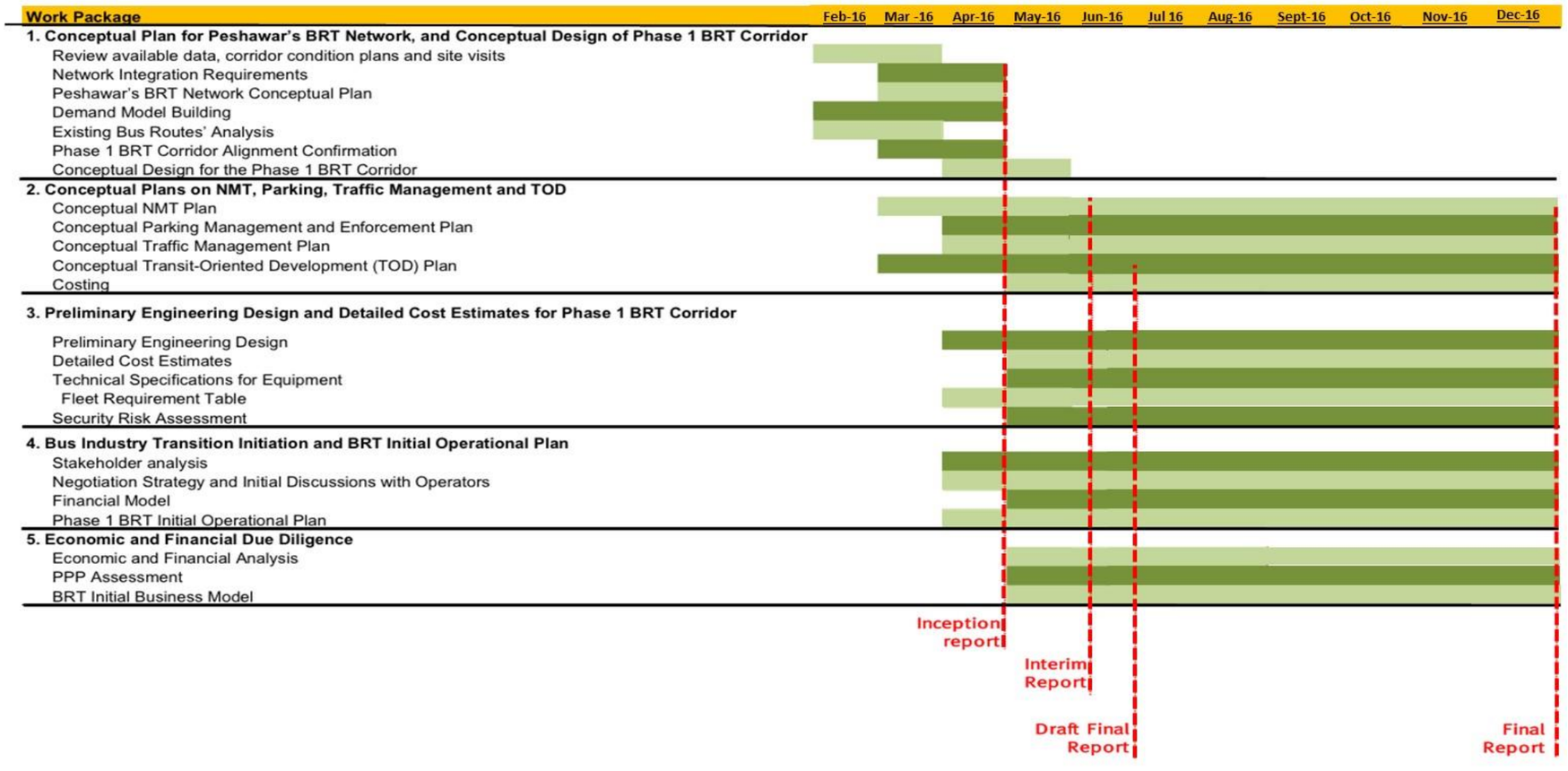
Following BRT preliminary design, financial analysis and PPP assessment of the BRT model is provided in separate report.

Box 1.1: BRT and public transport improvement

Globally, BRT systems are considered as a way to improve public transport conditions, and not only focus on the infrastructure development. In Peshawar, this will also be the case, where the public transport service is expected to improve, where new and modern fleet, comfortable station as well as more reliable bus services will be offered as part of the BRT.

1.4 Deliverables & Timeline

Figure 1. 2 Project Timeline and Work Package.



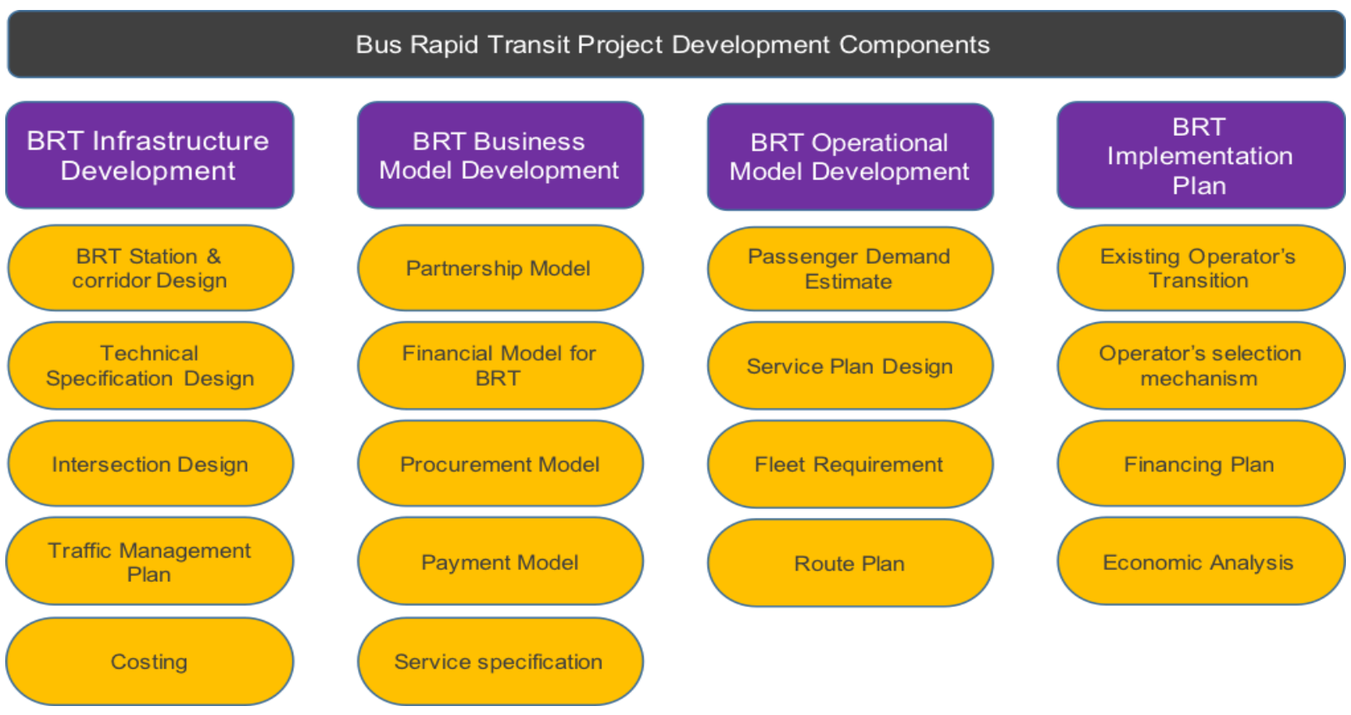
1.5 BRT Project Components and Design Highlights

The BRT project development components mainly include infrastructure development, business model development, operational model development and implementation plan.

BRT operator's contractual model is included as part of the business model development, as the service specification to be provided by the operators will be defined under the business model. However, this activity is closely linked with the existing operators' transition and the mechanism to determine the new one, should the existing operators are to be integrated as part of the BRT operator.

Including the existing operators or not is the government's decision, but analysis and strategy on the transition will be provided to the government to help with the decision making.

Figure 1. 3 BRT Project Development Components



Peshawar BRT project is different than existing BRT projects in Pakistan. Many innovations and new ideas are introduced for the BRT design. Few highlights of the design for Peshawar BRT are as follows:

i. Direct Service Operation covering off-corridor sections
ii. At-grade BRT for most of the network, with a few sections built as elevated
iii. Conflict-free for most of the network (BRT-only tunnel and bridge)
iv. High frequency service and multiple routes
v. Bicycle lanes along the BRT corridor
vi. Multiple bus sizes (9-meter and 12-meter buses), with future growth for 18-meter buses are also accommodated
vii. High capacity stations, able to accommodate up to 4 buses stopping at the same time in one direction
viii. *"facade-to-facade"* full corridor restructuring, including relocation of utilities, improvement of the drainage system, NMT, parking, shopfront

2 Peshawar Existing Transport Conditions

2.1 Public Transport Conditions

2.1.1 Main Problems for Public Transport in Peshawar

Like many emerging Asian and Pakistani cities, in Peshawar, transportation has become an important issue. With an increasing economy and a steady population growth, efficient mobility in the city has become problematic. Compared to other Asian cities in the region, Peshawar is still behind in terms of good quality mass transit provision for its residents, which is an issue that this BRT project is trying to solve.

The following list below summarizes the main problems in Peshawar public transport:

- Passengers are exposed to serious accidents due to poor driving behavior, boarding and alighting of passengers
- Buses are poorly maintained and lead to high consumption of fuel
- Bus stops are non-existent and buses stop randomly whenever a passenger is standing on the route
- Buses are overcrowded, and at times passengers are hanging on the bus railings
- Conductors are rude and offensive
- Drivers and conductors are at times under substance abuse while on duty

If not tackled soon, more problems can result from those poor public transport conditions in Peshawar:

- Degrading social and environmental issue from transport
- Decreasing mobility and long commuting time
- Declining living standard and high economic cost
- High level of GHG Emissions and noise pollution
- Low quality public transport service with limited capacity and coverage
- Increasing number of two-wheeler is worrying, emphasizing the risk of traffic accidents and traffic congestion
- Private cars dominating, taking more space in Peshawar

Figure 2. 1 Public Transport Vehicle Types used in Peshawar.


Passengers overload the suzuki pick-up van


Passengers overload the suzuki pick-up van

Sub-standard wagon used as public transport

Students sit on the roof posing great threat to safety

2.1.2 Type of Public Transport Vehicles

There are 4 types of vehicles operating as public transport vehicles in Peshawar. The biggest capacity is Minibus, which also has two sub-types: Mazda minibus and Bedford buses. Both sub-types have similar size of approximately 8 meters long with capacity of 41 passengers inside the bus. Passengers also often sit on the roof, despite posing great danger to their life and others. At most, 11 passengers can sit on the roof.

The second vehicle type is the Ford wagon, with a capacity of 15 passengers. The seat configuration of the wagon makes passengers difficult to get in and get out of the vehicles, thus most of the passengers on wagon are typically an end-to-end passengers riding the entire route.

In addition to the above, the Suzuki vans start to gain some public transport market shares, with at least 14 routes plying on Peshawar road. Suzuki vehicles are derived from pick-up minivans, modified with fragile roofs to provide cover for passengers. Despite their small size, the Suzuki can carry up to 18 passengers in total (inside and outside). Accident rates are not available, but it would not be surprising if they were listed as the most dangerous public transport option of Peshawar.

Small people carrier called Qingqi – named after the Pak-Chinese based motorcycle brand used as the vehicle, are also operating in Peshawar and relatively popular for short distance trips. This vehicle, a modified 3-wheeler with extra cabin at the back for passengers, has a capacity of 6 to 8 passengers.

2.2 Data Collection and Survey

2.2.1 Type of Surveys Conducted

The following surveys were conducted between February 2016 and March 2016 to collect data on the field.

The surveys were conducted by the local associate consultant team, Think Transportation, with the assistance of a team deployed from Peshawar. While we were aware of the security constraints and had taken measures to reduce the risks, there were still two incidents where the survey team got into scuffles with transporters, which resulted on our survey team members admitted to the hospital.

In addition to BRT survey, Transit-oriented Development (TOD), Parking and Non-Motorized Transport (NMT) related survey activities were also performed between February and March 2016. Detail of these surveys are described on the conceptual report on TOD, NMT and Parking.

Figure 2. 2 Type of surveys conducted.

Type of Survey	Activities
Public Transport	- Route Mapping - Boarding Alighting (on-board) - Boarding Alighting (at station) - Transfer Survey (on-board) - Transfer Survey (at-station) - Peak hour Bus Frequency & Occupancy - 12-hour Bus Frequency & Occupancy - Bus Travel Speed
General Traffic	- Volume Link Counts - Manual Classification junction counts - Car Travel Speed
Geometry	- Topography Mapping (in progress) - Road Cross Section - Photo Geotagging Mapping - Crossing Location mapping

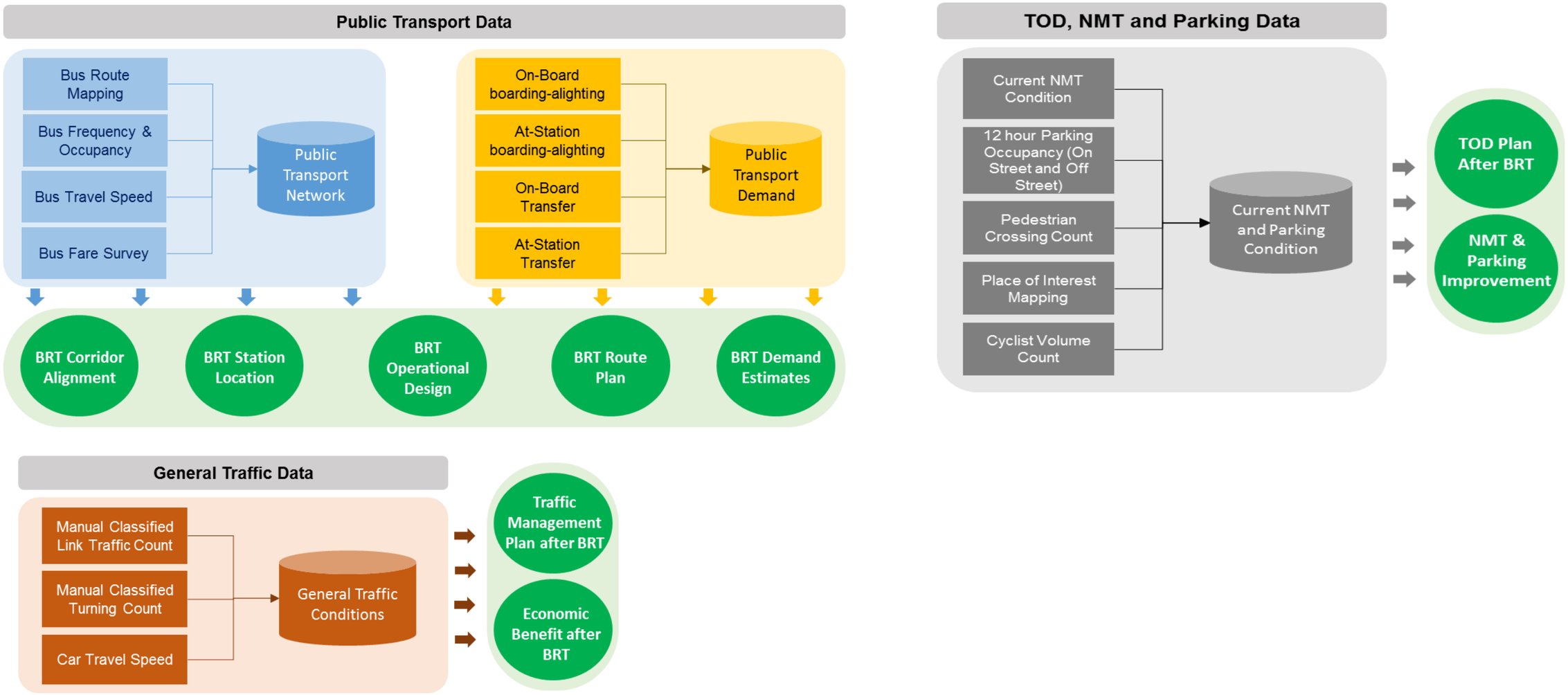
Figure 2. 3 one of BRT survey location

2.2.2 Objectives, Methodology and Approach

Public transport surveys have been conducted to get the understanding of public transport supply network and demand profile in order to analyze BRT corridor alignment, BRT station location, BRT operational design, BRT route plan, and BRT demand estimates. Surveys on general traffic were conducted to plan traffic management required with the opening of BRT corridor as well as to calculate economic benefit from the BRT.

Public transport network surveys that were conducted include the route mapping of buses, frequency and occupancy survey, travel speed, and bus fare survey. Surveys on public transport demand include boarding alighting survey as well as transfer (O-D) survey, both on-board and at-station. This report surveys are described in this report. Surveys on general traffic include manually classified link traffic count as well as manually classified turning count at junctions and car travel speed survey. Meanwhile, observation of the current NMT conditions, parking occupancy, pedestrian crossing location, place of interest mapping, and cyclist volume count were also conducted to gain understanding for designing the TOD plan, NMT improvement, and parking reform to support the operation of Peshawar BRT in the future.

Figure 2. 4 Survey Objectives, Methodology and Approach



2.3 Public Transport Data

2.3.1 Public Transport Routes & Map

In Peshawar, no public transport route map exists, although many routes operate in the city. The official data obtained from the government only listed the minibuses, rocket bus and wagon. Suzuki and Qingqi are operating illegally so no official data is available.

This problem of route map and unclear route signs also make it difficult for passengers to identify buses, although the bus conductor would normally shout routes to passengers. However, for Suzuki and Wagon this is not so much of a problem, since many of the passengers already on-board at the starting point of the routes, and they do not pick up many passengers on the road.

For this project, the consultant team was able to map 7 minibus routes, 2 wagon routes, 13 Suzuki routes and 6 Qingqi routes in Peshawar. This is the first time that those routes have been mapped and produced, as shown in Figure 2. 8 and

Figure 2. 9.

The mapping shows that most Qingqi and Rickshaw routes do not operate on the main corridor, but rather serve as feeders to the main corridor on GT road, University and Saddar. Along the Southern Ring road, there are many Suzuki routes plying. From our conversation with the Suzuki owners, although they seem to operate illegally, there is a consensus that they are only allowed to pick up passengers from one end to another, and not in between their trip. Most of the Suzuki routes comes from outside Peshawar city area such as Bara, Kohat, Charsadda and Phabbi

Since no proper routing number exist, Table 2.1 sets the route numbering convention used for this report. Most of the Minibuses are travelling along GT road from East to West, with majority of the routes starting at Kambo terminal, and end at different area at Hayatabad. Only 2 active wagon routes were identified, with route 10 going along the GT road, and route 11 going to the Ring road.

Table 2.1 List of Public Transport Routes in Peshawar as of May 2016

Type	Route Number	Route
Minibus	Route 1	Hayatabad Phase 6 – Kambo (via Saddar Road)
	Route 2	Hayatabad Phase 7 - Kambo
	Route 3	Karkhano - Kohat Stand
	Route 4	Karkhano - Kambo
	Route 6	Hayatabad Phase 6 – Kambo (via Shami Road)
Rocket Bus	Rocket 2	Saddar - Haji Camp
	Rocket 3	Bara - Saddar
Wagon	Route 10	Karkhano - General Bus Stand (via Grand Trunk Road)
	Route 11	Karkhano - General Bus Stand (via Peshawar Ring Road)
Suzuki	Suzuki 1	Pakha Ghulam - Hashtnagri Phatak (via Dalazak Rd)
	Suzuki 2	Hashtanagri Phatak - Charsadda Rd
	Suzuki 4	Charghano - Mall Mandi
	Suzuki 5	Charghano - Charsadda Rd
	Suzuki 6	Kambo Adda - Charsadda Rd
	Suzuki 7	General Bus Stand - University (via Charghano)
	Suzuki Ringroad 1	Grand Trunk Rd - Garhi Qamar Din
	Suzuki Ringroad 2	Grand Trunk Rd - Kohat Rd
	Suzuki Ringroad 3	Grand Trunk Rd - Karkhano
	Suzuki Ringroad 4	Grand Trunk Rd - Bara Rd
	Suzuki Ringroad 5	Grand Trunk Rd - Hayatabad
	Suzuki Ringroad 9	Hayatabad - Bara Rd
	Suzuki Ringroad 10	Hatayabad - Kohat Rd
Qinqi	Qinqi 1	Teaching Hospital - North Canal Rd
	Qinqi 2	City Circular Rd - Peshawar Ring Rd (via Phandu Rd)
	Qinqi 3	City Circular Rd - Gulbahar
	Qinqi 4	City Circular Rd - Peshawar Ring Rd (via Khan Mast Rd)
	Qinqi 5	Saddar - Manakrao
	Qinqi 6	Old Bara Rd - South Canal Rd

Figure 2. 5 Minibus in Peshawar

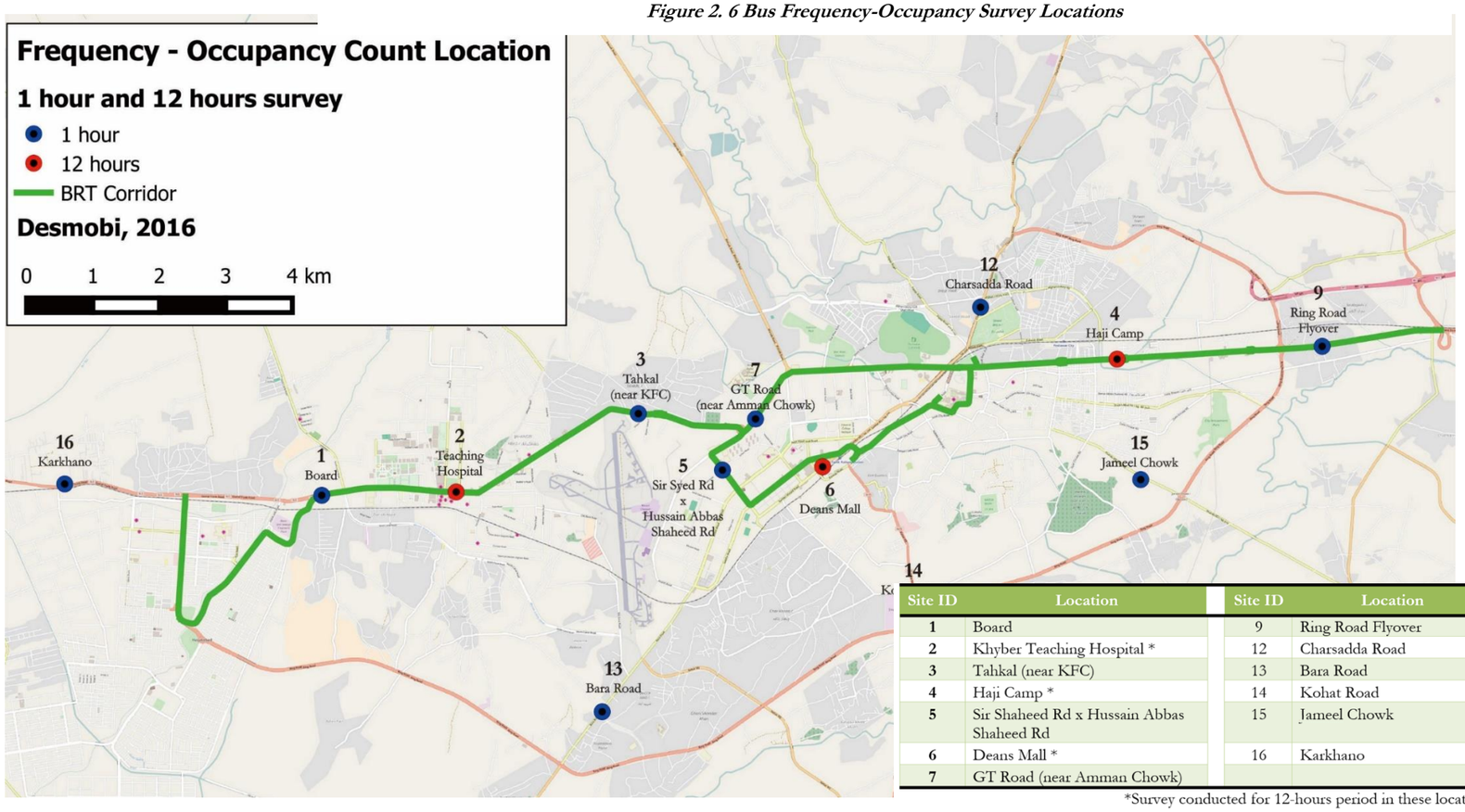
2.3.2 Public Transport Frequency & Occupancy

Out of the 5 minibus and 1 wagon routes, Wagon route no. 10 has the highest volume with 2033 passengers per hour in one direction, and frequency of 167 vehicles per hour per direction, or average occupancy of 12 passengers per vehicles, which is the maximum capacity of the vehicle. For the Qingqi and Suzuki, since there is no clear signage and identification of the routes, it is not possible to have the disaggregated frequency and occupancy data per route.

From 16 road segments surveyed, only 3 road segments have peak passenger volume under 1,000 passengers per hour per direction, and there are 5 locations with peak passenger volume above 3,000 passengers per hour per direction. Most of these locations are located along the BRT corridor on GT Road, which indicates the clear need to implement a BRT corridor on those roads. This passenger volume throughput is higher than some of the BRT systems in the world and Pakistan, where the peak passenger throughput in Islamabad BRT is only 2,100 passengers per hour per direction (December 2015).

Compared to Wagon and Suzuki routes, minibuses have lower frequencies, with the maximum frequency observed on route 2 at 24 bus per hour per direction. The Suzuki frequency recorded in Table 2.3 was from various routes captured on one road segment. Although the route identification for Suzuki is missing, the road segment frequency shows that Suzuki route has a very high frequency.

Figure 2. 6 Bus Frequency-Occupancy Survey Locations



Site ID	Location	Site ID	Location
1	Board	9	Ring Road Flyover
2	Khyber Teaching Hospital *	12	Charsadda Road
3	Tahkal (near KFC)	13	Bara Road
4	Haji Camp *	14	Kohat Road
5	Sir Shaheed Rd x Hussain Abbas Shaheed Rd	15	Jameel Chowk
6	Deans Mall *	16	Karkhano
7	GT Road (near Amman Chowk)		

*Survey conducted for 12-hours period in these location

Table 2.2 Bus Frequency and Occupancy Data.

Site ID	Location	Inbound		Inbound		Maximum 1-way Direction	
		Frequency	Occupancy	Frequency	Occupancy	Bus Freq. per hour/direction	Passenger Occ. Per hour/direction
1	Board	132	1.955	139	2.076	139	2.076
2	Khyber Teaching Hospital *	215	3.215	191	2.889	215	3.215
3	Tahkal (near KFC)	144	2.162	264	4.727	264	4.727
4	Haji Camp *	236	4.374	291	3.105	291	4.374
5	Sir Shaheed Rd x Hussain Abbas Shaheed Rd	232	3.424	147	2.753	232	3.424
6	Deans Mall *	187	3.250	192	4.165	192	4.165
7	GT Road (near Amman Chowk)	7	187	9	345	9	345
9	Ring Road Flyover	45	607	67	1.402	67	1.402
12	Charsadda Road	34	790	99	700	99	790
13	Bara Road	36	1.353	12	256	36	1.353
14	Kohat Road	31	1.052	20	449	31	1.052
15	Jameel Chowk	-	-	3	75	3	75
16	Karkhano	64	690	68	1.114	68	1.114

Figure 2. 7 Public transport capacity map

Table 2.3 Frequency and Occupancy of certain bus routes.

Bus Routes	Route Name	General Hourly Maximum	
		Frequency (Bus/Hour/Dir)	Volume (Pass/Hour/Dir)
Route 1	Hayatabad Phase 6 to Kambo	15	320
Route 2	Hayatabad Phase 7 to Kambo	24	666
Route 3	Karkhano to Kohat	13	151
Route 4	Kambo to Karkhano	13	232
Route 6-B	Hayatabad to Kambo via Shami Rd	12	874
Suzuki	Various routes	102	1537
Wagon 10	Karkhano to General Bus Stand	99	1251
Wagon 11	Karkhano to General Bus Stand via Ring road	67	781

Figure 2. 8 Peshawar minibus and wagon routes.

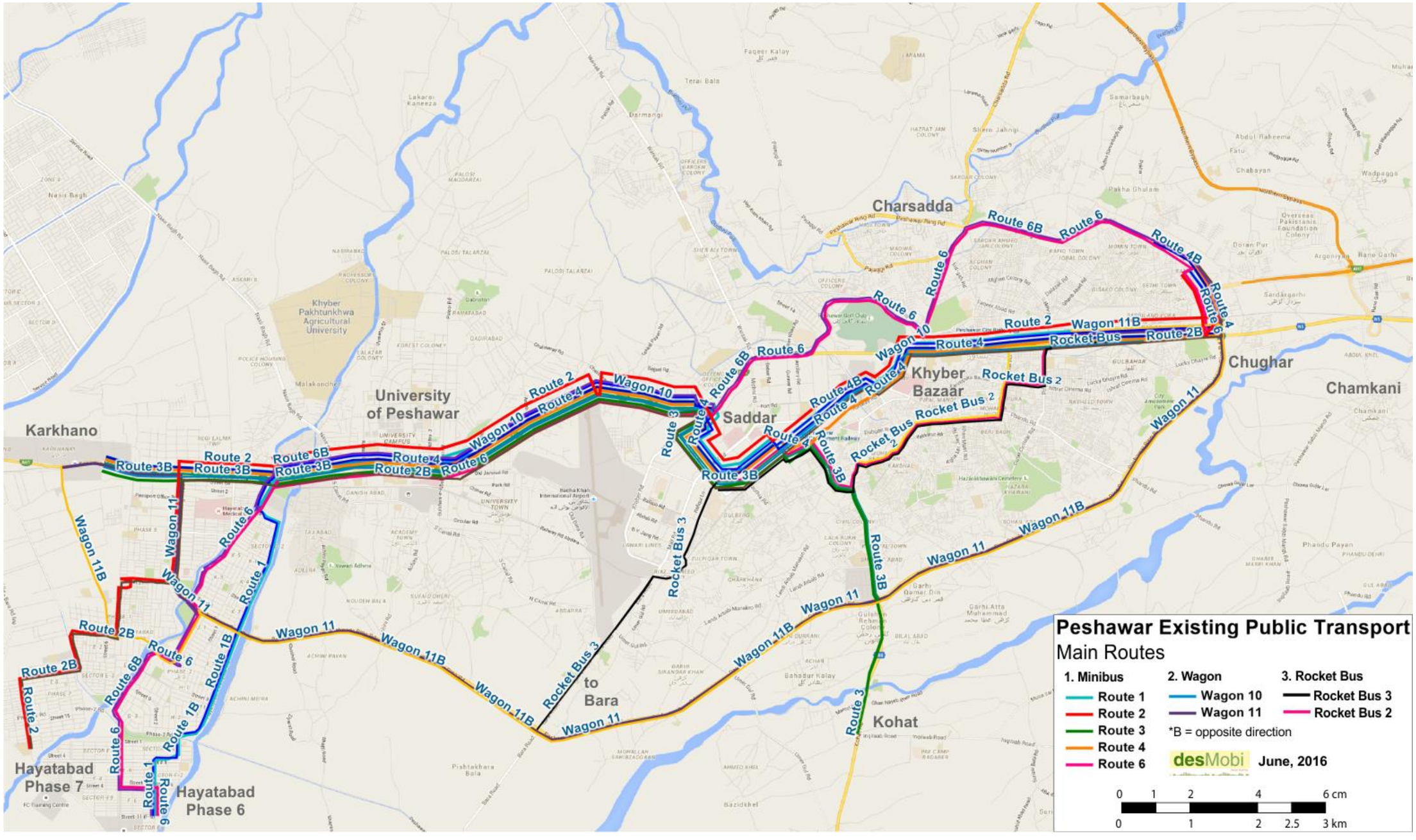
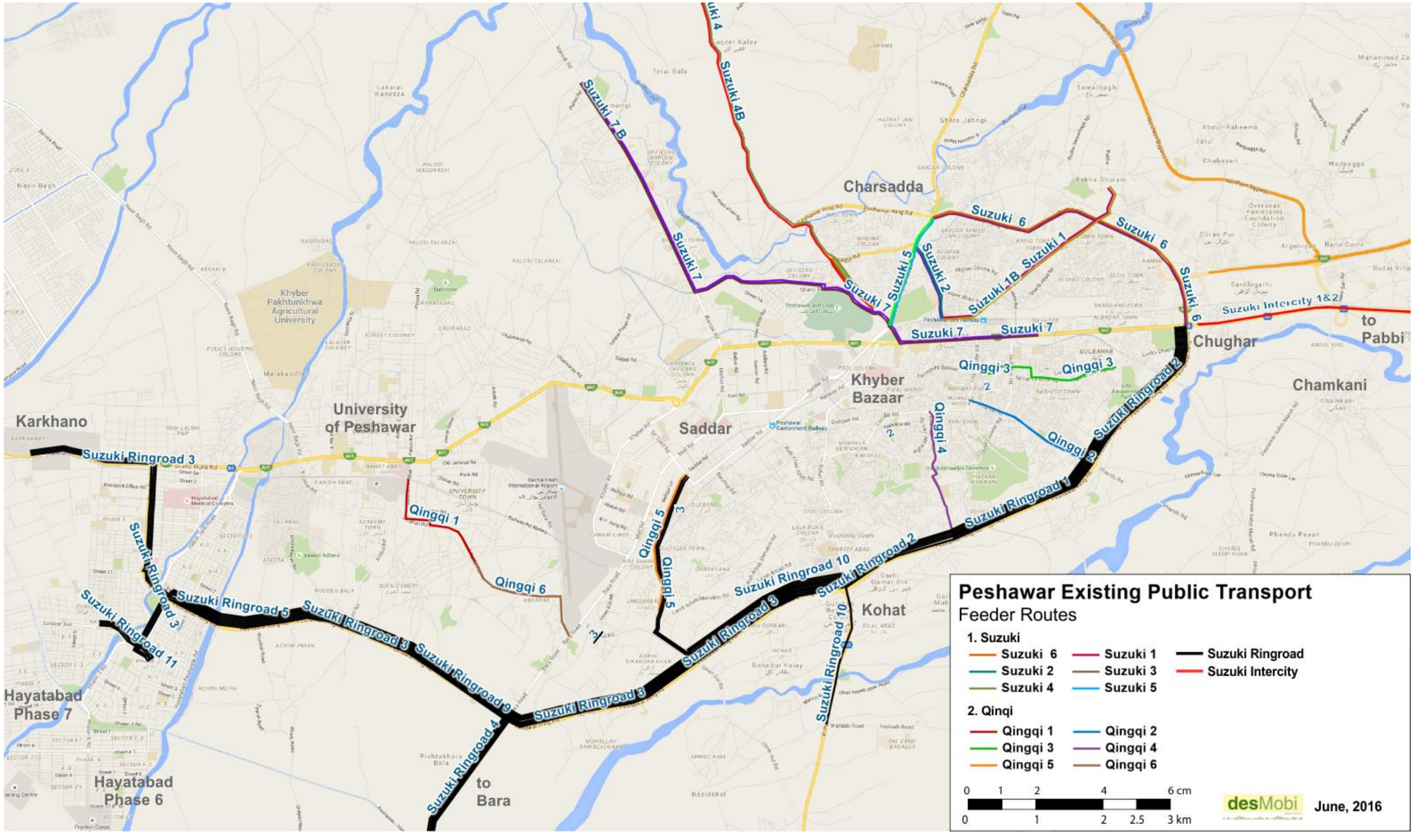


Figure 2. 9 Peshawar Suzuki and Qingqi routes.



2.3.3 Public transport speed

Travel speed data is collected using Global Positioning System (GPS) to record bus speed every second, for both directions and every route. This survey was largely conducted at the same time of on-board boarding and alighting surveys. All six types of public transport (Minibus, Wagon, Rocket bus, Suzuki, University wagon, and Qinqi) were included in this survey.

Buses are traveling slower than 20 km/hour on most part of the trunk line in Peshawar. In general, the low-speed travel of buses is due to buses running on slow-lanes along the GT road to pick up passengers standing on the side of the road. The ring road, which offers signal-free road, is able to get buses to travel faster than 20 km/hour. These numbers are represented in Table 2.4 and Figure 2. 11. .

Table 2.4 Bus and Wagon Travel Speed

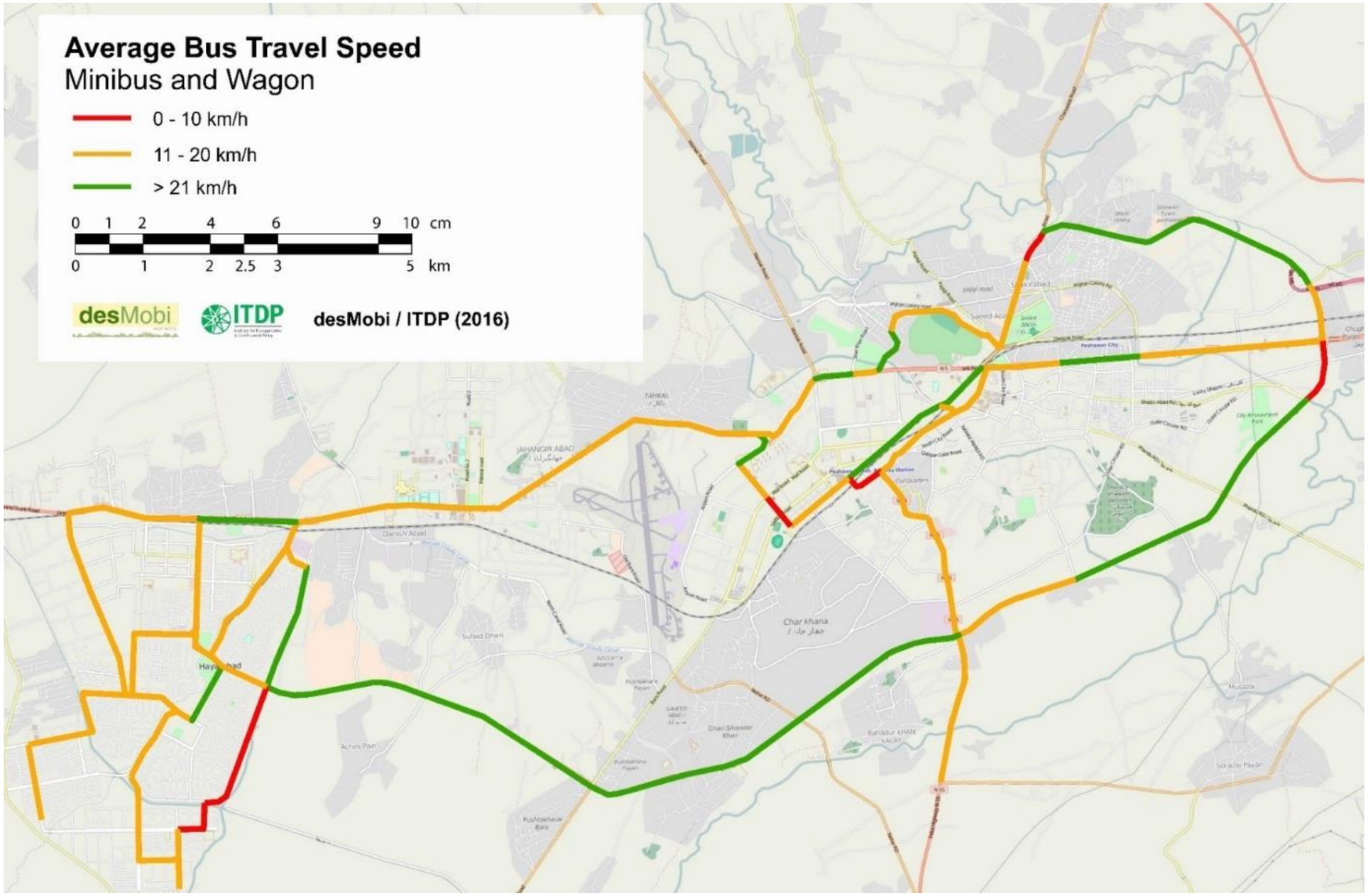
Route	Bus Type	Length (km)	Average Travel Time	Average Speed (kph)
Route 1	Minibus	25.76	02:09:29	11.9
Route 2	Minibus	27.58	02:21:23	11.7
Route 3	Minibus	17.56	01:25:46	12.3
Route 4	Minibus	21.96	01:45:19	12.5
Route 6	Minibus	26.17	03:51:07	6.8
Route 10	Wagon	19.68	02:05:34	9.4
Route 11	Wagon	26.87	01:18:17	20.6

Figure 2. 10 Bus travel on slow lane on GT Road.

The existing bus travel speed in Peshawar is currently 12.2 km/hour, which is quite low to attract more passengers to travel using public transport. Route 4, which runs from Kambo to Karkhano, or similar with the proposed BRT corridor, has an average speed of only 12.5 km/hour. This low speed is a combination of buses running on service lanes, delays caused by security checkpoints as well as traffic along Khyber Bazaar and Saddar area. Other factors which also delays current travel speed is the number of stops made by buses.

Currently, buses can practically stop anywhere along their route, without any proper enforcement in place. From the boarding and alighting surveys, it was discovered that in average, buses would stop every 300 meter to pick up or drop off passengers, which increases the delay experienced. With BRT, average distance between stops would be 750 meters, which would reduce total bus dwelling and stopping time, and lead to travel time reduction.

Figure 2. 11 Public transport travel speed map.



2.3.4 Security Check Point Locations

Security check points also play a big part in adding delays in Peshawar traffic. Currently, there are 10 security check points located in Peshawar, although some of them only operate on temporary basis. These locations are mapped below.

Figure 2. 12 Location Map of Security Check Points in Peshawar.

Table 2.5 List of Security Check Points in Peshawar.

No	Location	No	Location
1	Khyber Road	6	Mall Rd East
2	Cemetery	7	Bara Road
3	Railway Road	8	Hayatabad
4	Mall Rd West	9	Karkhano
5	Fakhar-e-alam Rd	10	Peshawar Club

Since these checkpoints might be a problem for the BRT, a measure to exclude BRT buses to be stopped at security check points needs to be devised, without necessarily posing threat to security caused by the BRT system. More explanation to overcome this problem is shown in Section 3.4.

2.4 Public Transport Demand

To capture existing public transport demand and trip patterns, few surveys were performed, such as on-board boarding & alighting surveys; static boarding & alighting surveys (at bus stops) and; passenger transfer surveys. The methodology and full results of the surveys are shown in a separate survey report.

2.4.1 Boarding Alighting

Peak hour boarding & alighting surveys were performed in all the routes identified in the previous section. These peak hour on-board boarding & alighting surveys recorded the location and number of passengers getting on and getting off the bus, wagon and Suzuki, with multiple samples taken per routes. An important proportion of trips originate from Kambo Adda and its surrounding, where currently 2 bus routes terminate.

The diagram shown in

Figure 2. 13 shows individual boarding & alighting activity. This data is disaggregated and each dot represent a single boarding & alighting activity at specific locations on specific routes. The big circle shown in Kambo Adda area shows that in a single occurrence, there are high volumes of people alighting and boarding at that location using specific bus route.

Figure 2. 13 Individual boarding and alighting locations.

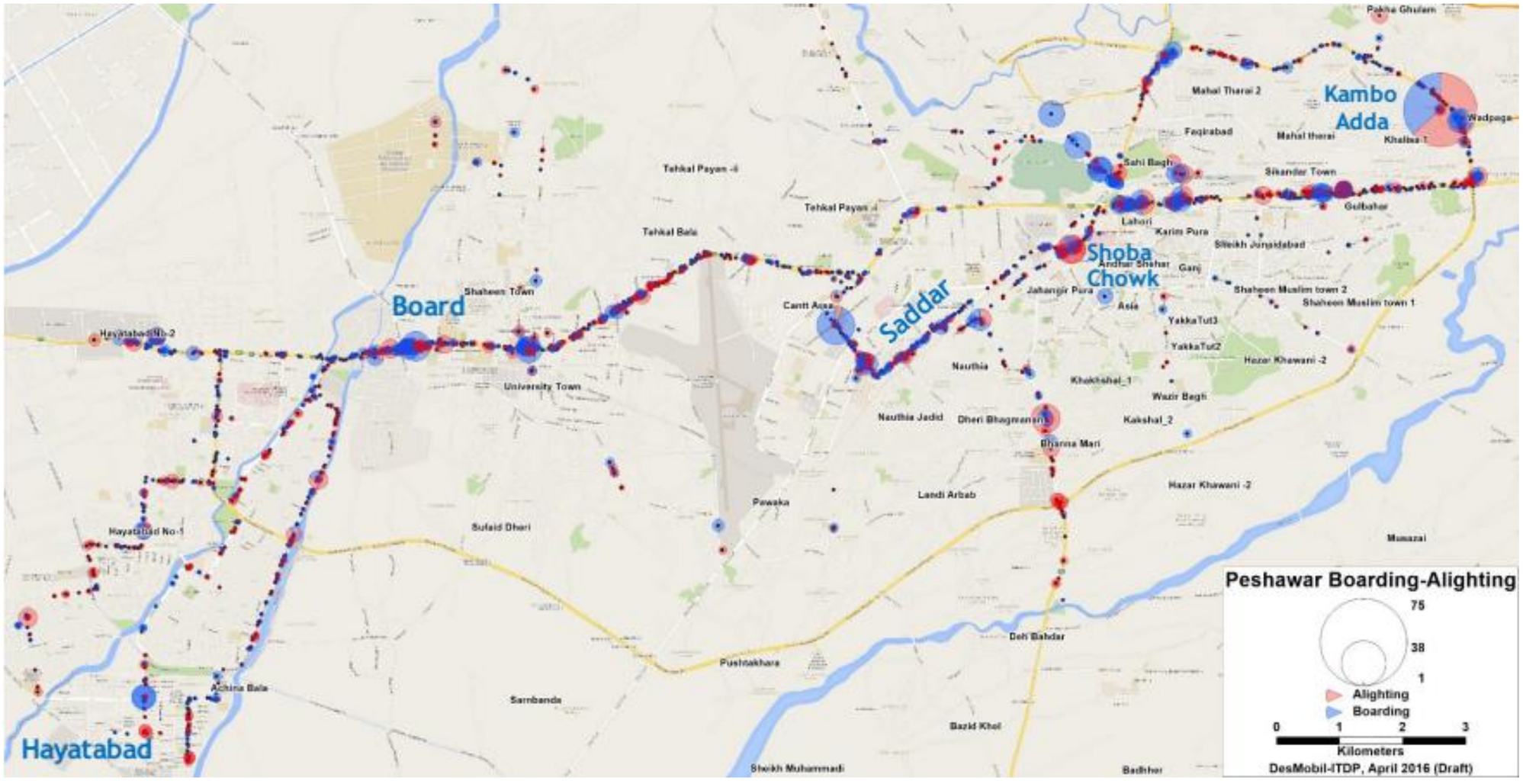
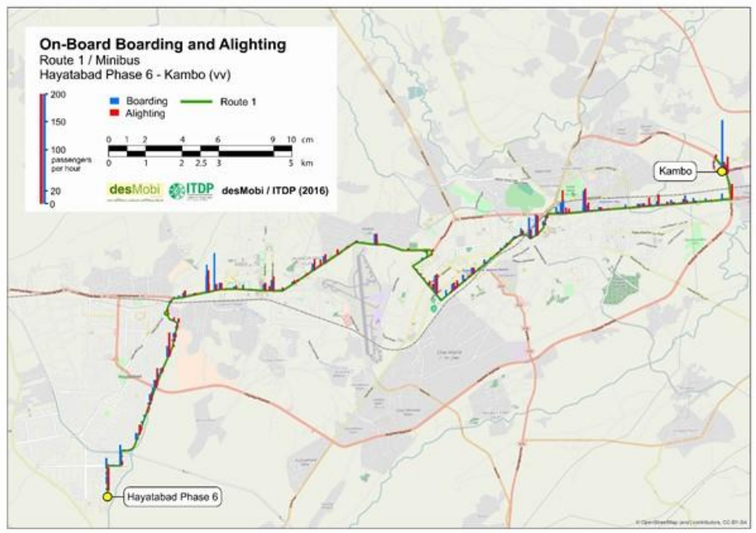
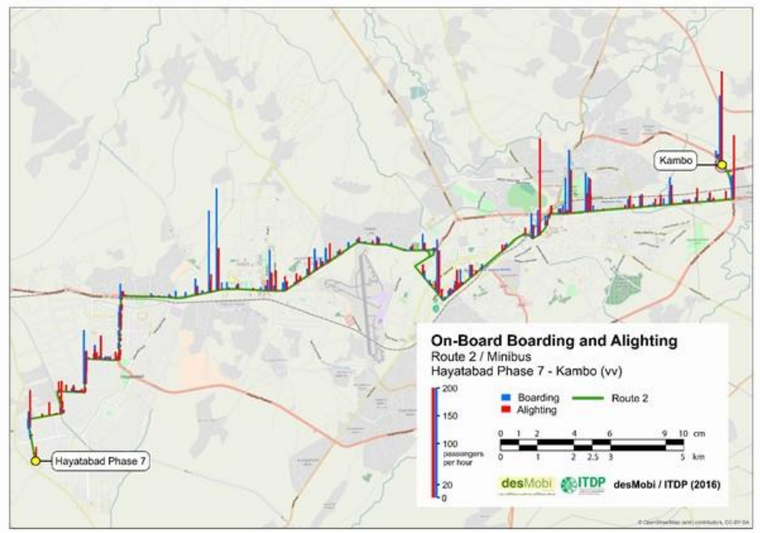
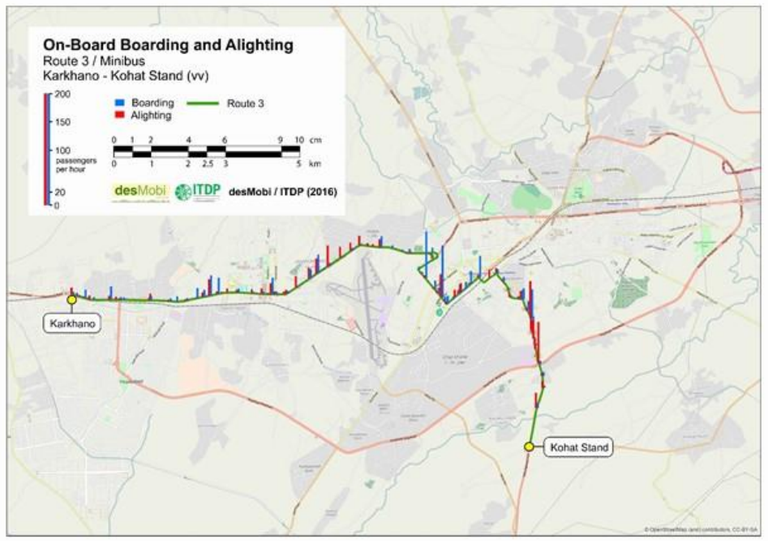


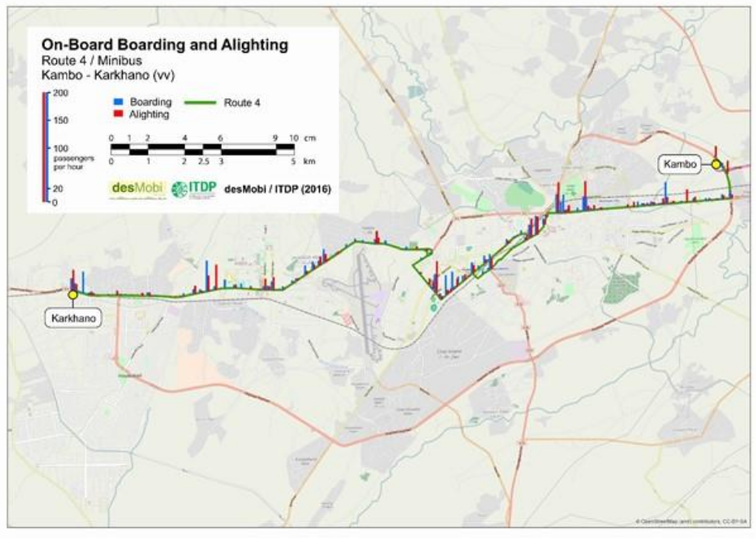
Figure 2. 14 shows the boarding & alighting points for each routes. Routes 1, 2 and 6 profile few locations such as Haji Camp bus terminal. Firdaous Cinema, Khyber Bazaar, Sadar, University and Board Chowk. In Hayatabad, passenger demand is not concentrated to one point or corridor, but rather spread to different development Phases in Hayatabad, such as Phase 2, Phase 6 and Phase 7. This demand pattern is important to identify at the beginning to determine the type of BRT operation plan to be introduced. For example, with such a high concentration along the GT Jamrud road, and less concentrated demand on Hayatabad, a BRT direct-service operational model could work well in Peshawar.

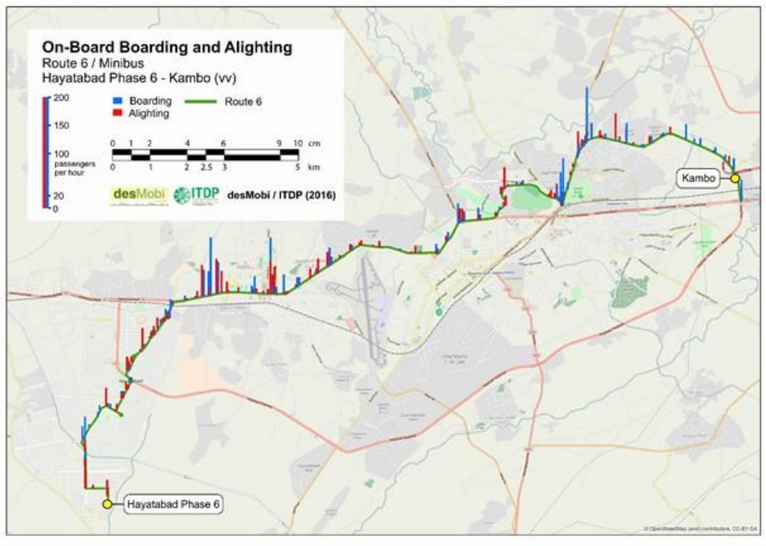
Figure 2. 14 Boarding & Alighting Profile for each Routes.

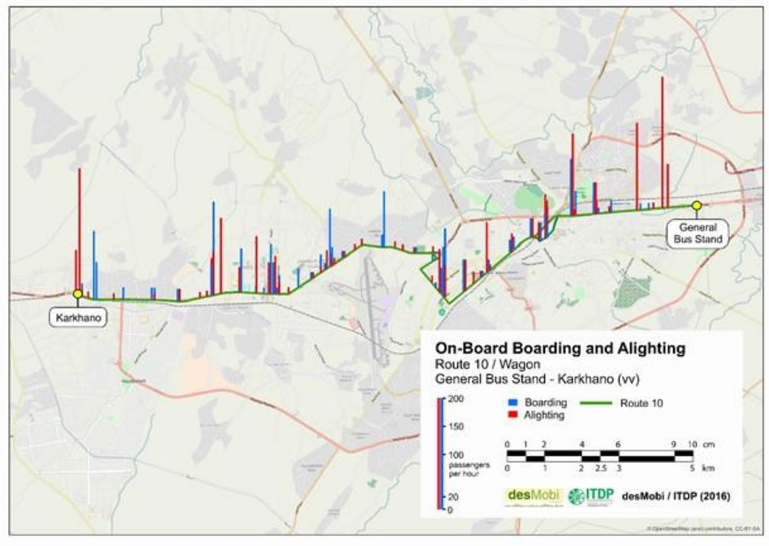












2.4.2 Transfer Survey

To completely understand the trip pattern of public transport demand in Peshawar, public transport passenger survey was also conducted. The survey was performed during the peak hour to capture the movement in the busy time of the day at different count locations.

The transfer survey data result is also used to derive the passenger trip Origin-Destination, as shown in Figure 2. 16 where the top 40 biggest O-D pairs are filtered to show more representative data. The data shows that Karkhano, board bus stop near the University, Hayatabad and Saddar are the main trip origin and destination locations for public transport passengers. Whereas to the east, Haji Camp Bus Stop and General Bus stands are the two main trip origin and destination locations.

Highly concentrated population area are spread along the BRT corridor, which guarantee the good public transport demand once the BRT is implemented along the GT road. On Khyber road, since only 1 bus route goes through that area, there is not enough demand to justify the need for a physical BRT corridor on that section, at least at the beginning. This is in line with the proposal, where Khyber Road section is reserved for the Phase 2 of the BRT, once the demand grows and the security check point issue is solved.

The transfer survey gathered the origin and destination of passengers, but also discovered their method of access (ingress and egress) to and from their bus along GT Road. Majority of passengers walk to reach their bus, and an important proportion of passengers changed from another bus before getting to their next bus.

As for the egress mode, i.e. the mode that bus passengers are transferring to, most passengers change to other buses and wagons, and around 15% walk to their final destination. This shows the importance of having a free-transfer BRT system, or even a direct-service BRT, which would make passengers pay less and spend less time than they currently do commuting.

Figure 2. 15 Transfer, Access and Egress of current bus demand.

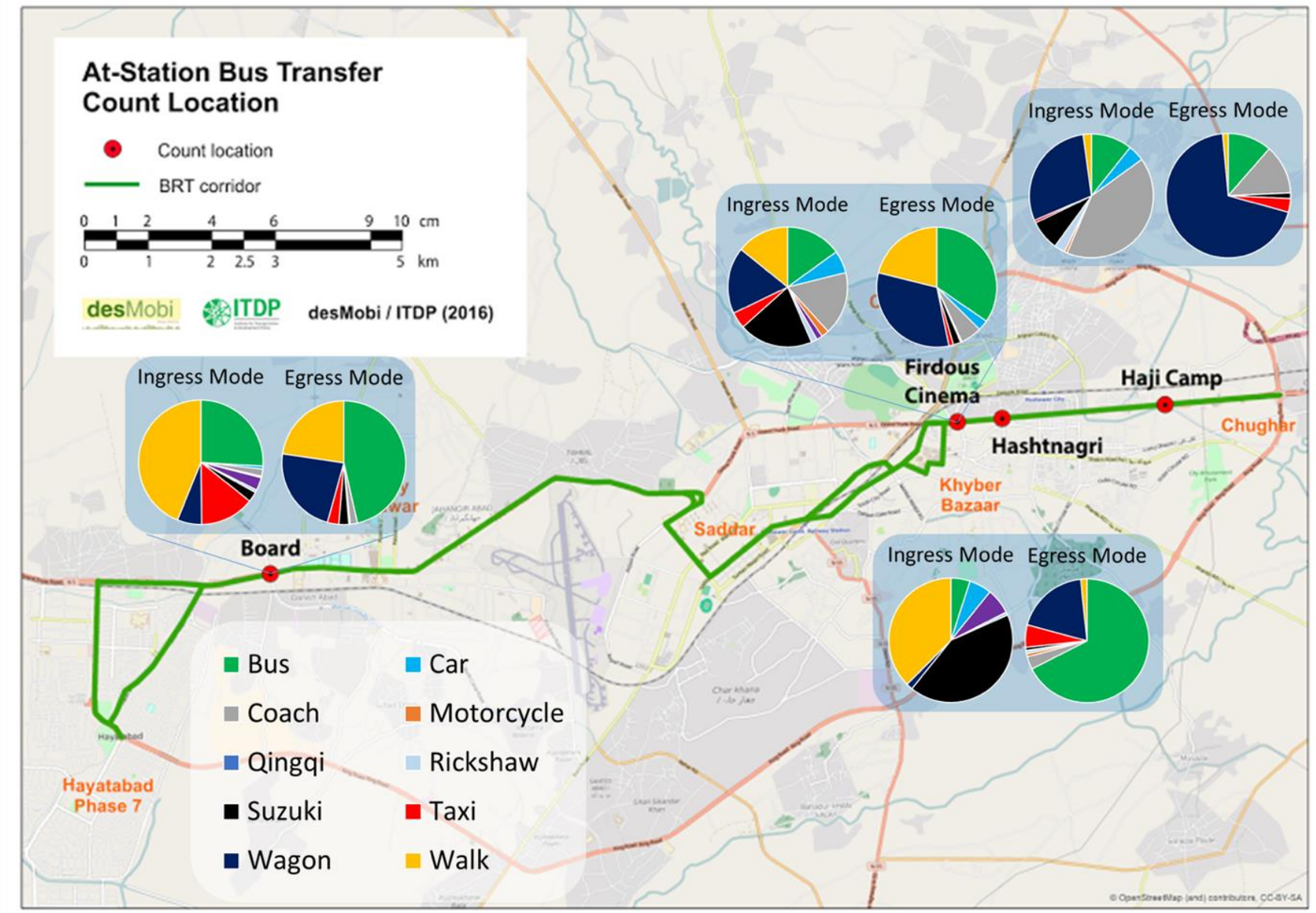


Table 2.6 Access ingress and Egress from bus.

Mode	Ingress	Egress	Mode	Ingress	Egress
Other Bus	17%	39%	**Car**	3%	2%
Coach	14%	5%	**Motorcycle**	1%	0%
Qingqi	3%	0%	**Rickshaw**	1%	0%
Suzuki	15%	2%	**Taxi**	7%	3%
Wagon	13%	34%	**Walk**	26%	15%

Aggregated demand at station for all 8 BRT routes below shows high demand profile stations, such as General Bus Stand, Firdaous Cinema, Khyber Bazaar, Shoba Chowk, Saddar, University Town and Board Bus Stop. This boarding alighting data at stations will later determine the station size required at each BRT stations. For example, high demand station with high bus frequency would require multiple sub-stops, and low demand areas can be served with single sub-stops only.

Demand estimates for BRT are estimated from the existing public transport passengers, as this is the most robust method, and there it is likely that the existing public transport passengers would shift to BRT if the BRT provides faster travel time and offer higher convenience to passengers.

Figure 2. 16 Desire line of top 40 biggest O-D pairs.

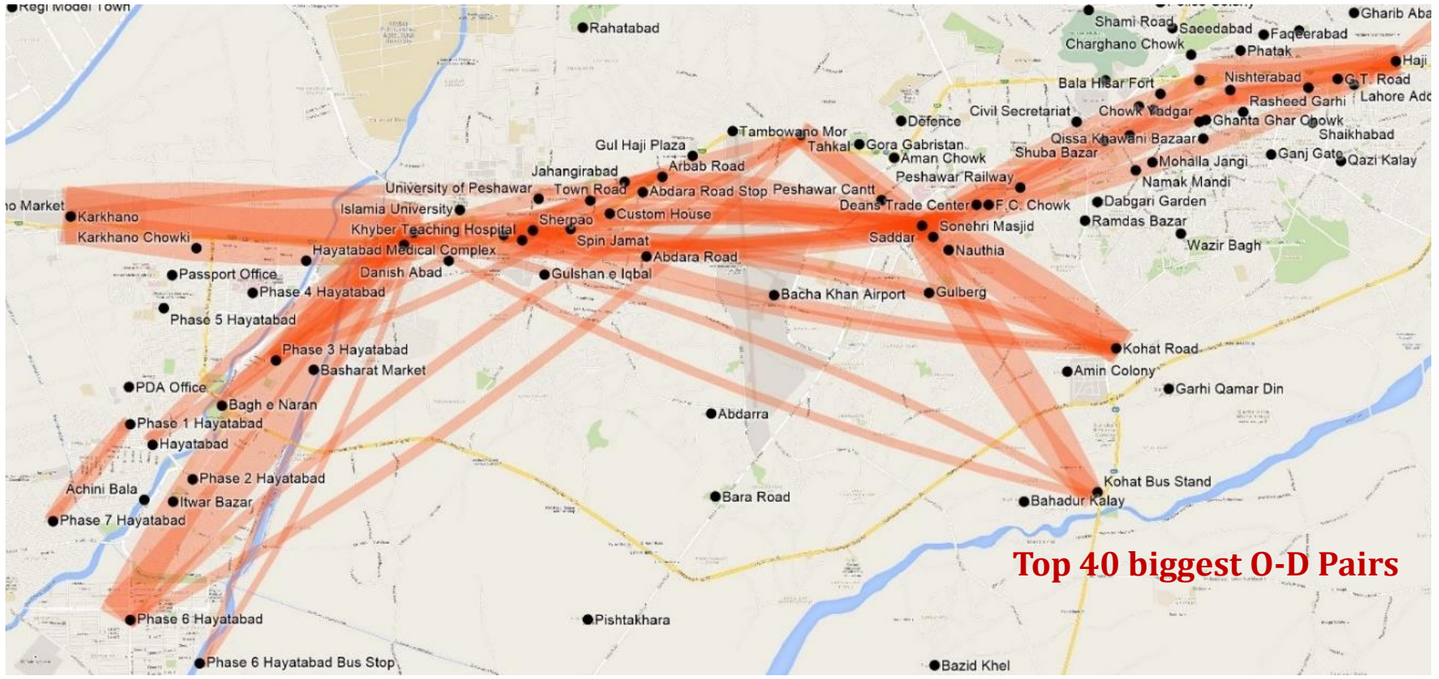


Figure 2. 18 Trip Generation and Attraction Points.

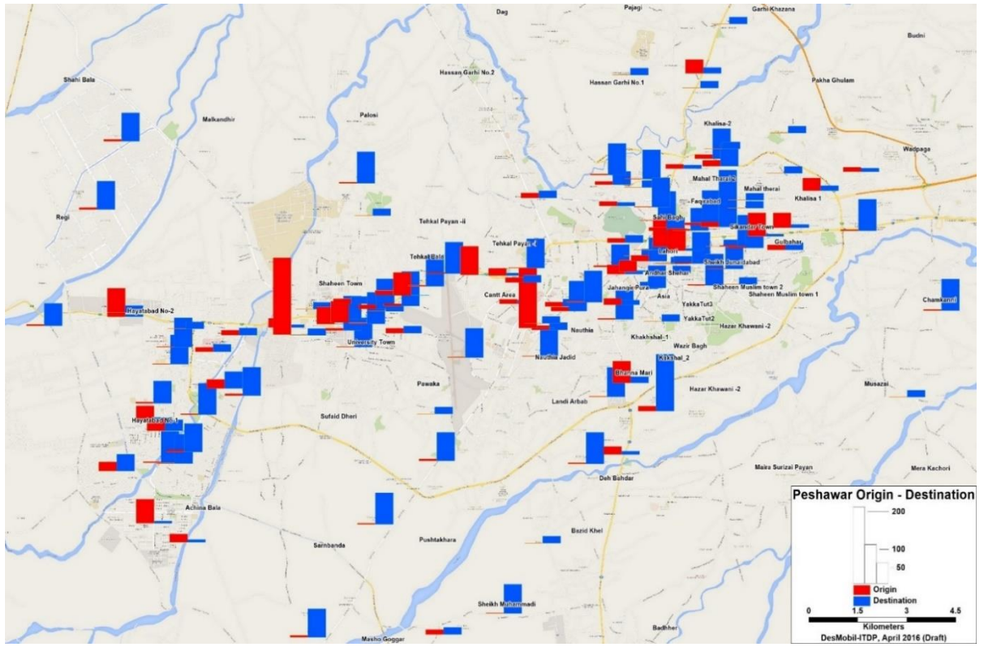
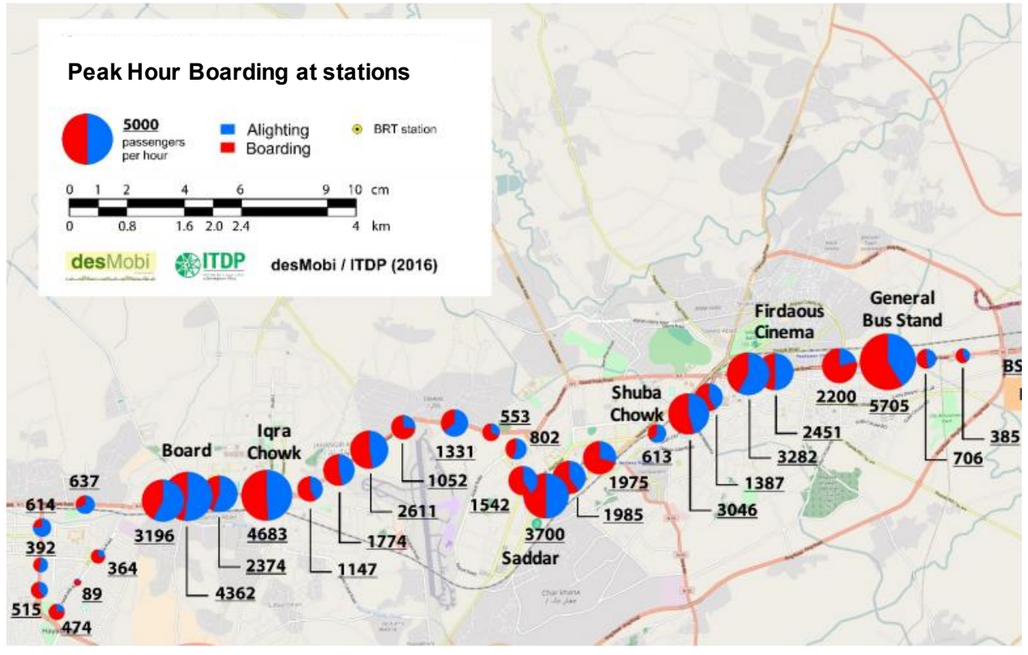


Figure 2. 17 Peak hour boarding demand at stations.



2.5 General Traffic Data

BRT corridor can have some effects on general traffic's speed, both on the links and at junctions. Therefore in the BRT design, link and junction improvements need to be addressed as well. The survey captured three types of traffic data; manually classified turning count, manually classified link count, and car travel speed.

2.5.1 Manually Classified Turning Count Data

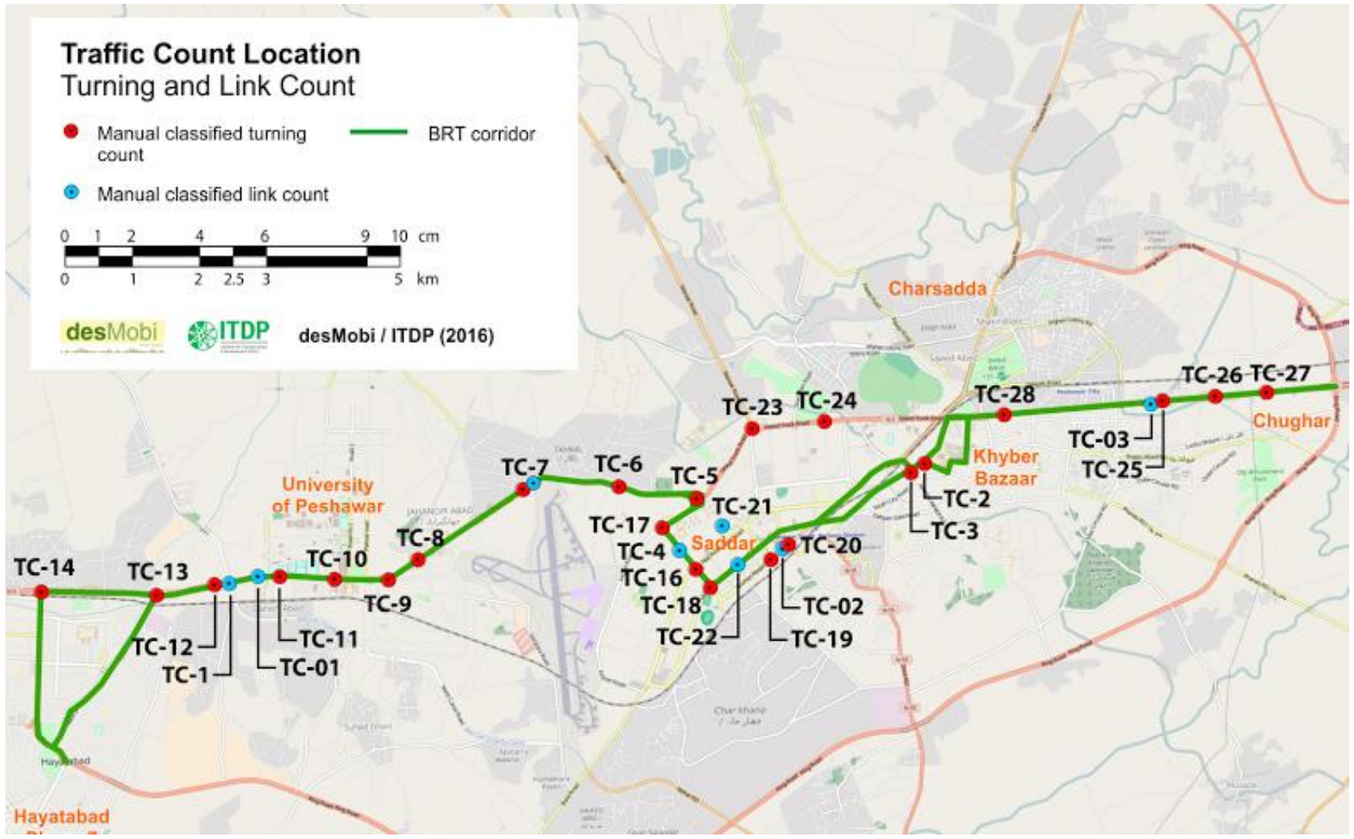
The manually classified turning count survey was conducted at 23 intersections during morning and evening peak hours, during 1-hour for each period. The locations of the surveys are shown in. They are well-distributed along the corridor to meet the required traffic volume information that will be used on traffic re-arrangement after BRT implementation in Peshawar. The manual classified link traffic count survey was conducted during morning and evening peak hours, 1-hour for each period. Additionally, 3 additional locations were assigned 12-hour period surveys of link count: from 08:00 AM to 08:00 PM. These locations are listed in Table 2.7. The geographical position of these survey data can be observed in Figure 2. 19, which also shows the distribution of non-public transport vehicles across the surveyed link..

Table 2.7 Manual Classified Turning Count Survey Locations.

Site ID	Location	Site ID	Location	Site ID	Location
TC-1	Board Chowk	TC-2	Khyber Bazar Intersection	TC-16	Darvaish Masjid
TC-4	Peshawar Cantt	TC-3	Suba Chowk Intersection	TC-17	Saddar x Khyber Road
TC-7	Tambowano Mor	TC-5	Aman Chowk Intersection	TC-18	Sadar Chowk
TC-21	Mall Road	TC-6	Tahkal (Near KFC)	TC-19	Next to Deans Mall
TC-22	Saddar Road	TC-7	Near Tambowano Mor	TC-20	F.C. Chowk
TC-01	Khyber Teaching Hospital*	TC-8	Near Custom House	TC-23	Warsak Road Intersection
TC-02	Deans Mall*	TC-9	Iqra Chowk	TC-24	Army Stadium Intersection
TC-03	Haji Camp*	TC-10	Khyber Teaching Hospital	TC-25	Near Haji Camp
		TC-11	Islamia University	TC-26	Near Haji Camp
		TC-12	Near Board Bus Stop	TC-27	Near Ring Road Flyover
		TC-13	Hayatabad Flyover	TC-28	Near Hashtnagri
		TC-14	Jamrud Chowk		

*12-hours period of link count

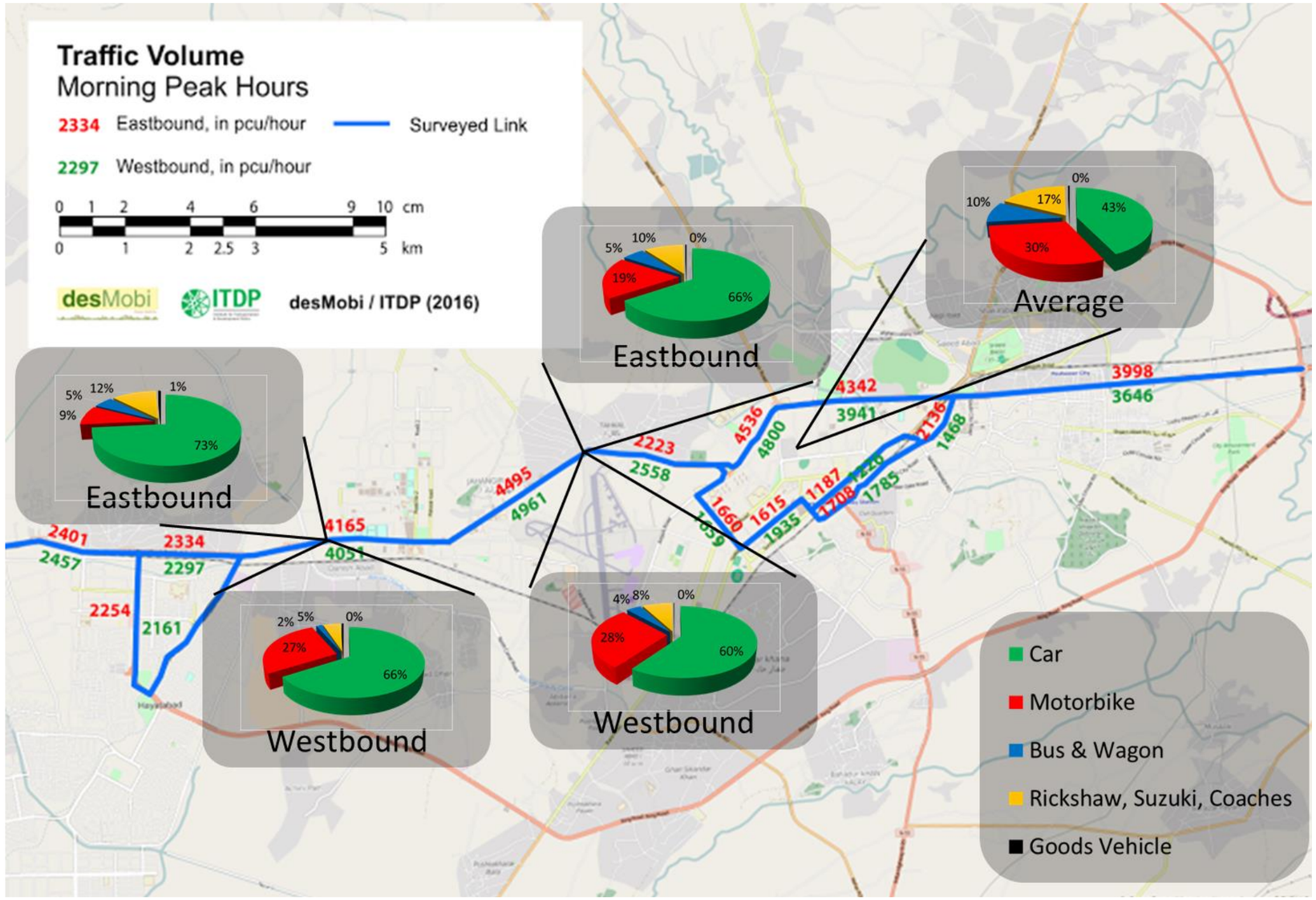
Figure 2. 19 Traffic Count Survey Locations.



Traffic volume share on GT Road is shown in Figure 2. 20 where cars dominates the volume share by 62%, and motorcycle contributes of 22% from the total modes. Public transport, including rickshaws, take up only 15% of total volume on GT Road, with 1% are for Goods vehicles. This data is not necessarily a mode share data, as it only calculates the volume, and does not calculate the passenger share made by each mode.

Figure 2. 21 Traffic on peak hour

Figure 2. 20 Traffic Volume.



2.5.2 Traffic Speed & Cause of Delays

Average peak hour speeds for cars along GT road are between 15 and 19 km/hour, and some segments on the east part have average speed higher than 20 km/hour. On the Cantonment area, cars travel at a slower speed. In the area such as Khyber Bazaar and Saddar area, with high commercial activities, average peak hour speed for car is lower than 10 km/hour, which is quite low.

Some of the delays in Khyber Bazaar and Saddar area are caused by buses and wagon stopping to pick passengers. Without clearly dedicated bus stop, they can stop anywhere, including the intersections. It is expected that after the BRT is implemented, most of these buses will be replaced by BRT buses, which will stop at designated stations with dedicated lanes. Thus such conflicts between cars and buses will be minimized, or even removed completely.

Other causes of congestion in Peshawar city center is on-street parking. Despite a strict enforcement of illegal parking being in place, on-street parking still takes up space on smaller roads, which reduces roads capacity and decreases travel speed. Good parking management is clearly needed to specify the location where cars are allowed to park, parking fare, as well as the duration that cars can park on-street. Currently, such regulation does not exist.

Figure 2. 22 Peak Hour Car Travel Speed.

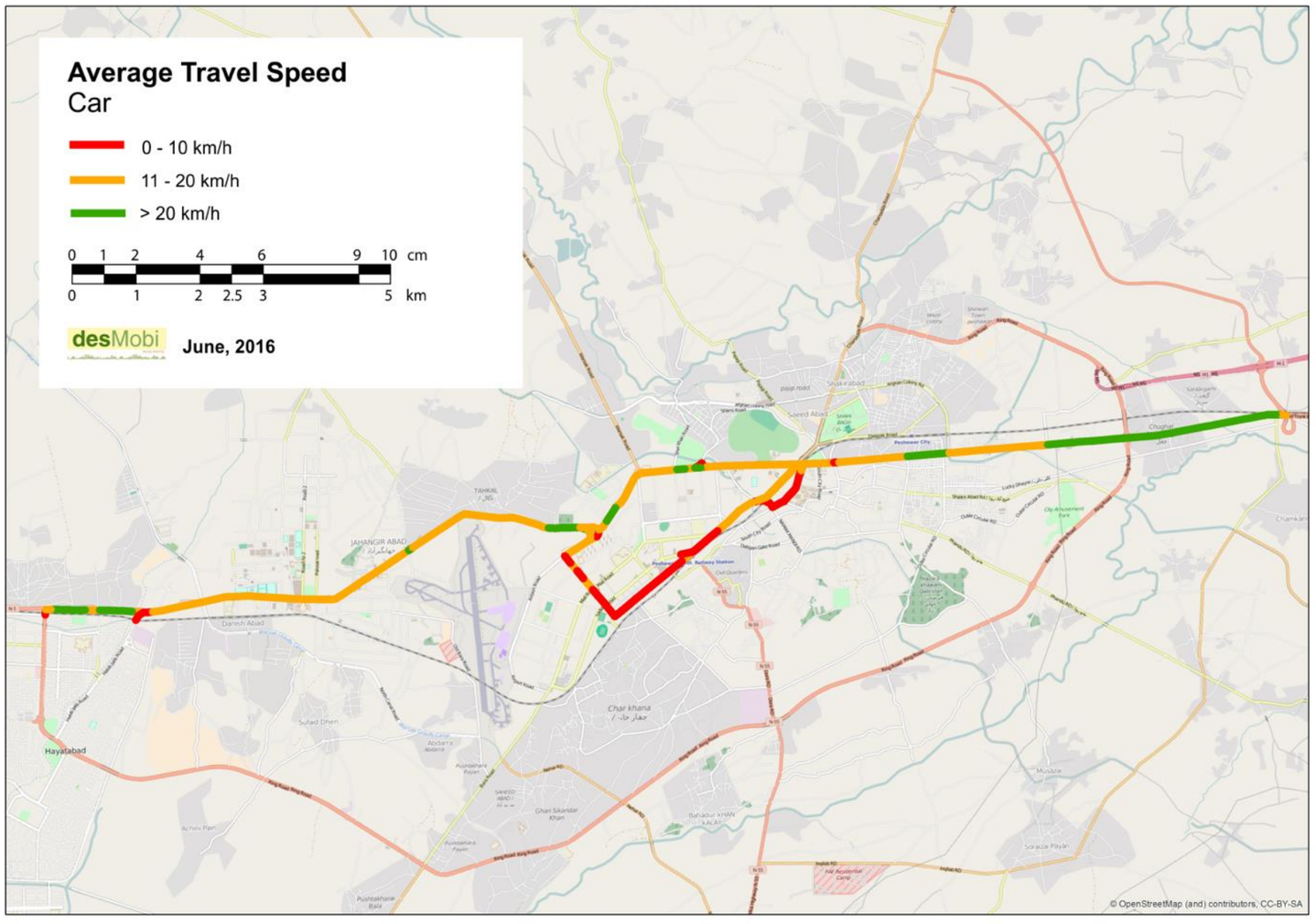


Figure 2. 23 On-street parking (left) and Illegal on-street Parking Enforcement in Peshawar (right).

3 Bus Rapid Transit in Peshawar

3.1 Need for BRT in Peshawar

There are many reasons to justify the need for BRT in Peshawar, but the main objective of implementing the BRT project is passenger time savings. BRT lanes can increase the bus travel speed and it should be built on a corridor where many public transport users travel and endure delays. In Guangzhou, the bus average speed during peak hour increased from 11 km/h to 19 km/h after BRT.

BRT can also mitigate congestion for car users, especially in areas where buses block whole roads to pick up passengers, which can occur practically anywhere in Peshawar. A BRT system generally gives priority to public transport passengers, but can also greatly improve conditions for mixed traffic by solving the congestion problem caused by stopping buses.

Compared to rail-based mass transit system, BRT offers flexibility and is easy to expand. Dedicated BRT lanes can increase bus travel speed significantly. But most importantly, with BRT, buses can operate inside and outside the BRT corridor, allowing rapid citywide coverage.

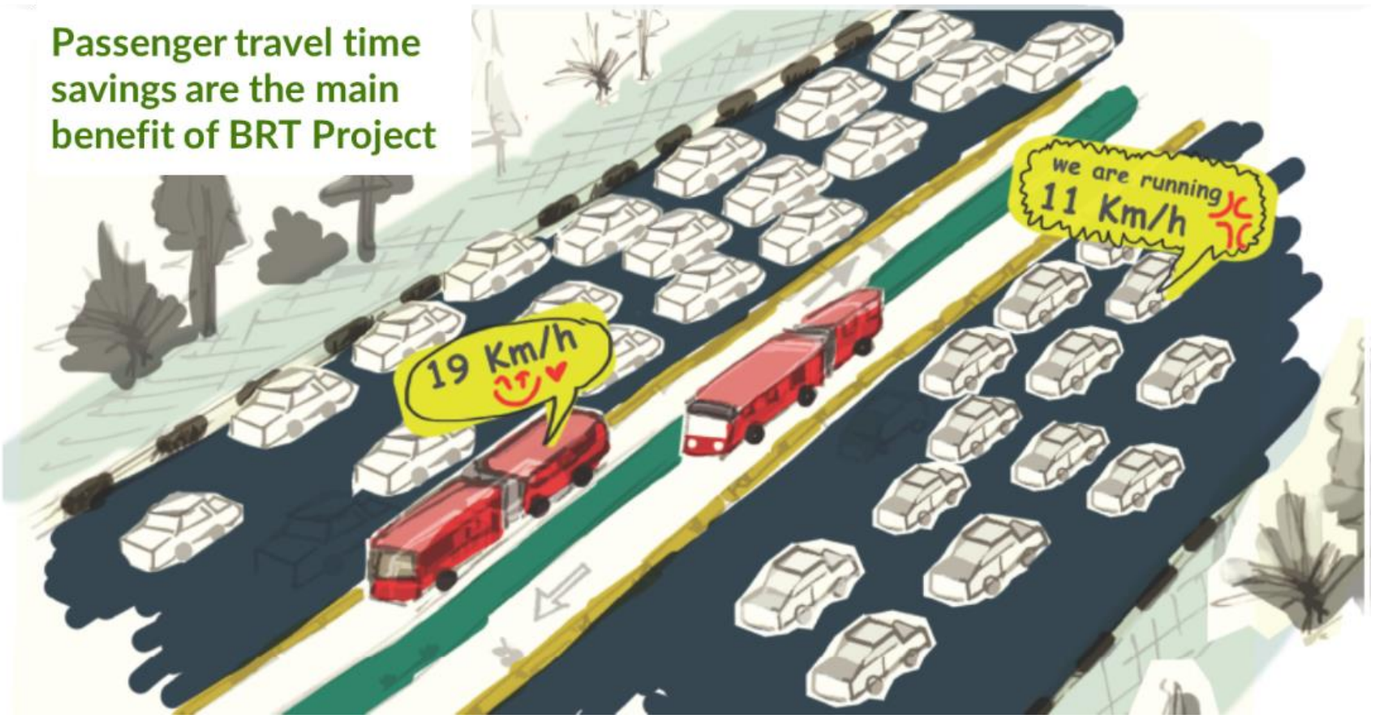
3.2 Benefit of BRT

3.2.1 Travel Time Savings

Without doubt, passengers travel time savings is the main reason why many cities implemented the BRT. By providing time savings benefit for passengers, BRT are expected to provide a more efficient way to travel. It eventually enables to attract more private vehicle users to shift to BRT, and reduce the number of vehicle kilometer travelled in the city.

Usually, the BRT would be built on the corridor where public transport passengers endure large delays due to traffic congestion. In Guangzhou for example, before the BRT was implemented, the corridor was very congested, and conflicts between buses and regular cars created delays, and left passengers in vulnerable conditions while waiting for buses to come. After the BRT was implemented, both buses and cars were able to travel faster, with significant speed increase: before the BRT, the average bus speed was only 11 km/hour, and after BRT it went up to 23 km/hour. With faster travel times, more time can be saved by passengers, which would ultimately create economic benefits in the city.

Figure 3. 1 Passenger travel time savings generated by BRT.



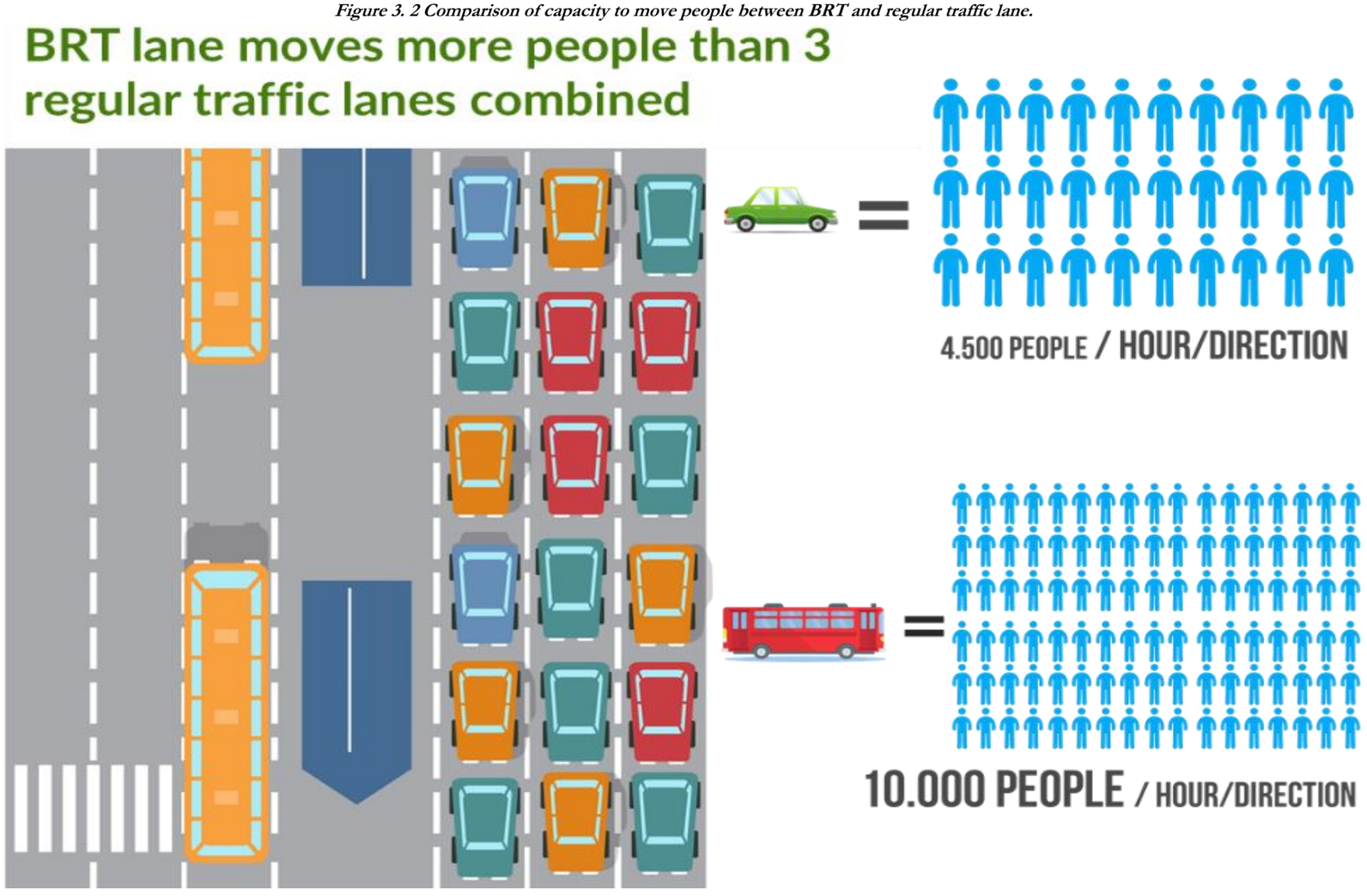
3.2.2 Use of efficient space

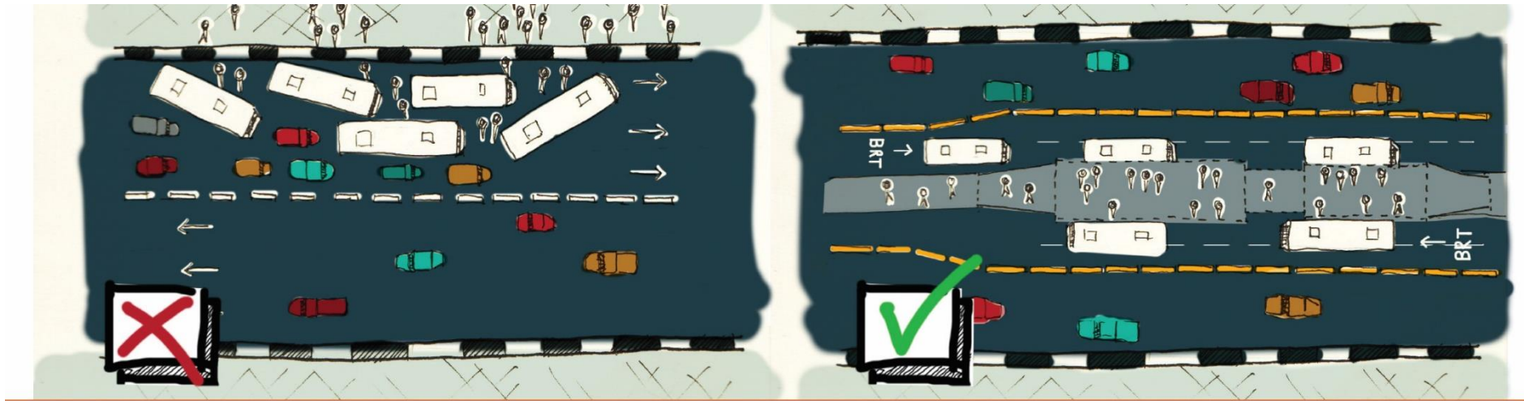
Growing metropolitan cities like Peshawar are normally faced by one major mobility issue: growth in population and economy are followed by growth in trips, but space to build more road is scarce. To overcome this issue, Peshawar should not follow other backward cities in other countries, where elevated double deck roads were constructed to increase road capacity, but in fact failed to create efficient mobility, since more roads leads to more clogging by private cars. Over time, this condition would make cities less efficient and less productive, and even lead to slow economy growth.

BRT is an effective way to use space to move people in the city. One BRT lane of 3.5 meter can move up to 10,000 passengers/hour in one direction, whereas 3 car lanes of 10-meter width total can only move 4,500 to 6,000 people/hour in one direction.

With this logic, the only way for Peshawar and other growing Pakistani cities to improve their mobility and make it more efficient is through provision of BRT system, instead of building elevated roads. There are also cases where a single BRT lane could move up to 18,500 passengers/hour/direction, such as in Istanbul. Furthermore, if there are p BRT passing lanes at stations, the capacity can significantly increase, up to 45,000 passengers/hour/direction (Bogota, Colombia).

Figure 3. 2 Comparison of capacity to move people between BRT and regular traffic lane.





3.2.3 Improved Public Transport Conditions

In most BRT systems, the BRT project was done as a complete public transport improvement program. It involves not only constructing the infrastructure, but also improving the bus service quality, changing the bus industry and promotes reform in public transport management. In Jakarta, Indonesia, the Transjakarta BRT system changed the public transport business model from an individual owner with rent basis to become professionally managed by private companies with gross cost contract with the government. Not only it improved the business of bus operators, it also created a multiplier effect in bringing more employment in the public transport industry, from bus manufacturers, bus drivers, bus maintenance companies as well as other supporting businesses, like ticket collection, bus scheduling and controlling.

In Peshawar, the BRT can be used as an opportunity to restructure the whole public transport industry, from Minibus and Bedford bus, Wagon, Suzuki up to Qingqi. With BRT implemented, the government could have more bargaining power to reform the public transport in Peshawar. BRT could also be used as an opportunity to bring a professional bus operating companies to run in Peshawar, and show the best practice model to the existing operators, and tell them to improve and upgrade themselves, before asking them to join the BRT system.

3.2.4 Environmental Impact

Almost all BRT systems implemented generated positive impact on environment, which is created from many improvements, such as:

- Cleaner and more fuel efficient fleet used in BRT
- Shifting from private vehicle users
- Reduction in private vehicle kilometer travelled.

Figure 3. 3 Before and after implement BRT system in Guangzhou, China

3.2.5 Economic Benefit

The economic benefit gained by the BRT project is mostly a result of passenger time saving benefits from both public transport passengers and private vehicle passengers, as travel speed will increase for both users. Other factors which contributes to the economic benefit from BRT project is also the vehicle operating cost decrease, for both public transport and private vehicles.

In the case of Peshawar, since there is no formal bus industry yet in the city, the BRT will open up more formal employment associated with the BRT, such as station guards, security officers, bus drivers, mechanics, and other supporting industries such as station maintenance and cleaning, ticketing and information technology.

In terms of gender equality, both man and women can have equal access to all types of formal employment in BRT industry, including women drivers, such as the case of Transjakarta, where women bus drivers are common sight in the Jakarta BRT system. In Islamabad and Lahore Metrobus, there are many women who work as ticket sales officers at station.

The economic impact of BRT will also be extended to the existing public transport system. Arguably, the existing public transport system is closely linked with the life of 40,000 people, who are the families and relatives of the existing transporters' workers (bus drivers, conductors, bus stand fee collectors). It is expected that the BRT project will also increase the quality of life of these 40,000 individuals.

3.3 BRT Design Principles

3.3.1 Why Choose BRT

Compare to any other mass transit mode, BRT is the most efficient use of public funds to create improvement in urban public transport. For example, for a BRT, a city will only need to spend maximum US$ 20 million per kilometer, whereas building a metro costs at least US$ 50 million per kilometer. Sometimes, the decision to go for BRT is also determined by the planning and construction time required to implement the mass transit system. With BRT, the planning and construction time is much shorter than those of the metro. Hence, many city leaders prefer to build BRT as it can be completed and used by passengers in one electoral term, compared to metro which probably needs 3-4 electoral period upon construction completion.

3.3.2 Design Concept for BRT

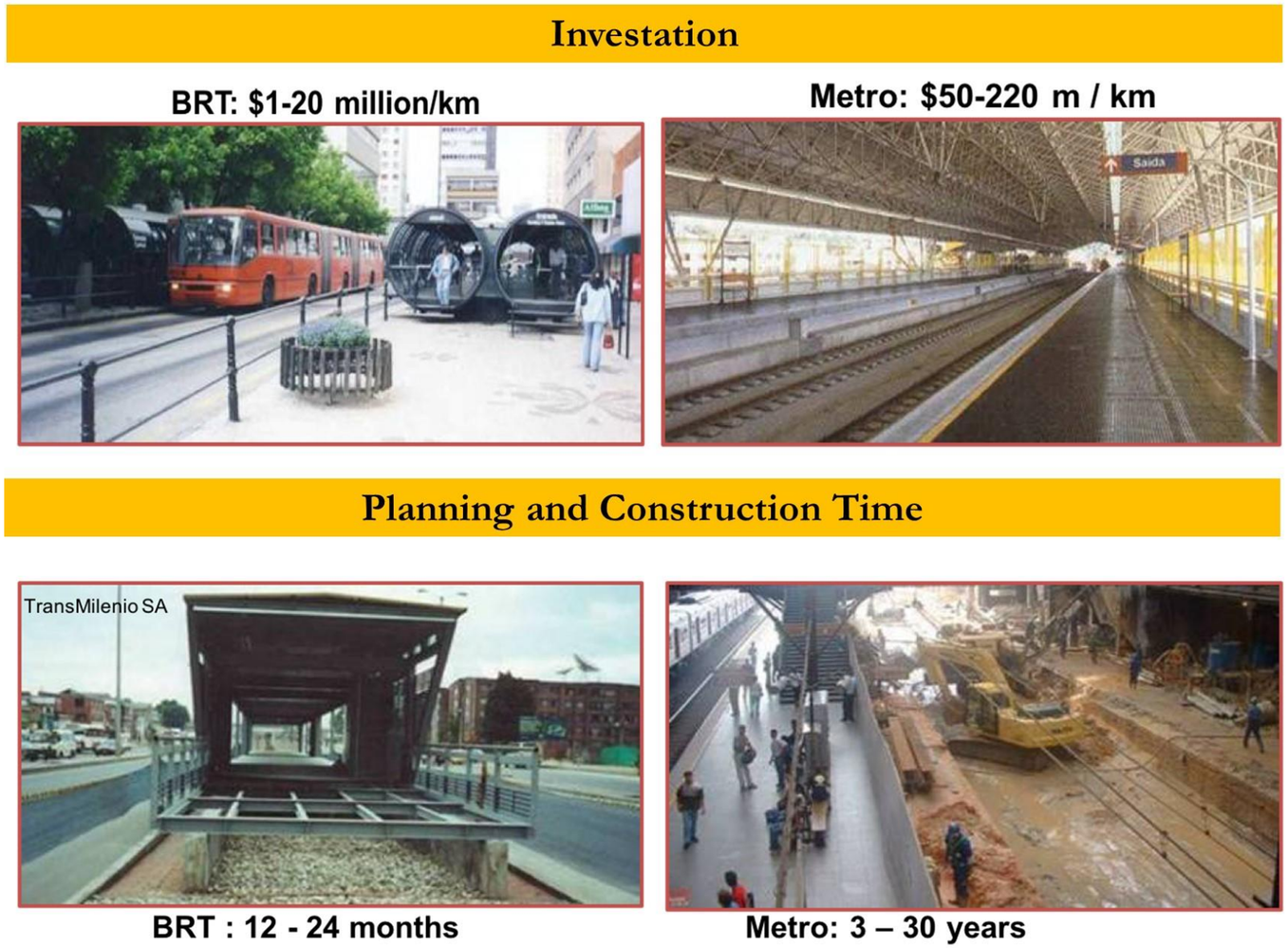
Many BRT advocates see BRT similar to metro in terms of functions. This perspective is accurate since many BRT systems have carrying capacity significantly higher than metro system. For example, Bogota's Transmilenio BRT has the capacity to carry up to 45,000 passengers per hour per direction, which is higher than the capacity of few metro systems built in Asia and the United States.

The design concept of BRT promotes three essential elements: High Capacity; High Speed and Flexibility. In high capacity context, the use high frequency bus services support this. Additionally, overtaking lane, which is provided at the station will ensure BRT buses running without obstruction and delay at stations.

The provision of exclusive and dedicated lane for BRT is crucial in ensuring the high speed characteristic of the BRT. At station, level-platform boarding and pre-board fare collection reduce the time needed for boarding and alighting process, thus allowing buses to minimize dwelling time.

The BRT is also very flexible in nature. Since buses can practically run on every major road, BRT opens up the possibility to extend the service to remote areas, such as outskirt residential areas and others. BRT can promote the wider network in much faster time compared to Metro and LRT.

Figure 3. 4 Comparison between BRT and Metro System



3.3.3 BRT Components

BRT components are illustrated in Figure 3.5 below. The essential components shown in the picture below are all proposed and designed for Peshawar BRT, according to international BRT design standards.

Figure 3. 5 BRT Design Components.

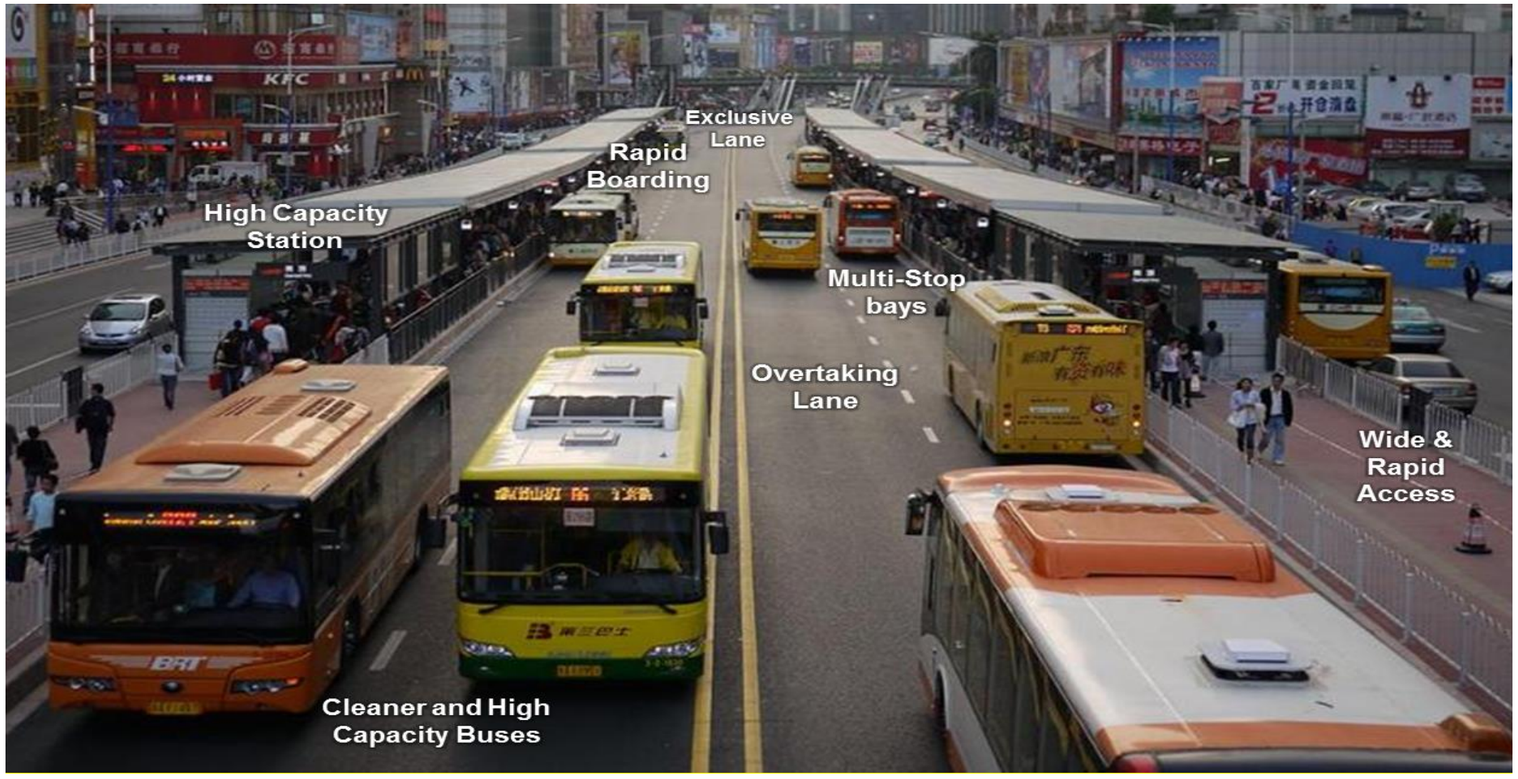


Figure 3. 6 BRT Components at a Station.

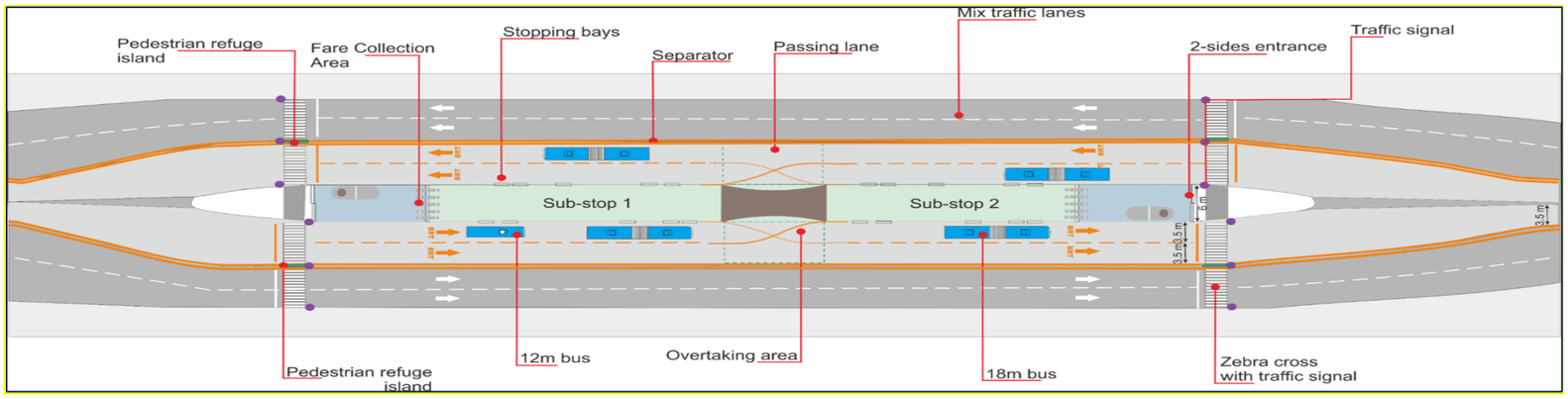


Figure 3. 8 BRT Station in Bogota with Passing Lane.

Figure 3. 7 Platform level boarding at station.

Figure 3. 10 Control Centre in Guangzhou BRT.

Figure 3. 9 Passenger Info in Gangding Station, Guangzhou, China

3.3.4 BRT Component Costs

The breakdown of major component costs for BRT is shown on Table 3. 1. The biggest cost components are roadwork and stations. Depot and control center also have a high unit cost. But in one BRT system, and to ensure high quality and efficient BRT service, it is necessary to have these components at the highest quality from the beginning.

Table 3. 1 BRT Typical component costs.

Components	Estimated cost
Civil works	US$ 3.0 – 7.0 million per km
Trunk stations	US$ 0.5 – US$ 1 million per station
Depots	US$ 15 – US$ 25 million per depot
Trunk vehicles	US$ 0.2 – 0.4 million per vehicle
ITS and fare equipment	R 0.07 – 0.15 million per station
Control center	US$ 20 – US$ 30 million
Land acquisition	Variable
Industry compensation	Variable

Source: ADB

3.4 Security Risk Assessment

3.4.1 Current Assessment

While the cause of any attack to the BRT is not the primary focus of this work, this section explains the possibilities of security threats for the BRT and the measures to mitigate them.

Security risk is one of the biggest risk when implementing the BRT in Peshawar. Over the last few years, Peshawar has seen many major attacks (shootings, bombings) which involved general building, schools, the university, and even public transport. The last incident involving public transport occurred in February 2016, where a private bus carrying government employees was blown out on Sunehri Masjid Road, close to the proposed BRT corridor. It was later found out that a bomb was planted under the bus and detonated automatically. Although it never happened in Peshawar, another case saw a bus attacked from the outside. One last notable incident occurred in Karachi in 2015, where a private bus was shot by a gunman and killed 43 passengers on-board.

Many of the attacks involving buses targeted a specific group of passengers/communities. In the case of Peshawar, the government employees were targeted, whereas for the Karachi attack, it was certain group of individuals who were the main target of the attack. There was also a case where public transport itself became the target of the attack, such as the London Underground attack, Brussel Underground attack and the Urumqi BRT attack. These types of attacks are mostly executed by terrorists aiming to create fear and chaos among the general public. Regardless of the main reasons behind the attack, the security measures that are introduced in this section will minimize the risk attack occurrence on the Peshawar BRT.

However, the experience from Metrobus in Lahore and Islamabad shows some hopes for BRT in Peshawar. Lahore Metrobus has been running for two years at the time this report was written, and fortunately until today there has not been any attack or threat in any of those BRT systems.

3.4.2 Possible Security Threat involving BRT

The following table lists the possible security threats that involve the BRT system in Peshawar: (Table 3. 2)

Table 3. 2 List of Security threat for BRT.

Possible Security Threat	Likelihood	Impact to the BRT
BRT bus shot by gunman	Low	Partial disruption of BRT system
BRT bus hijacked by gunman	Low	Partial disruption of BRT system
BRT bus blown up by a bomb	Medium	Partial disruption of the BRT system
BRT Station blown up by a bomb	Medium	Closure of impacted BRT station
Multiple BRT stations shot and blown out	Low	Partial or full closure of the BRT system

3.4.3 Security Measures applied to BRT

On-board CCTV and Station CCTV

Closed Circuit Television (CCTV) network cameras will be installed at every BRT stations in Peshawar, including several bus stops located outside the corridor. These CCTV cameras will enable real-time feed of the station condition, both to monitor station crowd level and any suspicious activities. The live feed from CCTV cameras will be directly transmitted to the control center, where officers can inform the security guards if any suspicious activity or unknown package is spotted.

In addition to stations, CCTV cameras will be installed in each of the BRT buses. It is suggested that 4 CCTV cameras are installed on-board, with 3 cameras monitoring inside conditions, and another camera placed at the front directed to the road. The reason to install the camera at the front is to record any incident involving other road users, such as motorcycles, cars or pedestrians crossing the road. In the multiple cases of incidents involving BRT and other road users, the BRT driver did not have sufficient evidence to defend themselves. In those specific cases, CCTV records would make it easier for them to defend themselves.

Security scanner inside BRT station

In Islamabad Metrobus, security scanner gate is installed before entering the BRT station to automatically scan passengers. Although this might not be too effective to completely eliminate threats, it might give a feeling of security to passengers, especially for those who never use public transport because to security issues. To avoid delays potentially caused by security checking processes, scanners need to be placed in a way that does not obstruct passengers leaving the station. Also, the number of scanners to be installed needs to be aligned with the volume of boarding passengers at different BRT stations.

Security Guard at station and on-board

Placing security personnel at stations and on-board could also be done to improve security situation in BRT station and buses. On-board security personnel could be utilized to improve passenger safety, e.g. assisting passengers entering or exiting the bus. Whereas the station security personnel's duties can also be extended 24 hours to guard the station facility from being stolen or vandalized at night.

Having these security measures in place could also replace the need to have the security check points for BRT buses. Since these checkpoints will add delay into the BRT, replacing the security check procedures for BRT with the three measures above are guaranteed to add security for passengers. However, the final decision on the security measures for BRT should be made by the Station Commander, which plays an important role on Peshawar's whole security situation.

Figure 3. 11 Security guard and Security Scanner in Islamabad Metrobus Station

Figure 3. 12 Security entrance guard in BRT Beijing Station

4 BRT Corridor and Route Selection

4.1 Corridor Alignment

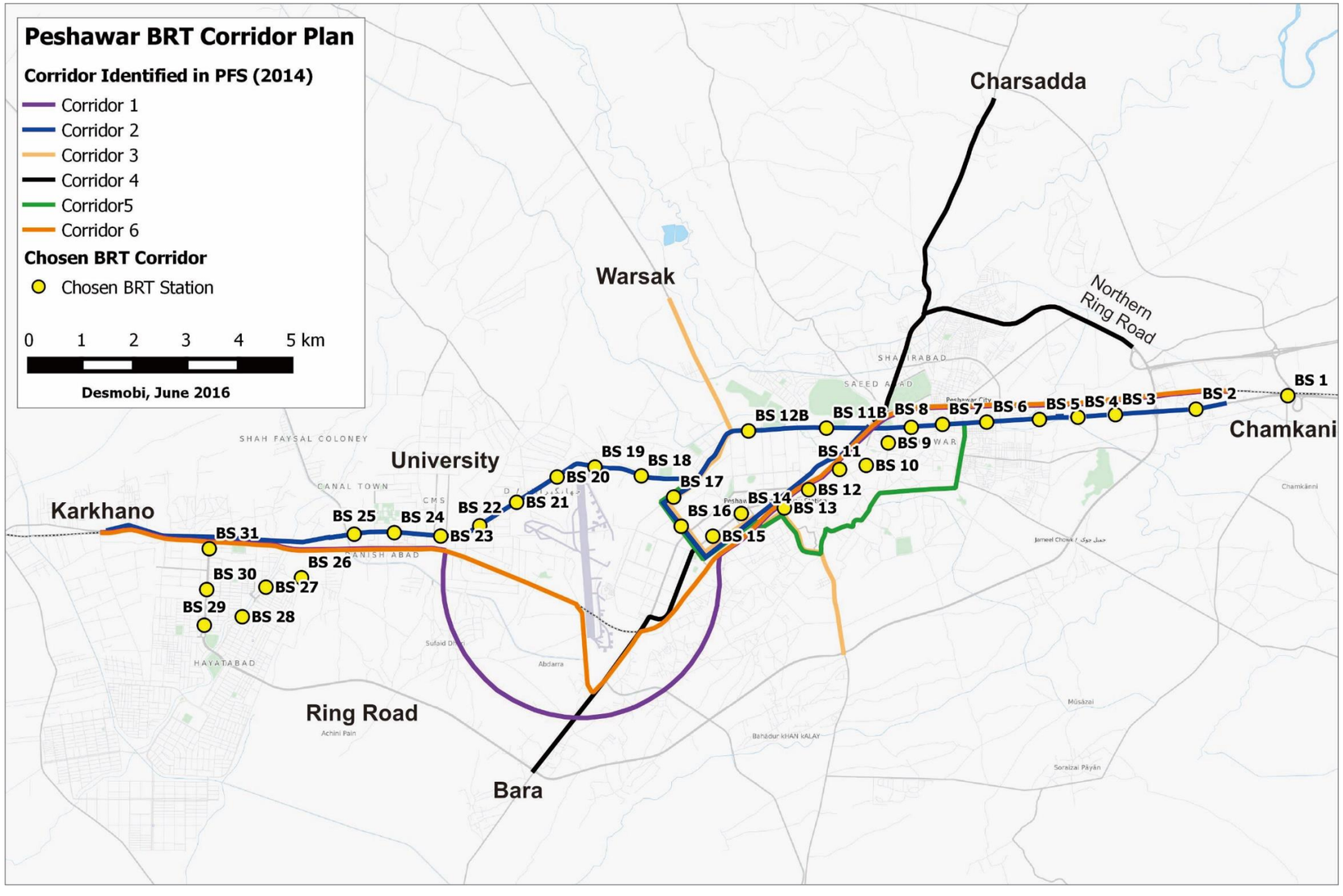
4.1.1 Corridors Identified in PFS

In 2014, CDIA Pre-Feasibility Study (PFS) identified 6 mass transit corridors in Peshawar, and recommended corridor 2, which starts from Chamkani to Karkhano as the recommended corridor to be built in the first stage as a BRT. PFS also identified 5 other corridors, but some of them are not too feasible to be built as mass transit corridor on the first stage. For example, the alignment for corridor 1 is proposed to run alongside to the railway track, and some of the sections do not have the minimum clearance required from the railway track. Other corridors identified on the PFS will also pose great difficulties on land acquisition to build the required mass transit infrastructure.

However, the corridor options identified in the PFS provides good information on the major movement in Peshawar, and shows the need to accommodate those movements in the BRT plan. Therefore, in our BRT conceptual plan, although only 1 BRT physical corridor will be built, proposed BRT routes will cover major movements identified in the PFS mass transit corridor plan. With direct-service operational concept, it is very feasible and provides great coverage of the BRT in the city of Peshawar.

In this PPTA study, the main corridor to be assessed is the Corridor 2 as identified in the CDIA 2014 PFS, with more detailed adjustments and modifications on the corridor alignment, especially at the start and end points of the corridor, as well as the alignment on the city center area and old market (saddar and Khyber Bazaar).

Figure 4. 1 Mass Transit Corridors Identified in the PFS



4.1.2 Factors in Determining the BRT Alignment

In recommending the best alignment option, the following considerations were taken into account:

- Road right-of-way (RoW) along the corridor
- Demand coverage of the corridor
- Practicality of construction
- Fastest option to build
- Impact on the area

While the elevated BRT might be seen as the easiest option to pass the Khyber bazaar, with such complexity on Khyber Bazaar area, a more careful and detailed assessment needs to be made. Before coming up with the preferred alignment option for the city area, 4 city center alignment options were examined, including:

1) At-grade via Jail Road
2) Elevated via Soekarno Road
3) Elevated via Hospital Road
4) At-grade via Hospital Road

Each of these options will be briefly discussed in the following section.

1) At-grade option via Jail Road

On this option, the BRT will go via Jail Road instead of Khyber Bazaar. On the westbound direction, the BRT will go with the mixed traffic when turning left from GT Road to Jail Road. A traffic signal to allow BRT to turn left might be needed. On the eastbound direction, to cater the right turn BRT from Jail Road to GT Road, new traffic signal or BRT-only Tunnel can be proposed.

Although this option can make the BRT travel fast, in terms of passenger demand, it might yield the least demand, compared with other options, since Khyber Bazar and the Shoba Chowk, the two high demand areas, will be missed by this alignment option

To cater the demand going to those two areas, good pedestrian connections should be built to connect the nearest BRT stations at Firdaus Cinema and Shoba Bridge to Kyhber Bazar area. These connections will add walking between 300 and 500 meters from the stations to those areas.

2) Elevated via Soekarno Road

With this option, 2-directions BRT lanes will be constructed in elevation for 2.7 km, starting from GT Road, connecting Soekarno Road, continuing to pass Soekarno Chowk and Shoba Chowk until railway road, and crossing the railway station via new BRT-only bridge to finally come back at-grade at Saddar Road. In this option, two critical junctions at Shoba Chowk and Soekarno Chowk will be avoided, ensuring high BRT speed.

1 BRT station can be built before the Khyber Bazaar Chowk and another one south of Shoba Chowk on the railway road. However, this option will still miss some part of the high demand point on cinema road and Qisa Khwani Bazaar. Although with better pedestrian conditions, it is possible to have high pedestrian volume to Qisa Khwani Bazaar.

Figure 4. 2 City Centre Alignment Option 1.

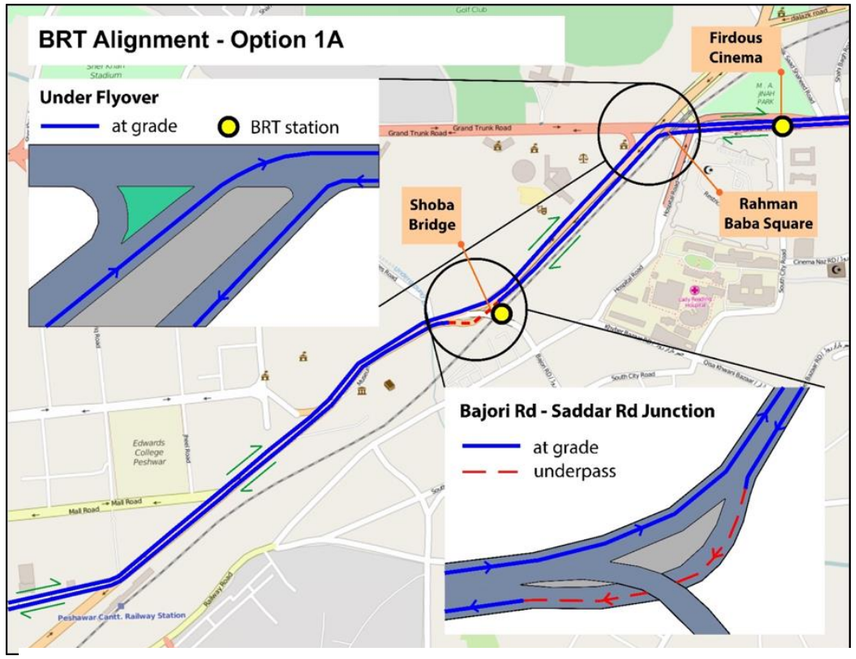
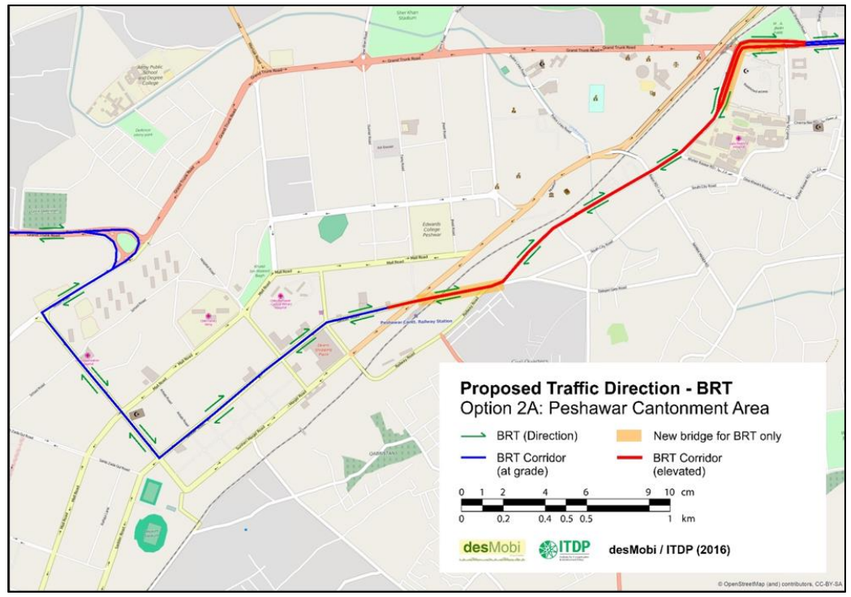


Figure 4. 3 City Centre Alignment Option 2.



3) Elevated via Hospital Road

This option poses a serious issue due to narrow wall-to-wall width on the narrow section of the Cinema Road on the south, making it almost infeasible. However, since this option also came up during the discussion with the government, a quick assessment was done.

If elevated BRT is constructed on this section, the structure will entirely block the road underneath from the sun and leave no distance between building façade and the BRT structure. Thus, out of the 4 options, this option is the least recommended one, as it will not only take longer to build compared to the other options, but it will also have negative impact on the Khyber Bazaar area.

The illustration in Figure 4.5 shows the option if elevated section is built on Hospital Road. With limited road width, this will leave no space between the BRT structure and the building façade. While this option might be preferred by some, in our opinion, this will further degrade the quality of life along the Hospital Road.

4) At-grade via Hospital Road

This option will ensure the BRT to go to the high demand point at Khyber Bazaar and Shoba Chowk, and make the BRT going at-grade through the area. Since most of the roads are not sufficiently wide to accommodate the BRT and the mixed traffic, it is proposed to close the road for regular traffic on the south part of the Hospital Road and Khyber Bazaar Road, and only allow 2-way BRT with ambulance and emergency vehicles. As for regular traffic, they will be diverted to Soekarno Road.

The BRT will go elevated from Khyber Bazaar Road approaching the Soekarno Chowk, and stay elevated on Shoba Chowk, Railway Road until crossing the Railway station, and goes back at-grade on Saddar Road. BRT-only tunnel will be constructed on GT Road-Malik Saad Road-Hospital Road intersection. On hospital road, general traffic will be allowed to go on southbound direction until Naz Cinemas Road. Beyond this point, only BRT and emergency vehicles will be allowed to go.

This option is the revised version from the option offered in the interim report. Initially, there were concerns about the difficulties of ambulance and emergency vehicle access to the Lady Reading Hospital with the BRT. This concern was mitigated by allowing the ambulance and emergency run on BRT lane shared with buses. Thus, in the event of emergency, both emergency vehicles and BRT buses would still be able to run smoothly.

Figure 4. 4 City Centre Alignment Option 3.

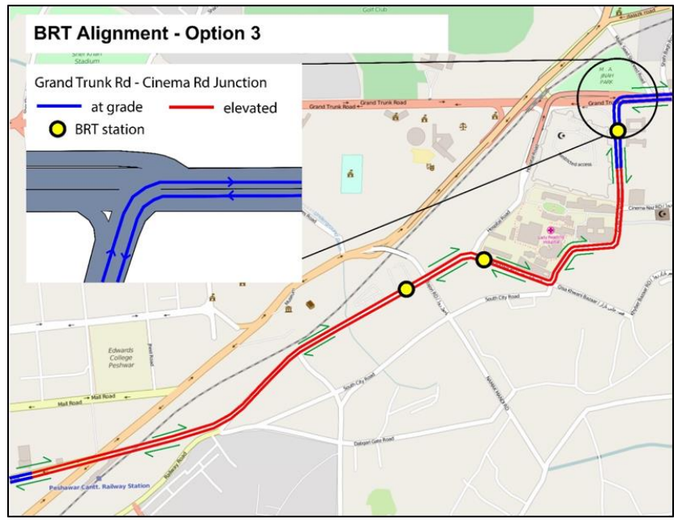


Figure 4. 5 Illustration of Option 3 on Hospital Road.

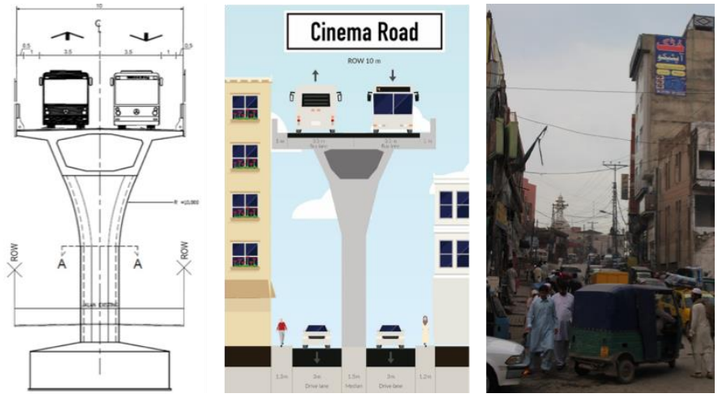
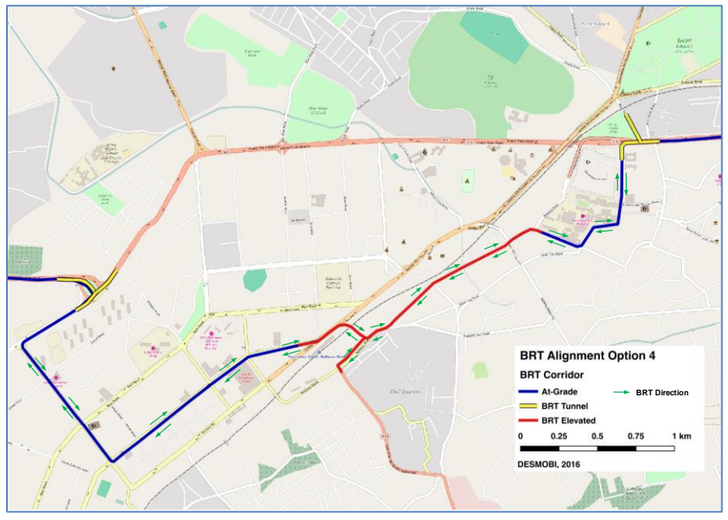


Figure 4. 6 City Centre Alignment Option 4.



Summary of assessment for the city center alignment option is shown in the following table.

Figure 4. 7 City Centre Alignment Assessment Summary Table.

Alignment Option	Features	Results
#1 : At-Grade at Jail Road	++ Faster construction time ++ Goes to non-congested road -- Skip high demand area -- Need to remove parking -- Pass through government sensitive area	This can be considered the 3rd best option after option #2 and #4, due to minimum investment required and faster construction time
#2 : Elevated at Soekarno Road and Shuba Chowk	++ Capture high demand area ++ Avoid conflict with general traffic @ Khyber Bazaar ++ Minimize impact for resettlement and acquisition -- Higher construction cost -- Might degrade the area underneath elevated section -- Pylon for elevated section are too close to Bala Hissar Fort	This option could have been feasible. However, due to concern on the pylon for elevated BRT being too close to the Bala Hissar Fort structure, the option is not selected.
#3 : Elevated at Hospital Road	++ Capture high demand area -- Highest construction cost out of all options -- Narrow section on Hospital road makes it difficult -- Might degrade the area underneath elevated section	This option can only work if elevated section is made for 1-direction BRT, which will further increase the cost. Thus should be considered as last option
#4: At-Grade at Hospital Road	++ Capture high demand area ++ Traffic re-direction also helps to ease the congestion ++ Will change the overall street realm along BRT corridor -- Pose emergency risk with one-way traffic for ambulance	Preferred option

Figure 4. 9 At-grade BRT Corridor in Yichang, China

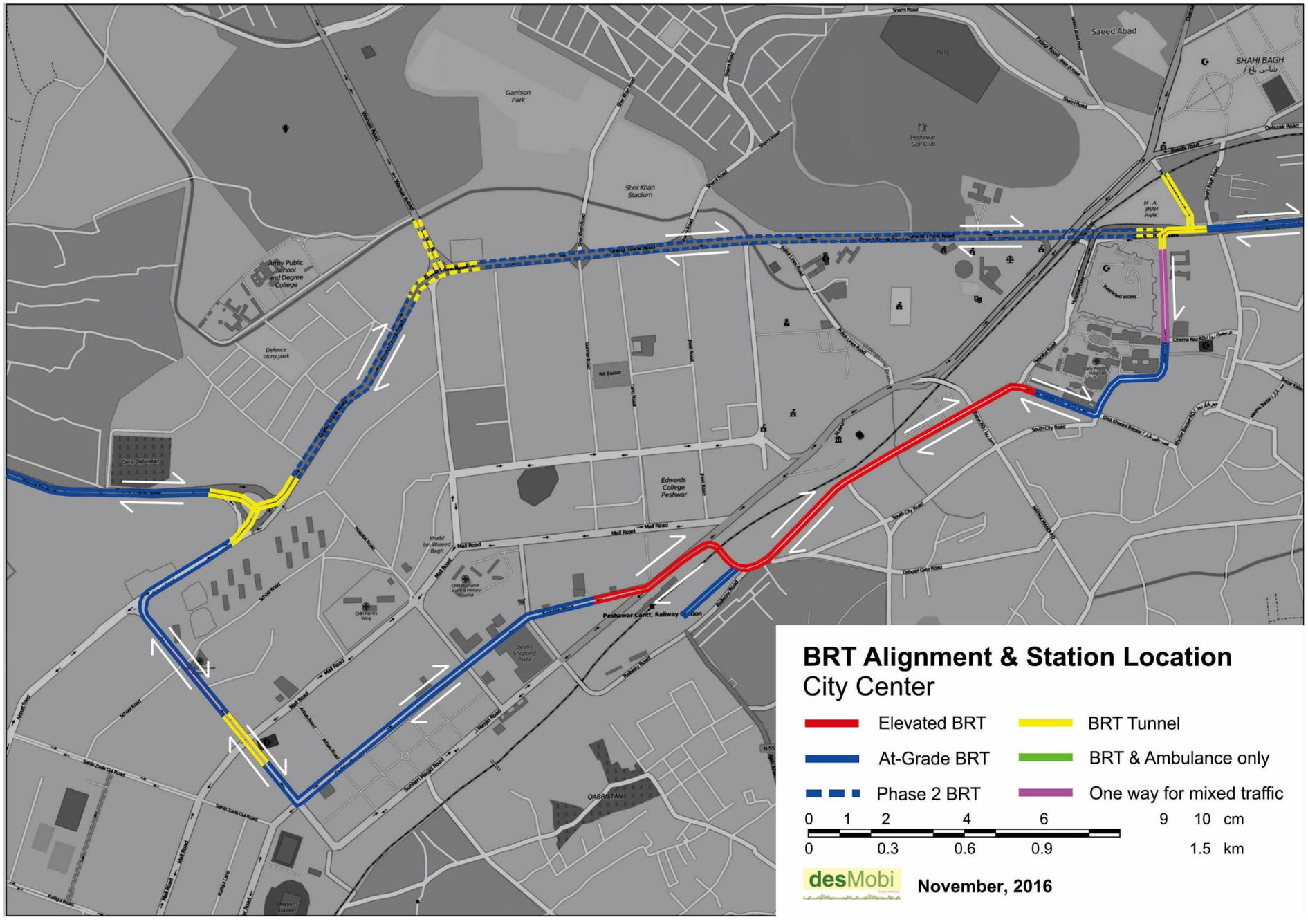
Figure 4. 8 Elevated BRT Corridor in Chengdu, China

In the initial discussion with the TMTD, the option #2 would be the preferred option, but later it is decided that due to the high construction cost and security and livability impacts, the advantages of the second option could not overweight its disadvantages. This referred us to alignment option number 4. In order to mitigate the risk concerning emergency vehicle access to the Lady Reading Hospital, we propose to dedicate a section for BRT and ambulance only access along the south part of Cinema Road and the east part of Khyber Bazaar Road.

4.1.3 Khyber Road

The Khyber Road is also considered as an important section for the BRT, since it connects to Warsak Road, and has few high demand points, such as the Secretariat complex as well as the Court. However, since this area is considered high secured area, thus the BRT can be built on the next Phase, or upon the approval from the Cantonment Board. However, it is highly recommended that this section is built at the same time with the remaining section of the corridor.

Figure 4. 10 Preferred BRT Alignment in City Centre



4.1.4 Preferred Alignment Option

The option 4 above, which goes through Hospital Road and Khyber Bazaar Road at-grade will be referred to as the preferred option in this report. For the rest of the study, all the design and analysis are developed for this option.

The BRT full alignment option starts from Chamkani, near the Chamkani train station. It goes along the GT Road at-grade until the junction with Ashraf Road where it will go into a tunnel connecting both approaches of GT Road, Malik Saad Shaheed Road, and Cinema Road. After the tunnel, the main BRT route follows Cinema Road at-grade where it goes elevated to bypass the junction with Hospital Road. It stays elevated on Khyber Bazaar Road and Railway Road, and pass the Soekarno and Suba Chowk, the two most congested intersections in the Khyber Bazaar area. After the railway road, the elevated BRT section turns right at Anwar Saeed medical center to cross the railway station, where a BRT-only bridge will be constructed. After crossing the railway station, the BRT goes at-grade again and join Saddar road just after Peshawar Press Club.

On the preferred alignment, the BRT stays at-grade on Saddar Road, turns right to Khadim Hussein Road and Sir Sayed Road to go to Amman Chowk, where the BRT goes on BRT-only tunnel to cross Amman Chowk. The corridor continues through GT Road and Jamrud Road where it goes into an elevated BRT only corridor above a dried up river bank before the Bab-e-Peshawar Marco Polo Bridge until it joins the Habib Jalib Road towards Tatara Park and joins the Ring Road. In this alignment option, total length of BRT is 30.8 km, in which 25.8 km will be built in Phase 1, and 5 km in Phase 2. Out of the 30 km, there are some segments that will be built elevated, which is 4.1 km long, and tunnel with 3.5 km long. This will leave the at-grade BRT segment at 23.3 km long for both phase. In this option, 31 BRT stations will be constructed, with an average distance of 922 meters between stations.

Figure 4. 11 Full BRT Corridor Preferred Alignment option from Chamkani to Hayatabad.

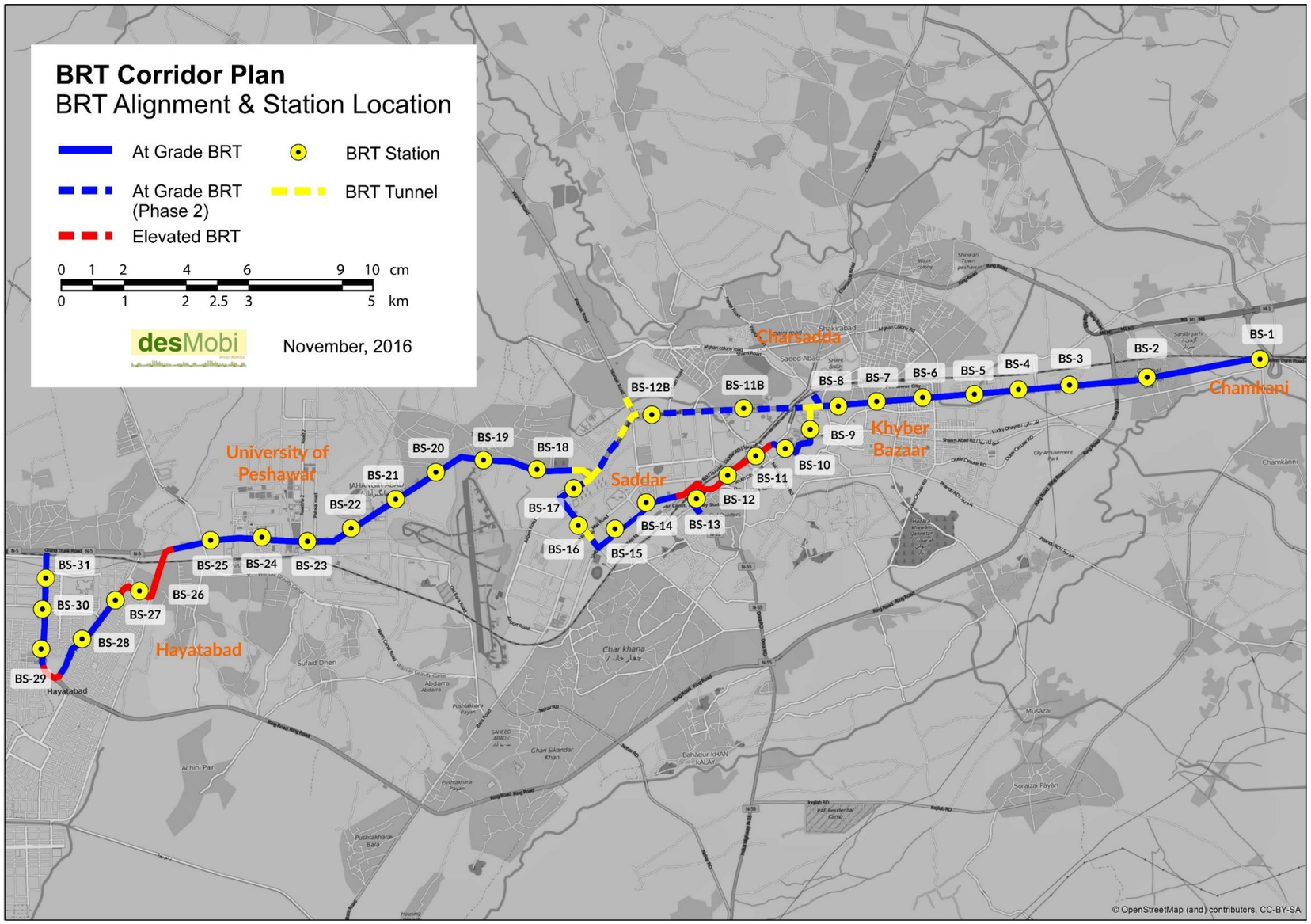
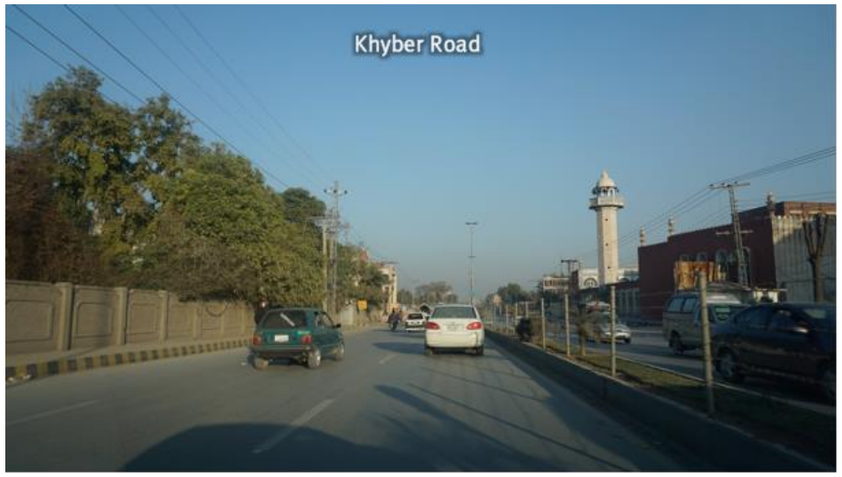


Figure 4. 12 Road Conditions along the BRT Corridor.


Railway Road


Khyber Road


Saddar Road
Gehna
Sona Centre


GT Road (University side)


Sunehri Masjid Road


Hayatabad

4.2 BRT Routes

4.2.1 'Direct-Service' Operational Model

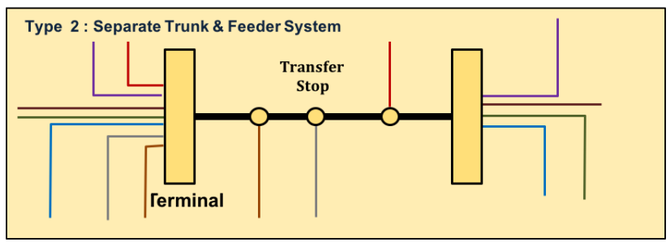
For Peshawar BRT, a 'Direct-service' operational model is proposed, where BRT buses can run along the BRT corridor and beyond the corridor. This will enable passengers to access the BRT from outside the corridor, without the need to transfer to other buses once they are in the BRT system. Many BRT systems using a separate trunk and feeder system require passengers to transfer from feeder service to BRT trunk service. Although this transfer might be free, the time and the walking distance required to change buses and wait for the connecting service might discourage people to use the BRT.

In short, the benefits of having direct-service BRT are as follow:

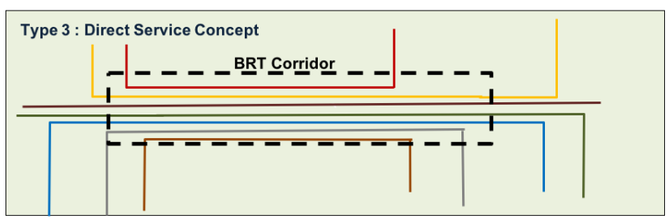
- Minimize transfer between trunk and feeder
- Reduce passenger whole end-to-end journey time
- Avoid the need to have big transfer terminal at the end of corridor
- Ability to increase coverage of the BRT service, without the need to build the physical infrastructure widely
- Flexibility in operation.

Figure 4. 13 BRT Operational Model Comparison.

- **Trunk-only system** is the first generation of BRT
- Many have failed due to highly inflexible system, unable to grow and expand
- Should be avoided for future BRT system introduced

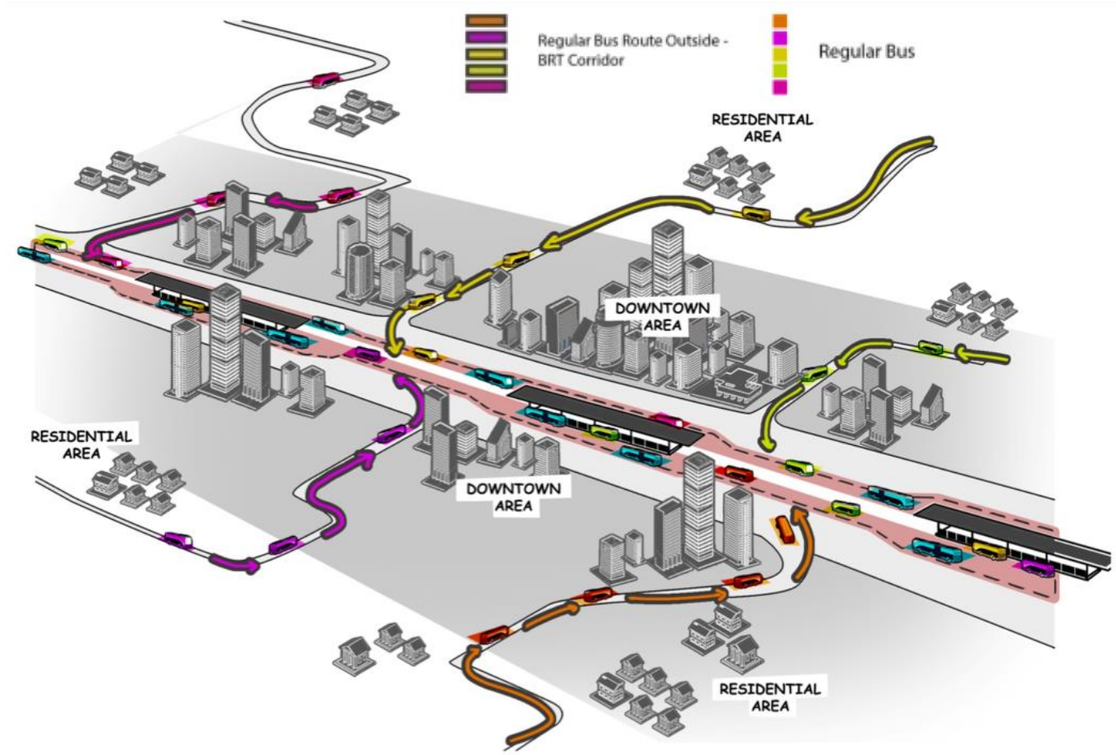


- **Trunk & Feeder system** requires passengers to transfer
- Transfers have a large cost, even at well-design transfer location
- Access to terminals requires additional time for vehicle and passenger circulation



- **Direct service system** minimizes passenger transfers
- Frequency on the BRT lane increases, as many more routes are included in the BRT
- Route service for the BRT service will also be greatly expanded throughout the city

Figure 4. 14 Illustration of BRT 'Direct-Service' Operation.



With 'Direct-Service' operation, buses can travel both on and off the BRT corridor.

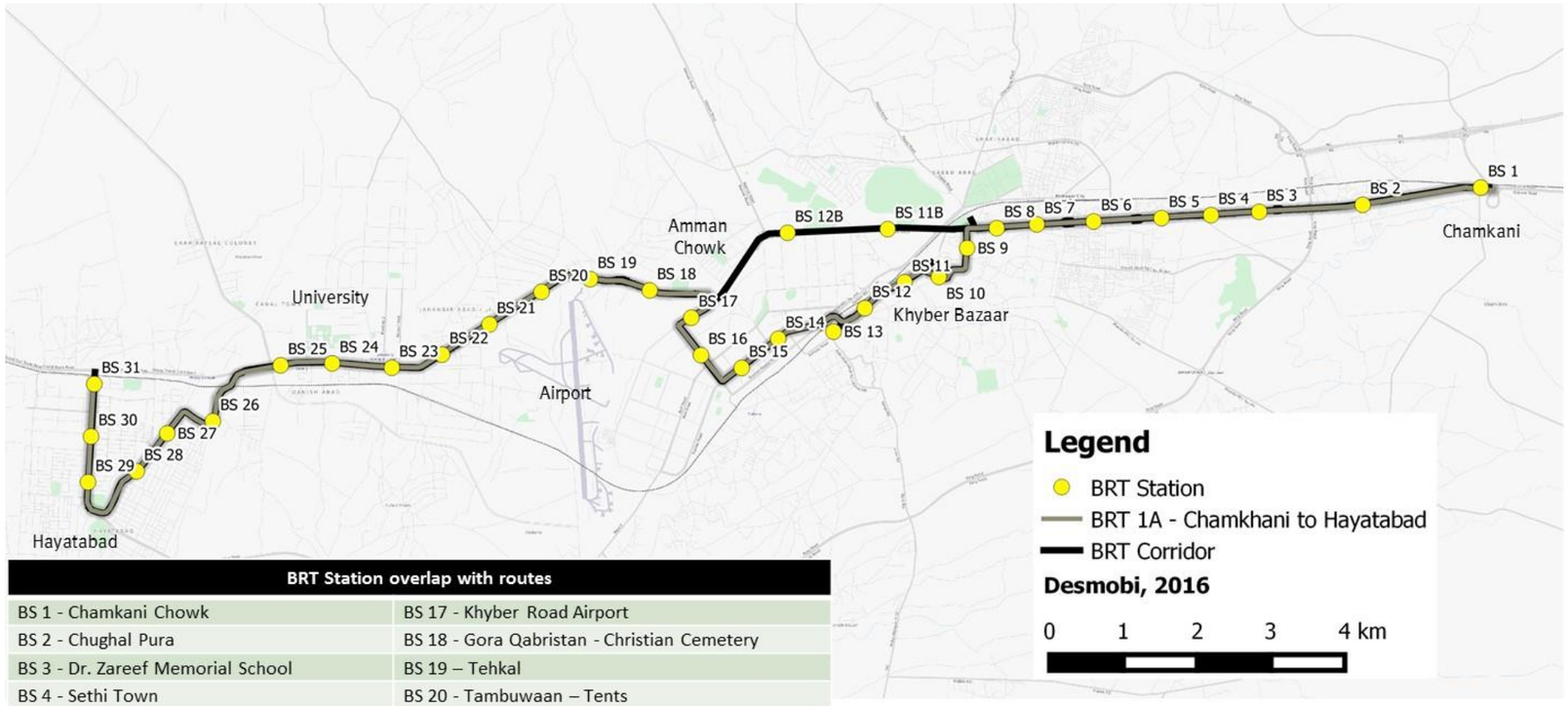
This eliminates many transfers, minimizes waiting time for passengers, and means that transfer terminals and interchange stations are not needed.

4.2.2 Routes Selection

To select the routes for the BRT with 'Direct-Service' model, we consider the existing routes, and suggest modifications on some portions of the routes. The logic behind this is that the existing routes have already proven to carry passengers, and that those existing passengers need to be accommodated once the BRT is implemented. To choose the routes for BRT, the Minibus routes, Station Wagon and Suzuki routes that have some percentage of overlap with the BRT are all taken into consideration.

8 routes are selected as BRT routes, with 1 route (1A) runs only at trunk corridor from Chamkani to Hayatabad, and remaining 7 routes run as direct service operation. In total, these 8 routes cover 80 kilometer road, with 29 Kilometer on BRT, and 51 kilometer off-corridor on regular road. BRT routes operating on direct-service model will join and leave the corridor from the middle of the BRT corridor. For example, route 1F will start from Kohat and running outside the corridor on Kohat Road, and on the Railway Road, the route will join the BRT corridor and continues until Karkhano.

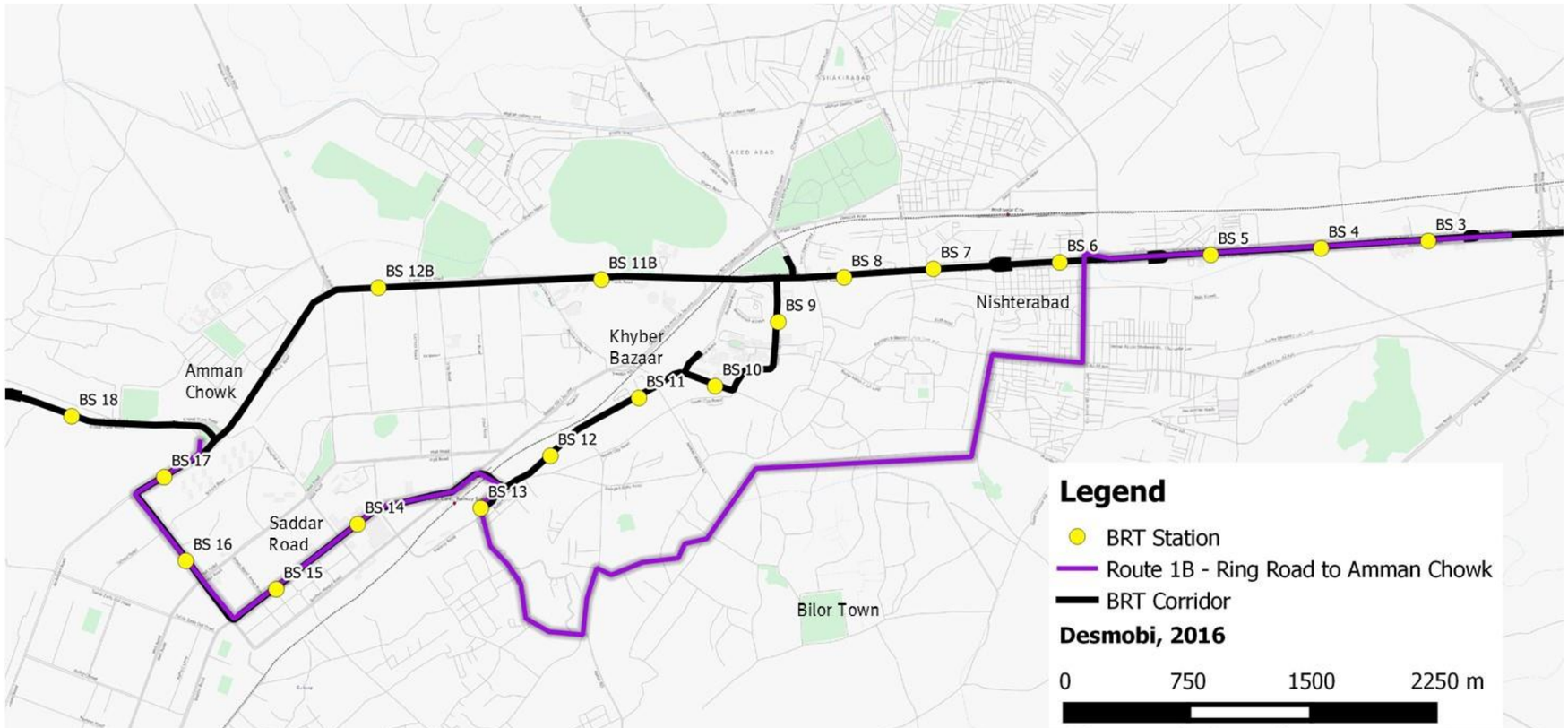
Figure 4. 15 BRT Route 1A.



BRT Station overlap with routes	
BS 1 - Chamkani Chowk	BS 17 - Khyber Road Airport
BS 2 - Chughal Pura	BS 18 - Gora Qabristan - Christian Cemetery
BS 3 - Dr. Zareef Memorial School	BS 19 – Tehkal
BS 4 - Sethi Town	BS 20 - Tambuwaan – Tents
BS 5 - Sikandar Town	BS 21 - Abdara Road
BS 6 - Gulbahar Square	BS 22 - University Town
BS 7 – Hashnagri	BS 23 - KTH University of Peshawar
BS 8 - Qila Balahisar	BS 24 - Islamia College
BS 9 - Hospital Road	BS 25 - Board Bazar Regi
BS 10 - Khyber Bazaar	BS 26 - Taj Abad
BS 11 - Soekarno Square Secretariat	BS 27 - Hayatabad Model School
BS 12 - Dabgari Gardens	BS 28 - Hayatabad Phase 3
BS 13 - Railway Station	BS 29 - Tatara Park
BS 14 - State Bank of Pakistan	BS 30 - PDA Hayatabad
BS 15 - Saddar Bazar	BS 31 - Cancer Hospital
BS 16 - Mall Road	

Route Name	1A (Silver Line)
Route Alignment	Chamkani to Hayatabad
Route Length	25.8 km
Route inside BRT Corridor	25.8 km
Number of BRT Station Overlap with Routes	31 station

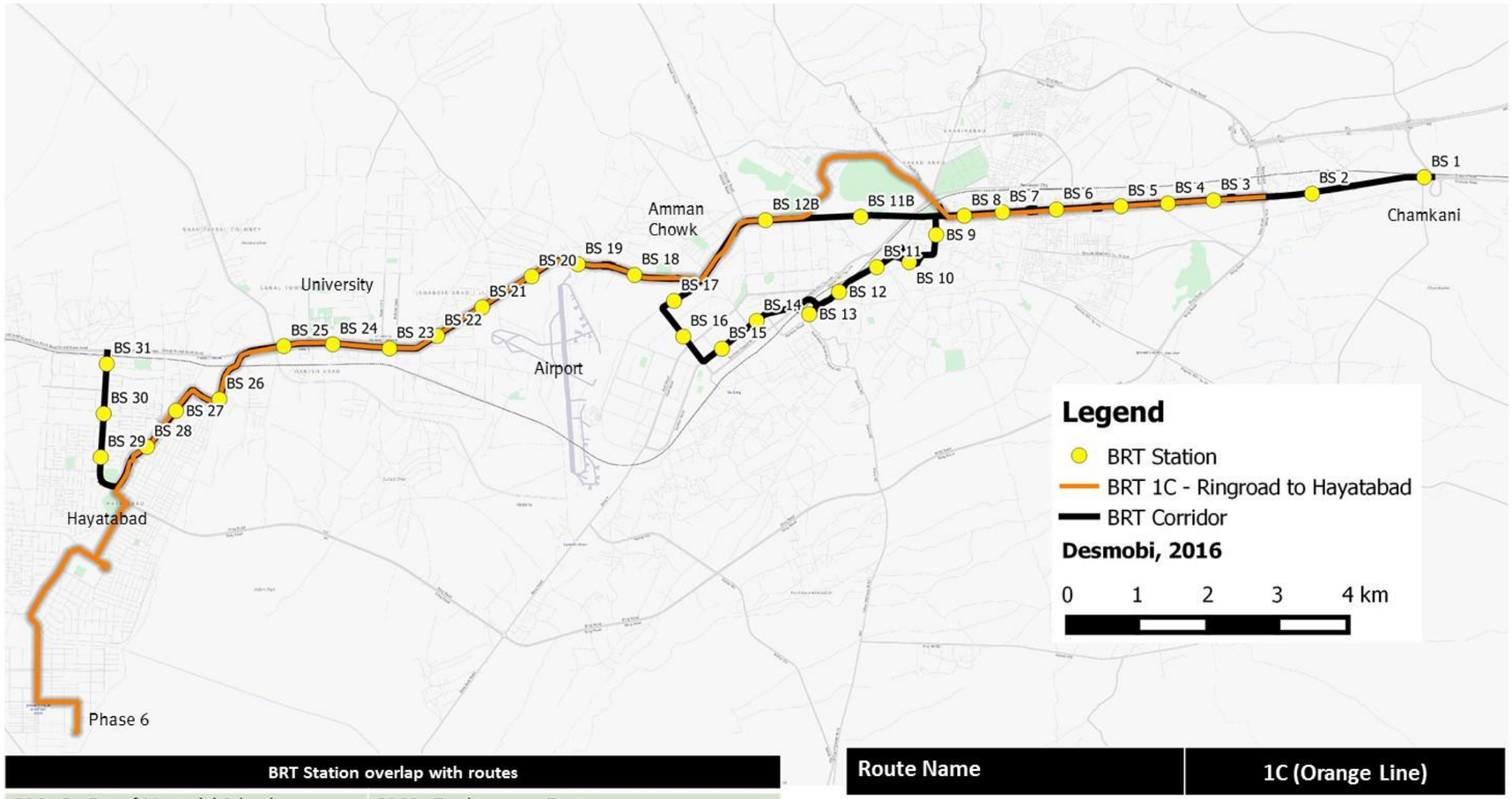
Figure 4. 16 BRT Route 1B.



BRT Station overlap with routes
BS 3 - Dr. Zareef Memorial School
BS 4 - Sethi Town
BS 5 - Sikandar Town
BS 13 - Railway Station
BS 14 - State Bank of Pakistan
BS 15 - Saddar Bazar
BS 16 - Mall Road
BS 17 - Khyber Road Airport

Route Name	1B (Purple Line)
Route Alignment	Ring Road to Amman Chowk
Route Length	12.9 km
Route inside BRT Corridor	6.2 km
Number of BRT Station Overlap with Routes	8 station

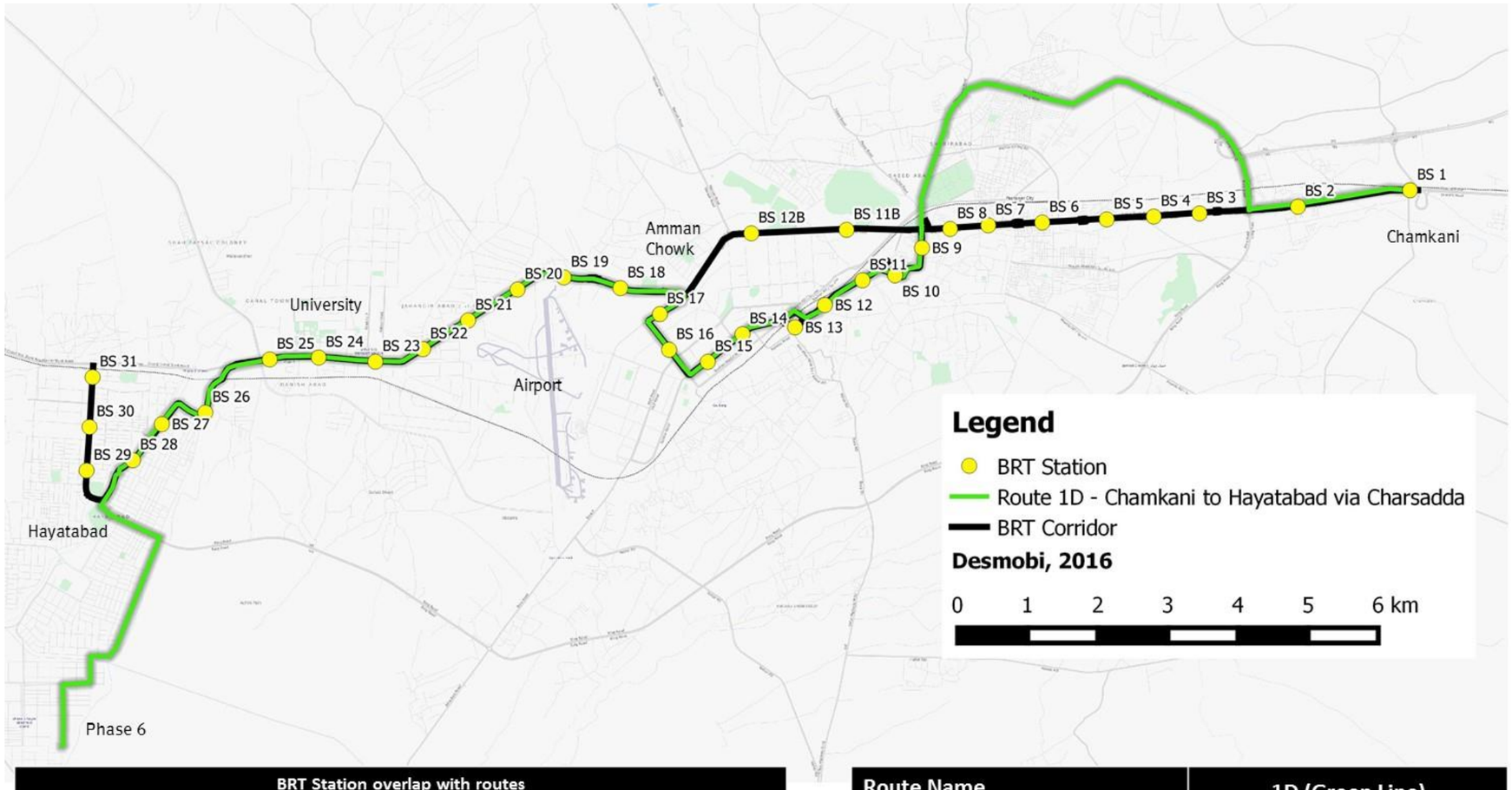
Figure 4. 17 BRT Route 1C.



BRT Station overlap with routes	
BS 3 - Dr. Zareef Memorial School	BS 20 - Tambuwaan – Tents
BS 4 - Sethi Town	BS 21 - Abdara Road
BS 5 - Sikandar Town	BS 22 - University Town
BS 6 - Gulbahar Square	BS 23 - KTH University of Peshawar
BS 7 – Hashnagri	BS 24 - Islamia College
BS 12B – St. Marry High School	BS 25 - Board Bazar Regi
BS 17 - Khyber Road Airport	BS 26 - Taj Abad
BS 18 - Gora Qabristan - Christian Cemetery	BS 27 - Hayatabad Model School
BS 19 – Tehkal	BS 28 - Hayatabad Phase 3

Route Name	1C (Orange Line)
Route Alignment	Ring Road to Hayatabad Phase 6 via Shami Road
Route Length	25.8 km
Route inside BRT Corridor	15 km
Number of BRT Station Overlap with Routes	18 station

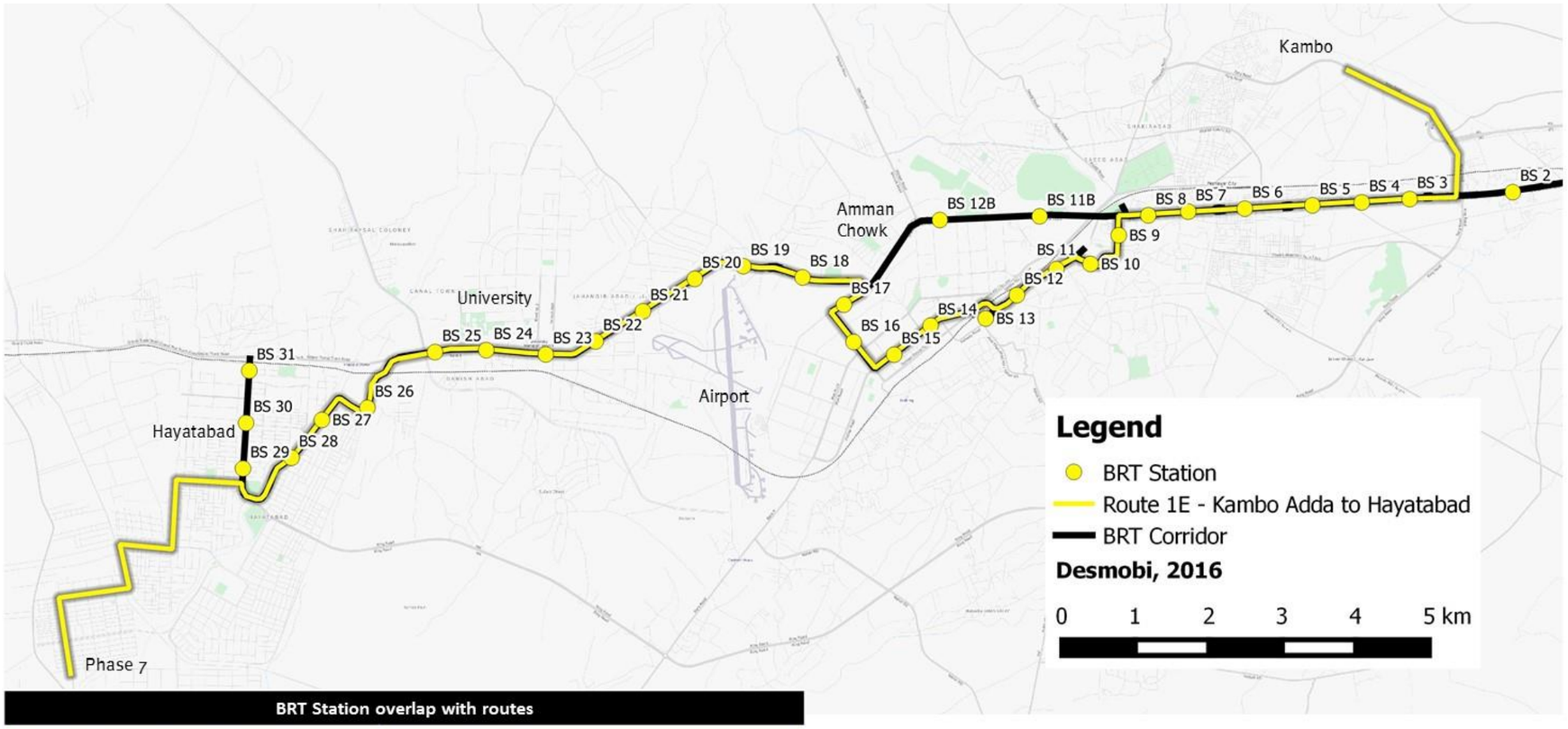
Figure 4. 18 BRT Route 1D.



BRT Station overlap with routes	
BS 1 - Chamkani Chowk	BS 17 - Khyber Road Airport
BS 2 - Chughal Pura	BS 18 - Gora Qabristan - Christian Cemetery
BS 9 - Hospital Road	BS 19 – Tehkal
BS 10 - Khyber Bazaar	BS 20 - Tambuwaan – Tents
BS 11 - Soekarno Square Secretariat	BS 21 - Abdara Road
BS 12 - Dabgari Gardens	BS 22 - University Town
BS 13 - Railway Station	BS 23 - KTH University of Peshawar
BS 14 - State Bank of Pakistan	BS 24 - Islamia College
BS 15 - Saddar Bazar	BS 25 - Board Bazar Regi
BS 16 - Mall Road	BS 26 - Taj Abad
	BS 27 - Hayatabad Model School

Route Name	1D (Green Line)
Route Alignment	Chamkani to Hayatabad Phase 6
Route Length	29.3 km
Route inside BRT Corridor	15.9 km
Number of BRT Station Overlap with Routes	21 station

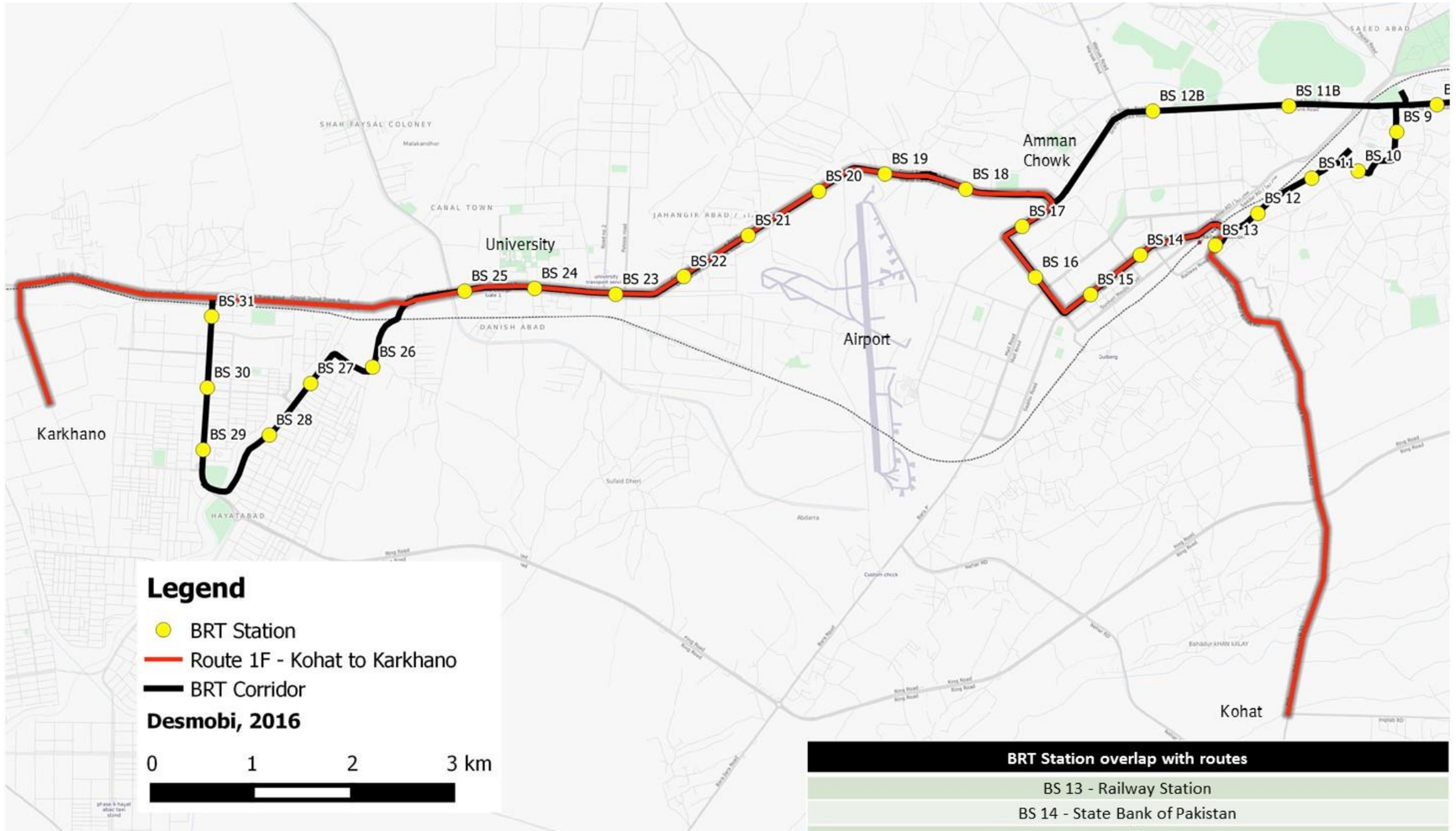
Figure 4. 19 BRT Route 1E.



BRT Station overlap with routes	
BS 3 - Dr. Zareef Memorial School	BS 16 - Mall Road
BS 4 - Sethi Town	BS 17 - Khyber Road Airport
BS 5 - Sikandar Town	BS 18 - Gora Qabristan - Christian Cemetery
BS 6 - Gulbahar Square	BS 19 – Tehkal
BS 7 – Hashnagri	BS 20 - Tambuwaan – Tents
BS 8 - Qila Balahisar	BS 21 - Abdara Road
BS 9 - Hospital Road	BS 22 - University Town
BS 10 - Khyber Bazaar	BS 23 - KTH University of Peshawar
BS 11 - Soekarno Square Secretariat	BS 24 - Islamia College
BS 12 - Dabgari Gardens	BS 25 - Board Bazar Regi
BS 13 - Railway Station	BS 26 - Taj Abad
BS 14 - State Bank of Pakistan	BS 27 - Hayatabad Model School
BS 15 - Saddar Bazar	BS 28 - Hayatabad Phase 3

Route Name	1E (Yellow Line)
Route Alignment	Kambo Adda to Hayatabad Phase 7
Route Length	28.4 km
Route inside BRT Corridor	20.4 km
Number of BRT Station Overlap with Routes	26 station

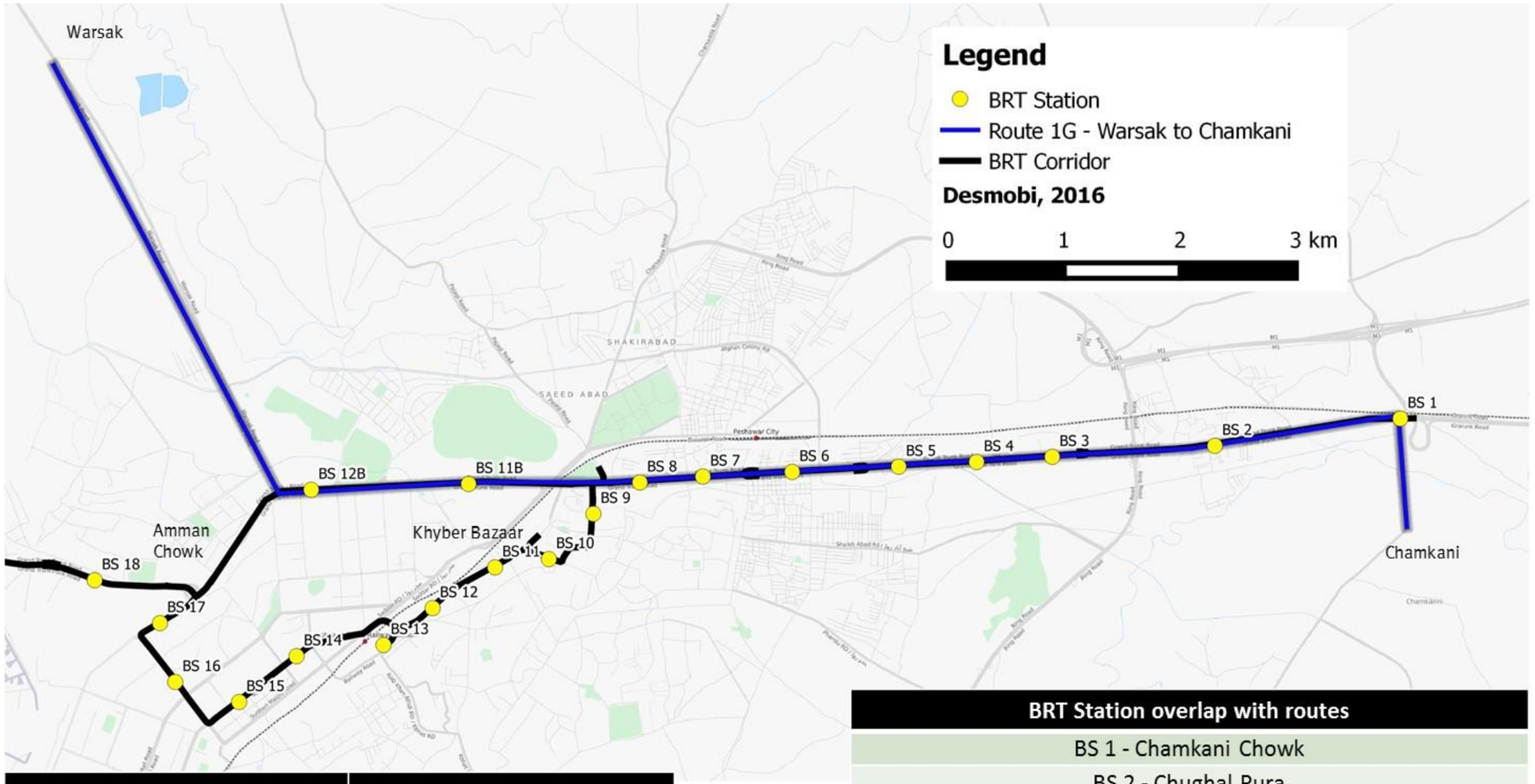
Figure 4. 20 BRT Route 1F.



Route Name	1F (Red Line)
Route Alignment	Kohat to Karkhano
Route Length	20.5 km
Route inside BRT Corridor	10.2 km
Number of BRT Station Overlap with Routes	13 station

BRT Station overlap with routes
BS 13 - Railway Station
BS 14 - State Bank of Pakistan
BS 15 - Saddar Bazar
BS 16 - Mall Road
BS 17 - Khyber Road Airport
BS 18 - Gora Qabristan - Christian Cemetery
BS 19 – Tehkal
BS 20 - Tambuwaan – Tents
BS 21 - Abdara Road
BS 22 - University Town
BS 23 - KTH University of Peshawar
BS 24 - Islamia College
BS 25 - Board Bazar Regi

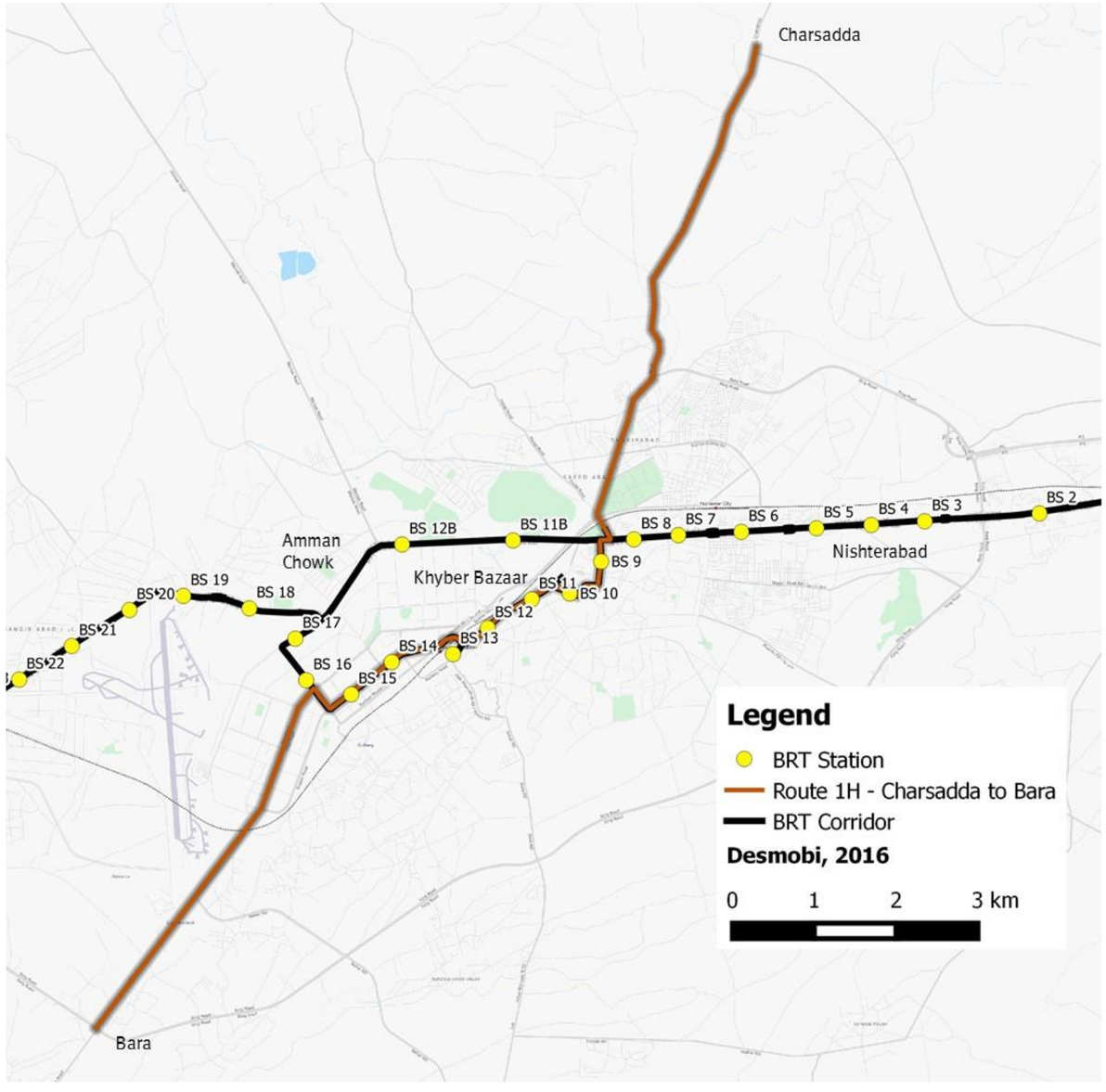
Figure 4. 21 BRT Route 1G.



Route Name	1G (Blue Line)
Route Alignment	Warsak ro Chamkani
Route Length	14.8 km
Route inside BRT Corridor	7.3 km
Number of BRT Station Overlap with Routes	10 station

BRT Station overlap with routes
BS 1 - Chamkani Chowk
BS 2 - Chughal Pura
BS 3 - Dr. Zareef Memorial School
BS 4 - Sethi Town
BS 5 - Sikandar Town
BS 6 - Gulbahar Square
BS 7 – Hashnagri
BS 8 - Qila Balahisar
BS 11B - Secretariat
BS 12B - St. Marry High School

Figure 4. 22 BRT Route 1H.



Route Name	1H (Brown Line)
Route Alignment	Bara to Charsadda
Route Length	15.8 km
Route inside BRT Corridor	4.5 km
Number of BRT Station Overlap with Routes	6 station

BRT Station overlap with routes
BS 9 - Hospital Road
BS 10 - Khyber Bazaar
BS 11 - Soekarno Square Secretariat
BS 12 - Dabgari Gardens
BS 13 - Railway Station
BS 14 - State Bank of Pakistan
BS 15 - Saddar Bazar

Figure 4. 23 All BRT Routes Map

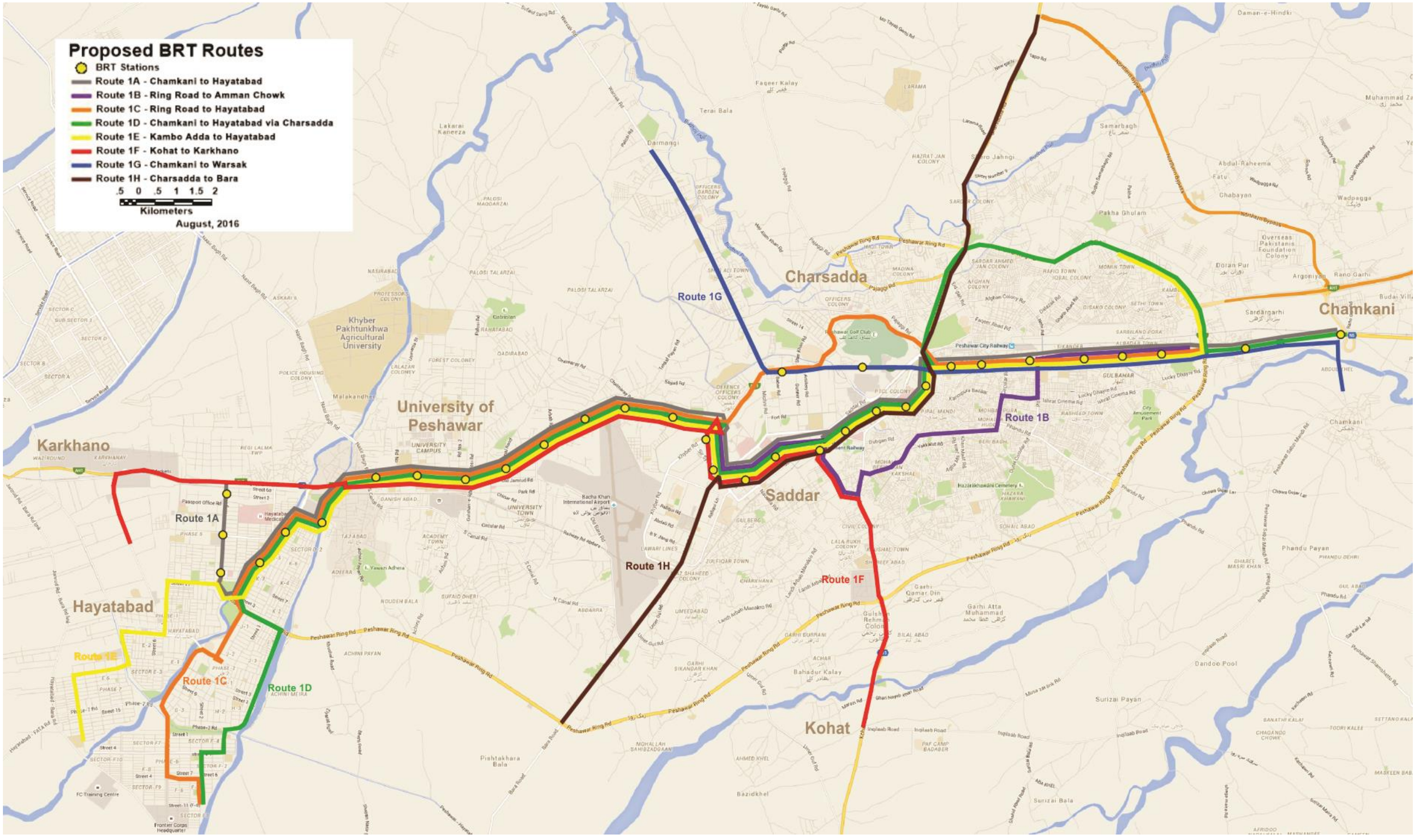
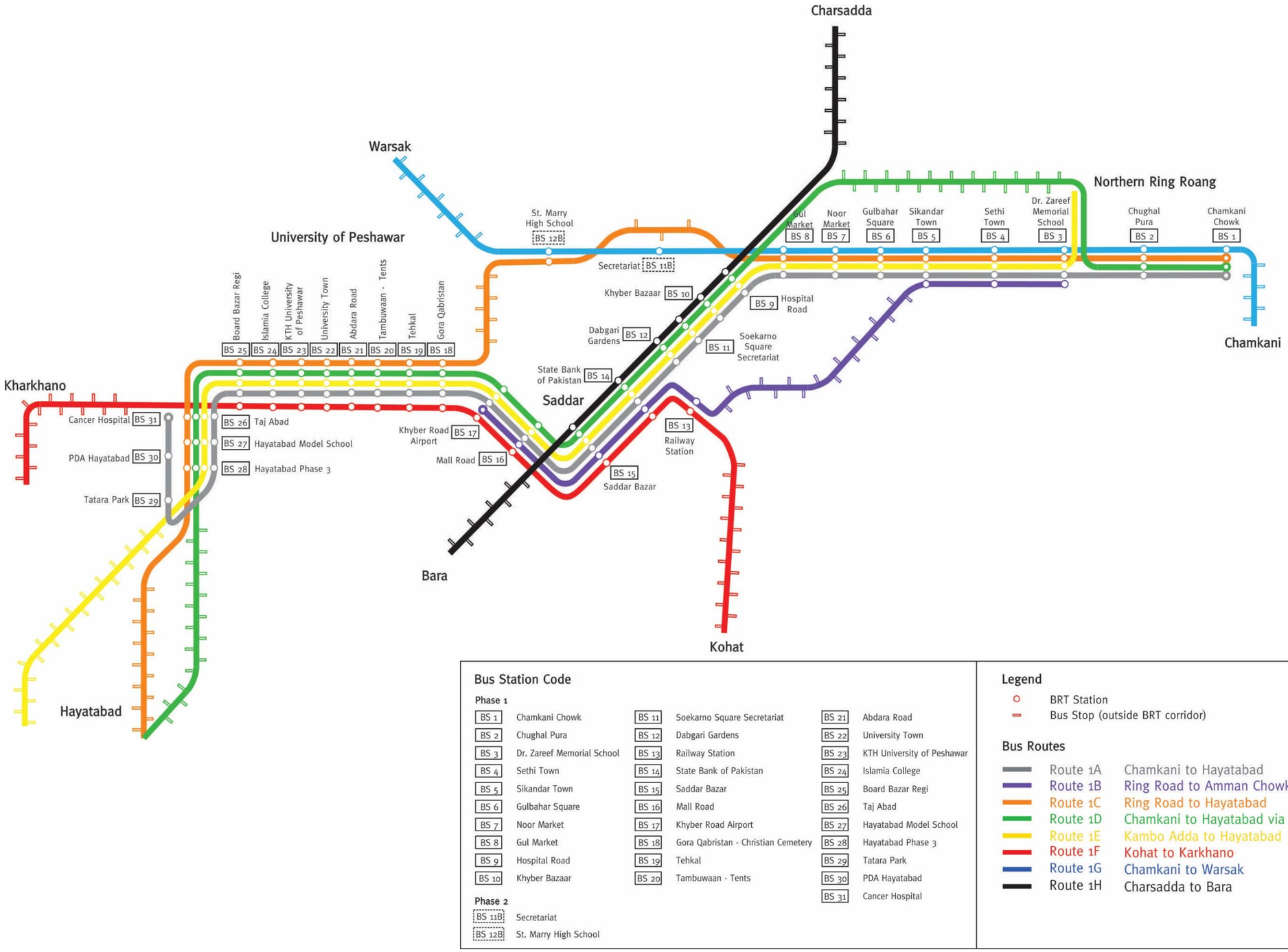


Figure 4. 24 BRT Route Schematic Map



Bus Station Code

Phase 1

BS 1	Chamkani Chowk	BS 11	Soekarno Square Secretariat	BS 21	Abdara Road
BS 2	Chughal Pura	BS 12	Dabgari Gardens	BS 22	University Town
BS 3	Dr. Zareef Memorial School	BS 13	Railway Station	BS 23	KTH University of Peshawar
BS 4	Sethi Town	BS 14	State Bank of Pakistan	BS 24	Islamia College
BS 5	Sikandar Town	BS 15	Saddar Bazar	BS 25	Board Bazar Regi
BS 6	Gulbahar Square	BS 16	Mall Road	BS 26	Taj Abad
BS 7	Noor Market	BS 17	Khyber Road Airport	BS 27	Hayatabad Model School
BS 8	Gul Market	BS 18	Gora Qabristan - Christian Cemetery	BS 28	Hayatabad Phase 3
BS 9	Hospital Road	BS 19	Tehkal	BS 29	Tatara Park
BS 10	Khyber Bazaar	BS 20	Tambuwaan - Tents	BS 30	PDA Hayatabad
				BS 31	Cancer Hospital

Phase 2

BS 11B	Secretariat
BS 12B	St. Marry High School

Legend

- BRT Station
- Bus Stop (outside BRT corridor)

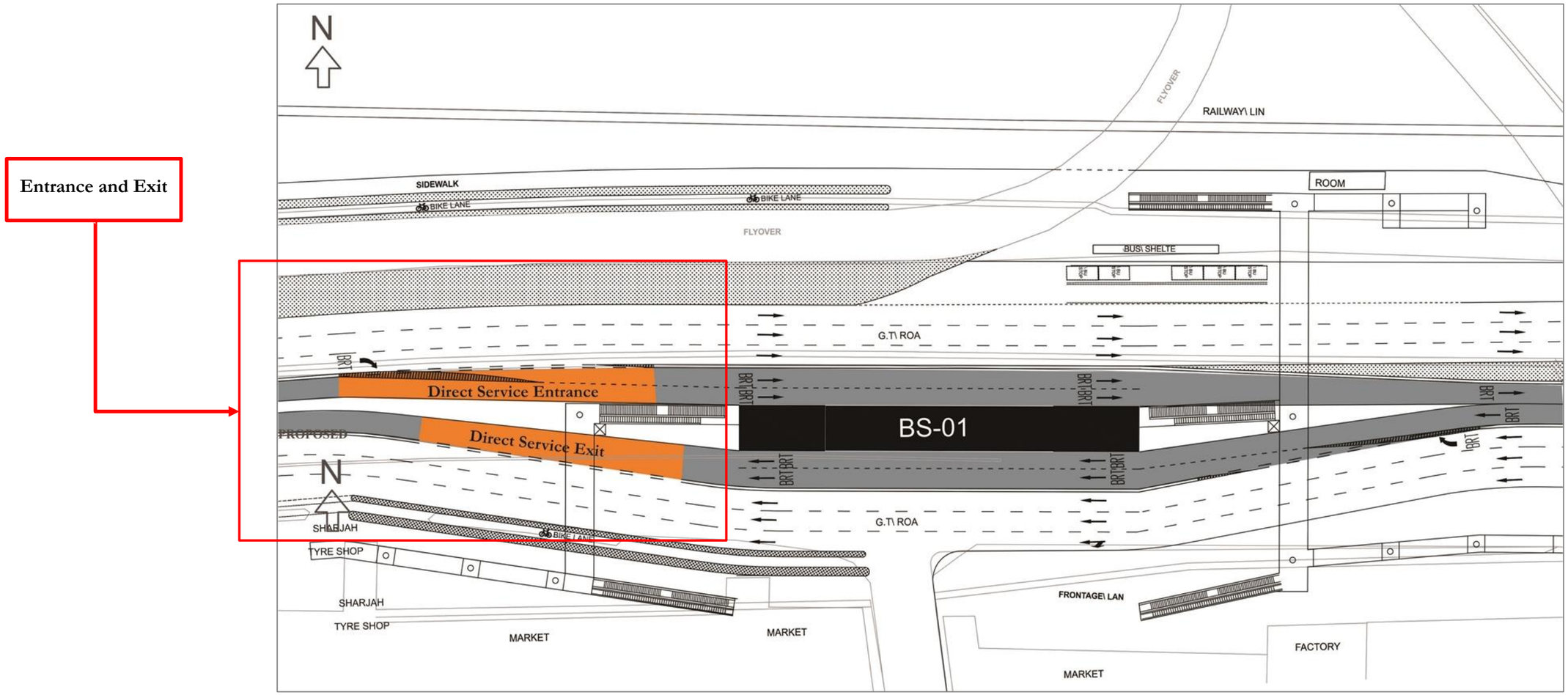
Bus Routes

Route 1A	Chamkani to Hayatabad
Route 1B	Ring Road to Amman Chowk
Route 1C	Ring Road to Hayatabad
Route 1D	Chamkani to Hayatabad via Charsadda
Route 1E	Kambo Adda to Hayatabad
Route 1F	Kohat to Karkhano
Route 1G	Chamkani to Warsak
Route 1H	Charsadda to Bara

4.2.3 Entrance and Exit from BRT Corridor for Direct Service

To enable the BRT routes to enter and exit the corridor, access needs to be provided at certain locations near BRT stations. Bus entrance to the BRT corridor will be provided before the station, where the BRT separator will be removed, and chevron will be provided to guide the bus to enter the BRT lane. To exit the corridor, an opening will be provided for bus to leave the BRT lane and join the mixed-traffic lane. The location of these openings for BRT direct service routes are only provided on certain locations, and these locations are clearly marked in the preliminary engineering drawings. The access for direct service on each station is illustrated on below.

Figure 4. 25 Access for Direct Service at BRT Station



4.3 BRT area coverage

4.3.1 Land-use along the BRT Corridor

The area in Peshawar urban district is dominated by residential and commercial activities. Along the GT Road, commercial and business area are found on the main road, whereas on the secondary roads, or 500 meters from the main GT Road, highly populated residential areas are found. The cantonment-controlled area is dominated by commercial activities and offices, such as in Khyber Bazaar and Saddar, and a significant portion of the area south of Khyber Road is dominated by government and military offices.

On the west part of the corridor, major residential area in Hayatabad dominates the area, and some proportion of industrial south of Karkhano also exist. This makes the BRT corridor surrounded by high commuting activities, which makes it ideal. The density of the urban area, where the BRT will run, is much higher than the density outside the urban district. Currently, 11,714 people per square km live in the urban district, whereas the density outside is only a tenth of the urban area's density.

Figure 4. 26 Land-use along Peshawar BRT Corridor.

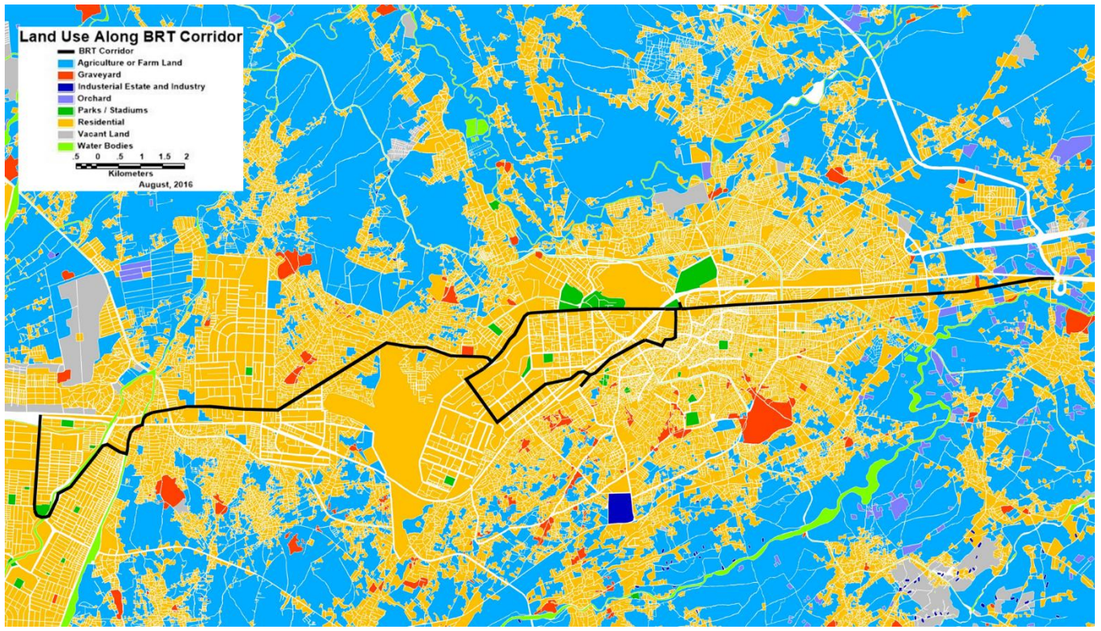
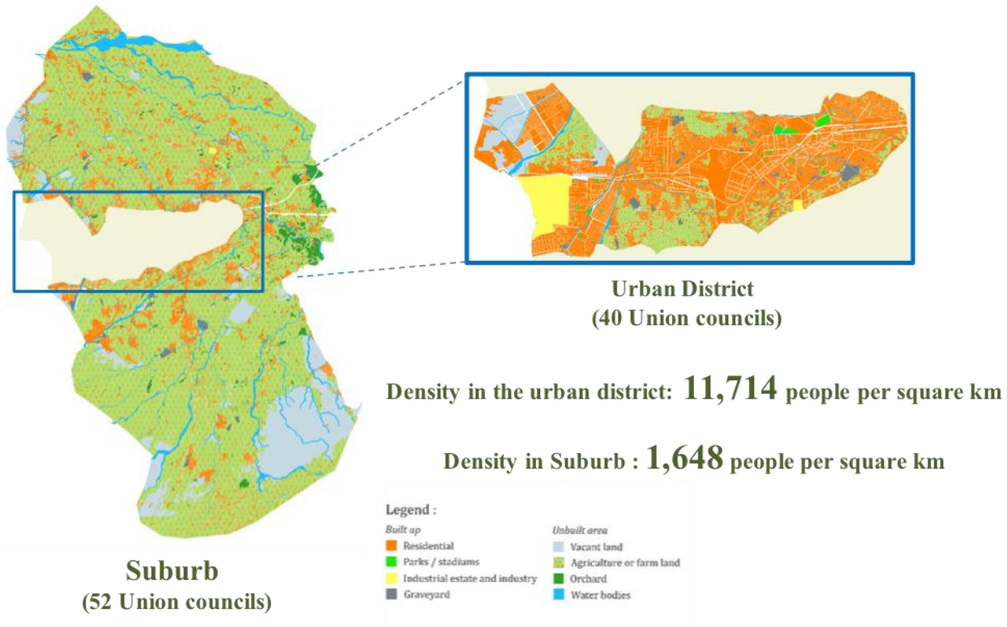


Figure 4. 27 Density in Peshawar Urban District and Suburb.

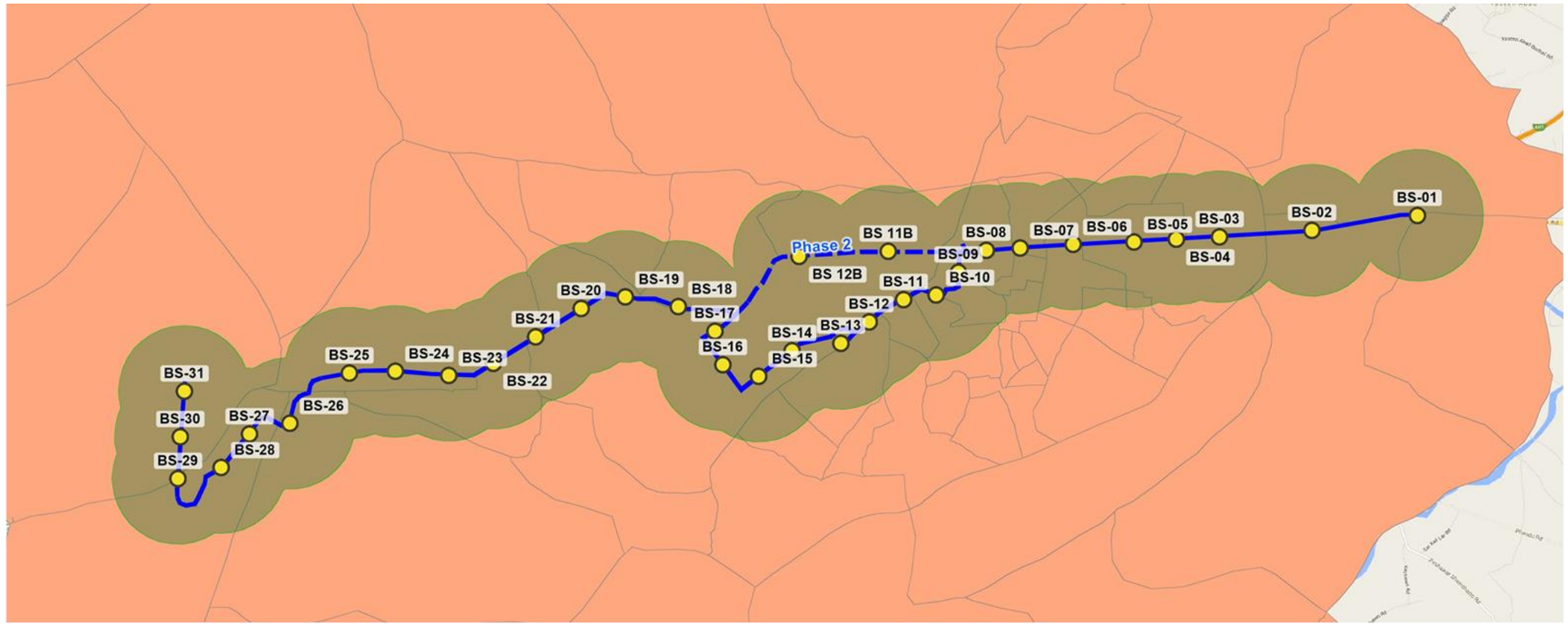


4.3.2 People Near Transit

One important factor when determining the BRT corridor is the area covered by the it, which is shown by the People Near Transit (PNT) metric. PNT metric is introduced by the Institute for Transportation & Development Policy (ITDP) to show how good the mass transit coverage is in a city, or urban area. PNT shows the percentage of population who lives within a 1 kilometer radius from the transit stations. In the case of Peshawar, since no mass transit system is available, the PNT is currently zero percent. But once the BRT corridor is implemented, **17.54%** of the total population in Peshawar, or around 519,000 people will have direct access to BRT station within 1 kilometer. The analysis is based on the Union Council (UC) data, where a detailed population data per UC is also included.

To increase the coverage of the BRT, a feeder bus system to support the BRT is generally needed. For Peshawar, this will be created through a 'direct-service' BRT operational plan, where the BRT routes will be extended beyond the corridor, to increase the coverage of the BRT services. From the density map, it also shows that the lesser density area outside the urban district is beyond the physical corridor. With extended 'direct-service' BRT routes, the low density area can also be served by the BRT system, thus increasing the whole coverage of the BRT as well as increasing accessibility for people to reach the BRT system.

Figure 4. 28 Percentage of People Near Transit (PNT) for proposed Peshawar BRT.



4.4 Off-Corridor Bus Stops

Off-corridor bus stops are required outside the BRT corridor segments, so that the BRT buses can pick up passengers. For the 8 direct-service routes, 100 off-corridor bus stops are proposed. Since practically no existing bus stops are adequate to be used as proper bus stop, new bus stops will be constructed with consideration of three main principles; location and placement of bus stops, type of bus stops, and their physical dimensions.

1. Location and Placement:
    a. **Average Distance:** Bus stops are located along the 8 proposed direct-service routes for off-corridor segments with average distance of 300 to 500 meters.
    b. **High demand for boarding and alighting:** Bus stops are located where there is currently high demand from public transport (current public transport passengers boarding and alighting locations), these are generally residential or office areas or in front of markets. If there are two boarding and alighting spots nearby, the location with higher number is chosen as bus stop location.
    c. **Land availability:** Bus stops are located where there is land availability.
    d. **Distance from intersection:** The minimum distance for a bus stop to be located from an intersection is 50 meters, or 100 meters for a busier intersection.
    e. **Curbside:** Bus stops are positioned curbside and placed on the sidewalk.
2. Type of off-corridor bus stops:
    a. **Shelters** are used on the side mainly used for boarding. Generally, this is the side of the road leading towards city center in the morning peak period. Passengers would have to wait for buses on this side so shelters are required to protect them from weather exposure.
    b. **Bus poles** can be used on the opposing side of shelters. On this side many passengers alight from the buses during evening peak period and will immediately walk towards their final destination and thereby do not require waiting space in the bus stops.
3. Shelters are 2 meters wide and 9 meters long. The design drawings for shelter are presented in this report.

Figure 4. 29Curb-side bus stops in Cape Town (left), London (middle) and Sydney (right).

For direct-service operation, we are in a view that no terminal building needs to be built at the end of the routes. For bus lay-over, few terminus locations can be upgraded with having lay-by and few parking space for buses at the end of the routes. In reality, these facilities, albeit very simple, already exist in Hayatabad and Karkhano. For Chamkani, lands are still available located nearby the first BRT stations.

Figure 4. 30 Bus Shelter Dimensions for Off-Corridor Bus Stop

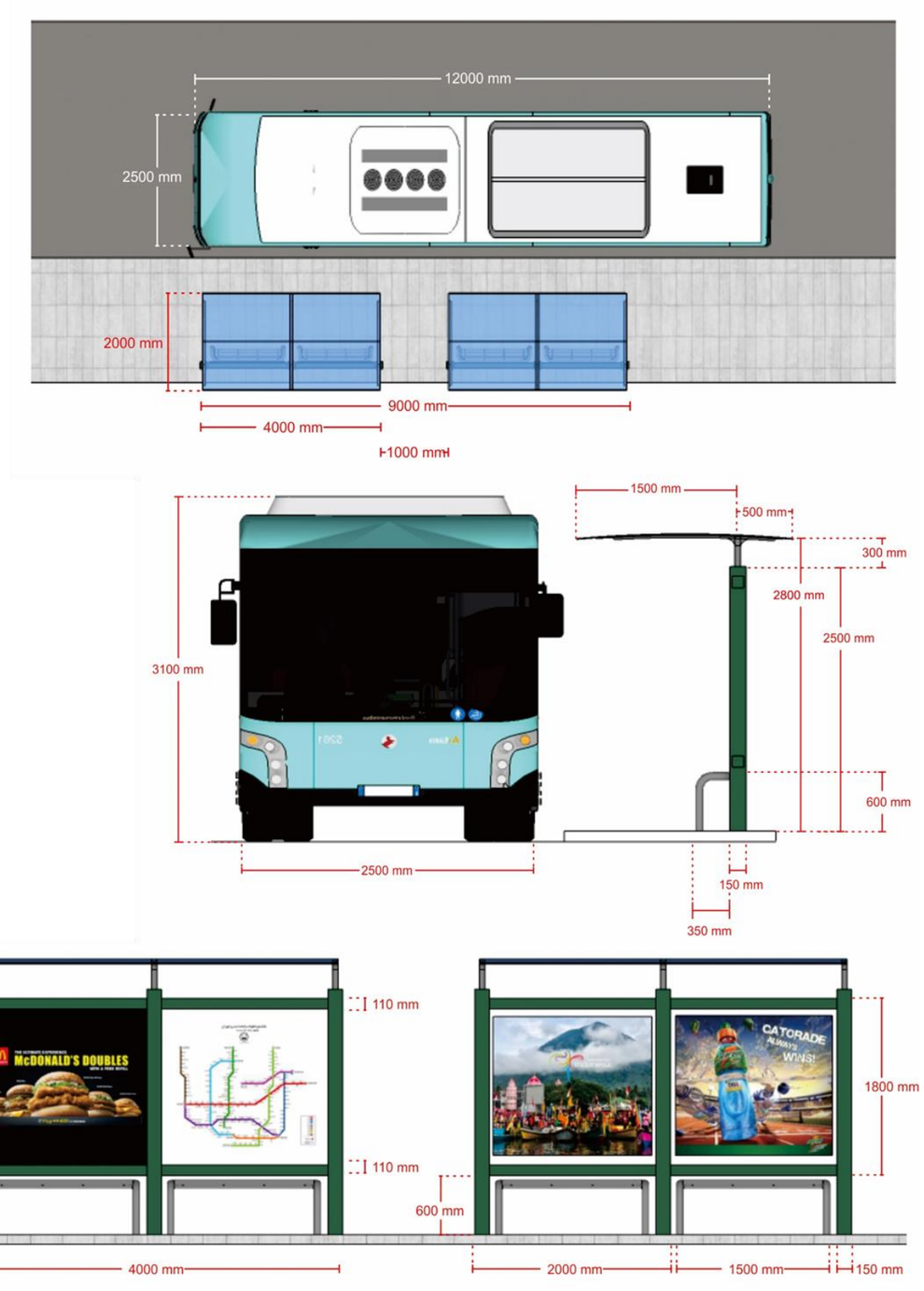
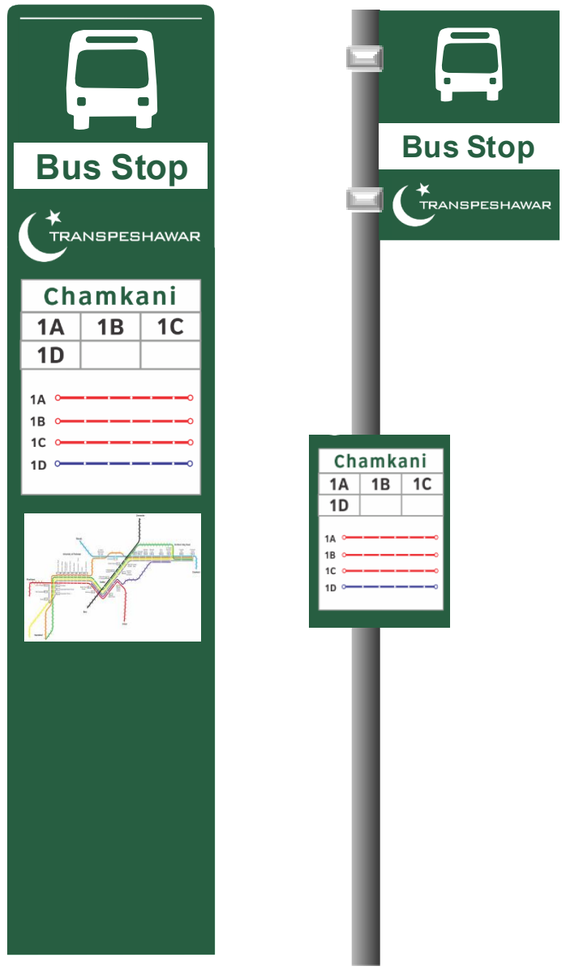


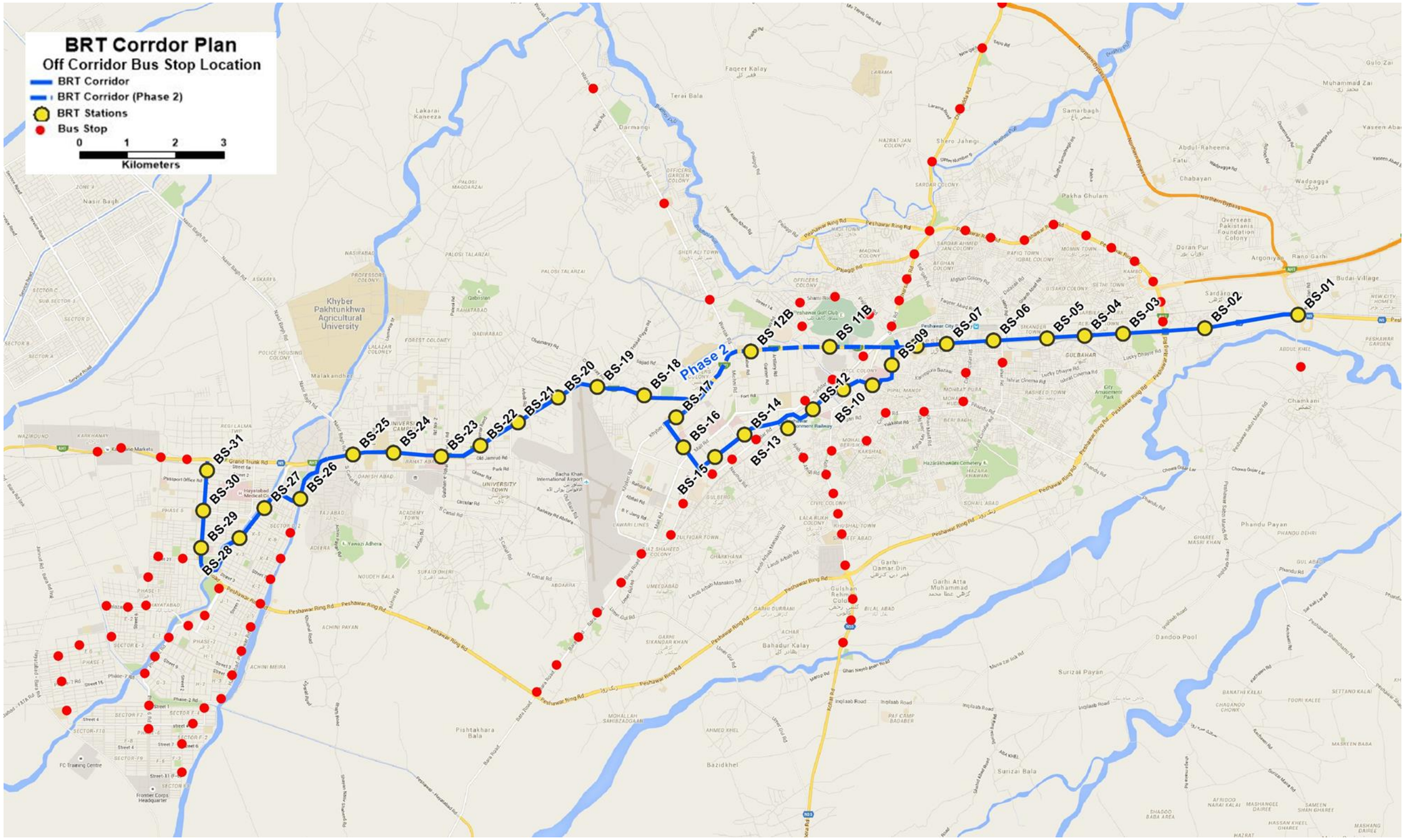
Figure 4. 31 Bus Shelter Design

Figure 4. 32 Bus Pole Design



option 1 Option 2

Figure 4. 33 Off-corridor Bus Stop Locations



5 BRT Vehicle and Infrastructure Design

5.1 Vehicle Design and Configuration

Two types of buses will be introduced for Peshawar BRT: 9-meter buses and 12-meter buses. With direct-service BRT operation, the BRT buses will be plying on the smaller road outside the corridor, such as Kohat Road, Bara Road, and residential roads at Hayatabad, where 9-meter buses with 2.2-2.5-meter width would be ideal to operate. Due to the seat configuration, the 9-meter bus is proposed to have engine placed at the front.

The 12-meter bus type will be used on routes with high proportion of the route passing the corridor on GT Road, with engine preferably at the rear.

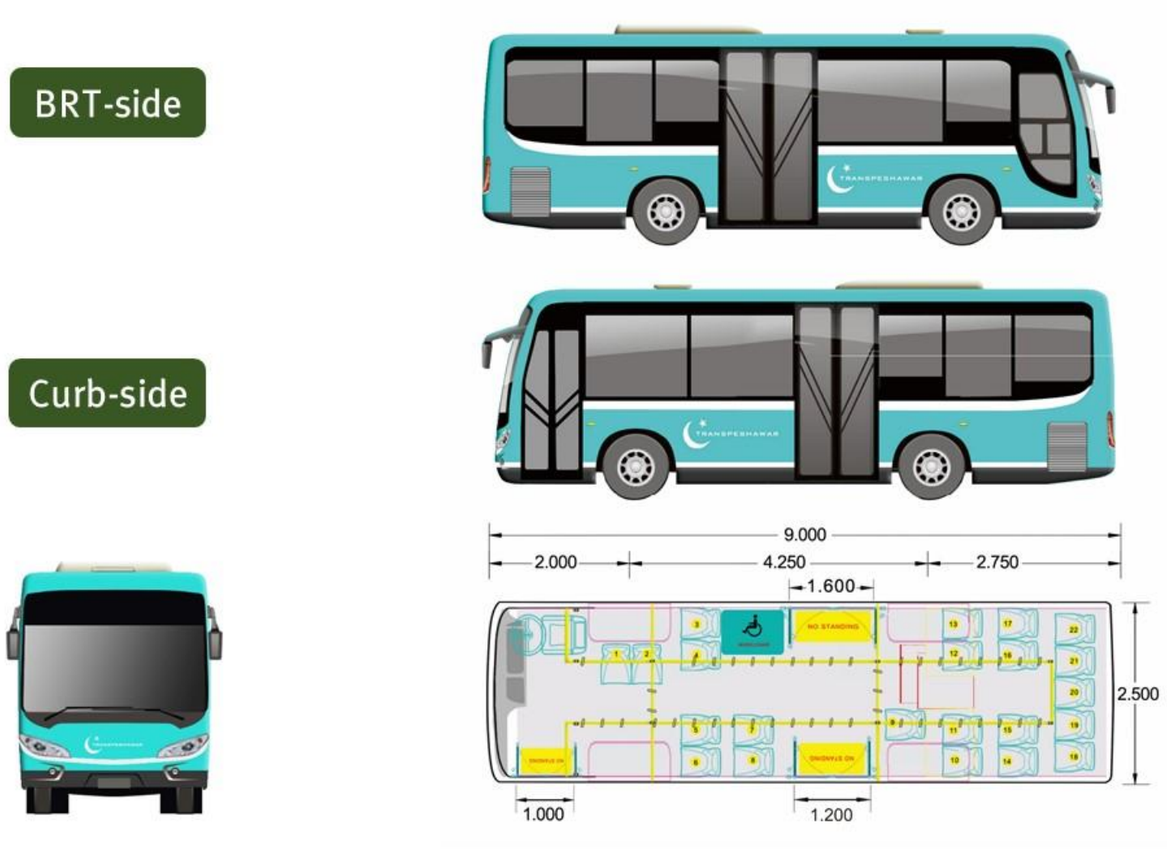
18-meter buses will only be proposed for Peshawar BRT for future growth at a later stage, when the demand starts to grow. The current station design already accommodates the use of 18-meter buses. This is mainly due to narrow streets and tight turning radius that most of the road along off-corridor segment.

All buses are proposed to use diesel-fuel engine. Although CNG supply is not scarce in Peshawar, the use of CNG buses could increase the bus price as well as the Operating and Maintenance costs. From an operational point of view, CNG poses big problems with limited tank size, which requires buses to refill every 120-150 kilometer, and the possibility of installing new CNG station close to stations will depend on the CNG pipe availability, unlike the diesel fuel where it only requires storage tank at the refueling stations.

With direct-service buses serving both the BRT corridor and off-corridor (feeder), they need to have doors on both sides, and low-floor entrance (30-35 cm) to ensure easy access from the road side onto the bus.

Such buses are available from both European manufacturers and Chinese manufacturer, and the manufacturers are more flexible to adjust the specification according to client's requirement.

Figure 5. 1 Bus Configuration (9m)



Dimension

Length	: 9000 mm
Width	: Max 2500 mm
Height	: Max 3500 mm (with A/C unit)
Entrance	: 350 (fully loaded) to 380 mm
Door width	: 1000 mm (left-front) 1200 mm (remaining 3 doors)
Engine Location	: Front Engine

Capacity

Seating	: 22 seats
Wheelchair	: 1 Wheelchair
Standing	: Max 25 passengers (No Wheelchair)

Price

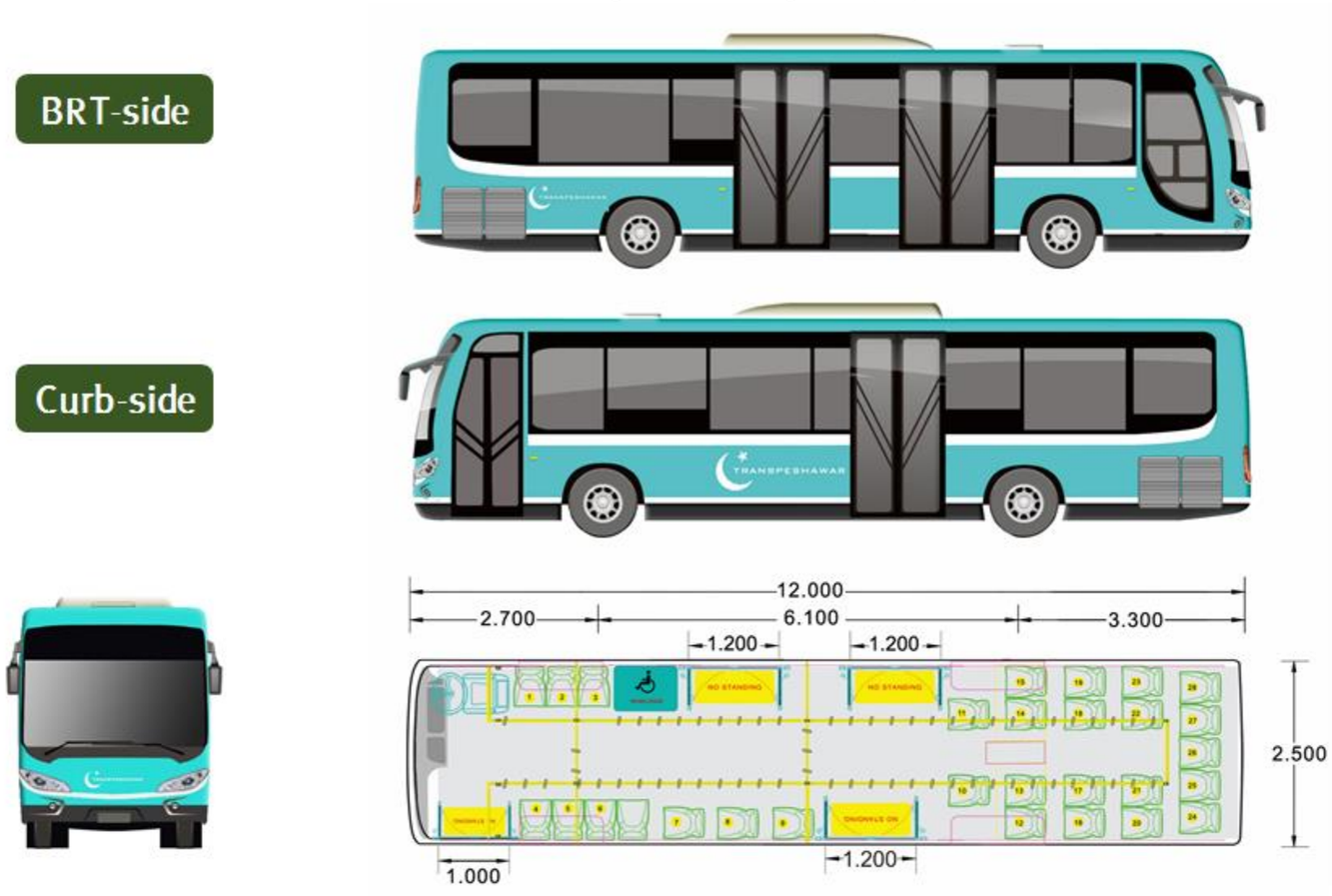
European OEM	: USD 100,000 – USD 150,000
Chinese OEM	: USD 75,000 – USD 90,000

It is estimated that for 12-meter bus, the cost is 250,000 USD for European buses, and 160,000 USD for Chinese buses.

For 9-meter buses, the cost is approximately 125,000 USD for European buses, and USD 80,000 For Chinese buses. All the figure quoted above do not include duties, shipping and delivery cost, which could add 10-15% to the bus price.

Typically, European buses have a lifetime of 15-20 years, whereas Chinese buses last between 8-10 years. Although at the end the quality of the bus will depend on the maintenance regimes performed during the service.

Figure 5. 2 Bus Configuration (12m)



Dimension

Length	: 12000 mm
Width	: Max 2500 mm
Height	: Max 3800 mm (with A/C unit)
Entrance	: 300 mm
Door width	: 1000 mm (front left) 1200 mm (remaining 3 doors)
Engine location	: Rear (preferred) or Front

Capacity

Seating	: 28 seats
Wheelchair	: 1 Wheelchair
Standing	: Max 55 passengers (No Wheelchair)

Price

Chinese EOM	: USD 160,000
European EOM	: USD 250,000

5.1.1 Bus Technical Specifications

At the time of writing, a Request for Proposal (RFP) document was issued to prospective bidders on procurement and operation of the 9-meter and 12-meter buses for Peshawar. Although initially these buses will be used as regular buses, the tender document specified the possibility of having these buses operating on BRT corridor, once the corridor is built. Thus, the technical specification and configuration of the bus should match the BRT requirements.

The technical specification for 9-meter and 12-meter buses are shown in the Appendix. They are taken from the RFP to avoid duplication, with revisions on few aspects such as door position, engine position and others. This revised document has already been submitted to the Transport and Mass Transit Department (TMTD) in June 2016.

5.2 BRT Station Design & Configuration

5.2.1 Key Design Features

In designing the BRT station for Peshawar, the following key design features were introduced:

- High capacity stations
- Wide and comfortable stations
- Safe and weather-protected stations
- Universally accessible
- Good passenger circulation
- Modern and create new branding image for public transport.

Those features are important to make Peshawar BRT successful and meet its goal to become the reliable mass transit of the city, as well as reaching the Gold Standard BRT. Proposed station design features include the following components:

- Wide station platform (5 to 6-meter-wide) and open-air to allow good air circulation
- Multiple stopping bays (up to 4 buses can stop at the same time)
- Passing Lane to allow overtaking at stations
- Space for overtaking at stations with minimum length of 13 meter to allow 18-meter bus overtake in the future
- Fast and universal access to BRT station with all kind of access provided (stairs, Elevator, Escalator) and special gate to allow wheelchair to enter station
- Tactile ground surface indicator/paving for visually impaired users
- Lane separator with guard-rail
- Cycle lane along the corridor, complete with secured cycle parking at station and guiding rail on stairs to carry bicycle
- Real-time passenger information system.

Figure 5. 3 Wider Gate for Wheelchair

Figure 5. 4 Passenger Information System at Station

Figure 5. 5 Tactile Paving at Station

Figure 5. 6 BRT Station Key Design Components.

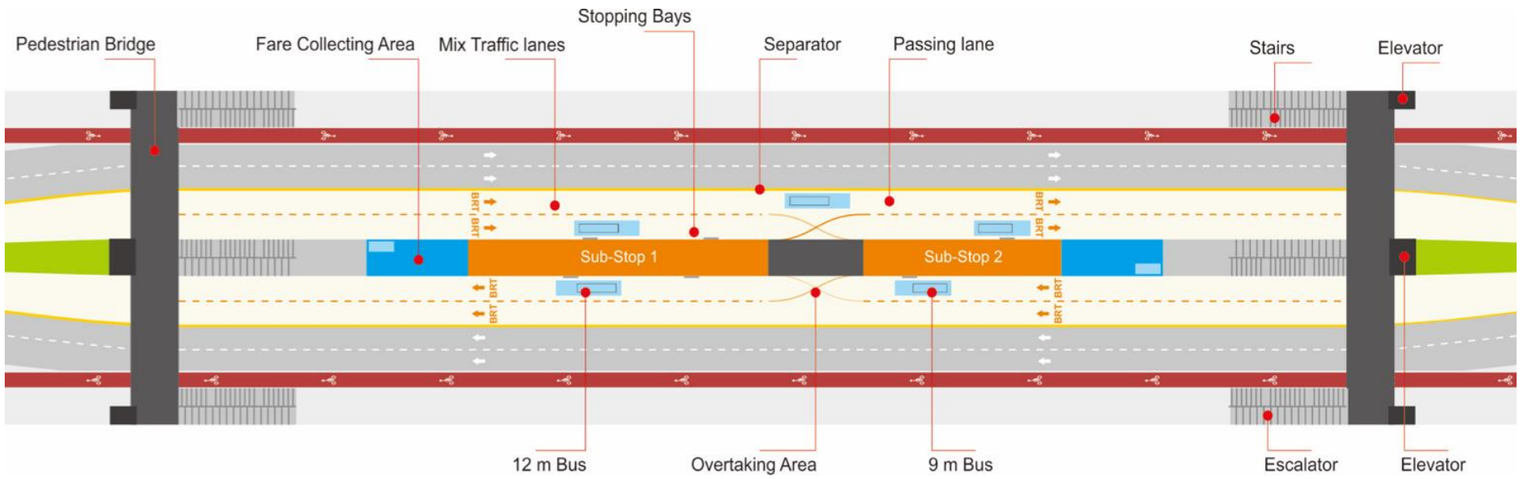
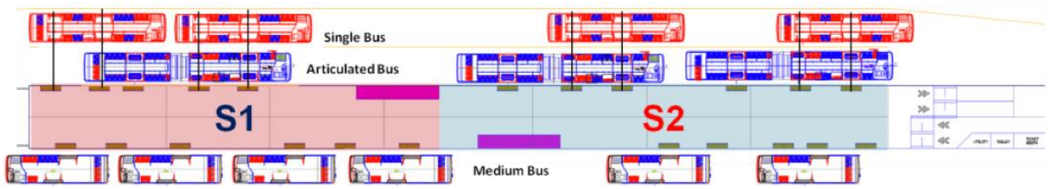
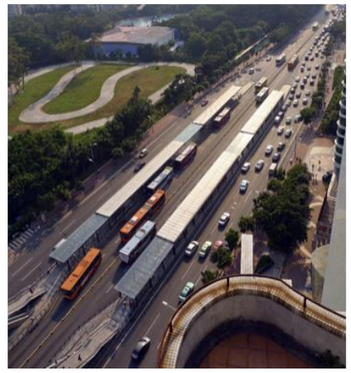


Figure 5. 7 Illustration of Sub-Stop.





5.2.2 Sub-Stop Concept

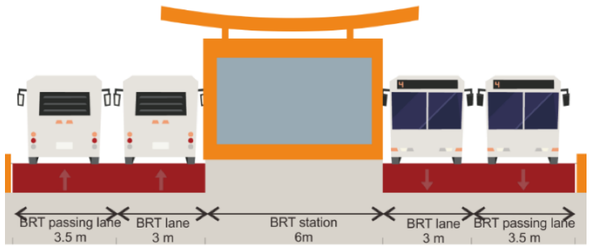
BRT stations are designed in different sizes to reflect different demands. Station saturation determines the required station size, which is represented by number of sub-stop required. The sub-stop calculation is determined by the number of boarding and alighting passengers, bus frequency per hour per direction as well as the type of bus and number of doors used per bus. If two or more sub-stops are chosen for station, passing lane will be required. Each sub-stop works independently, and buses stopping at the second sub-stop do not have to wait for the buses stopping on the first sub-stop to be able to move.

For Peshawar, 5 types of stations will be designed, with one sub-stop, two sub-stops and three modifications of two sub-stops configuration.

Table 5. 1 Station Type Detail Information.

Sub-Stop	Station Type	Dimension	Bus Type per Direction		
			9m	12m	18m
1SS	Standard	55m x 5m	2 bus	2 bus	2 bus
2SS	Standard	110m x 5m	4 bus	4 bus	2 bus
Longer Station					
2SS	Offset Station	205m x 4m	4 bus	4 bus	2 bus
2SS	Split Station	150m x 4m	4 bus	4 bus	3 bus

5.2.3 Station Types



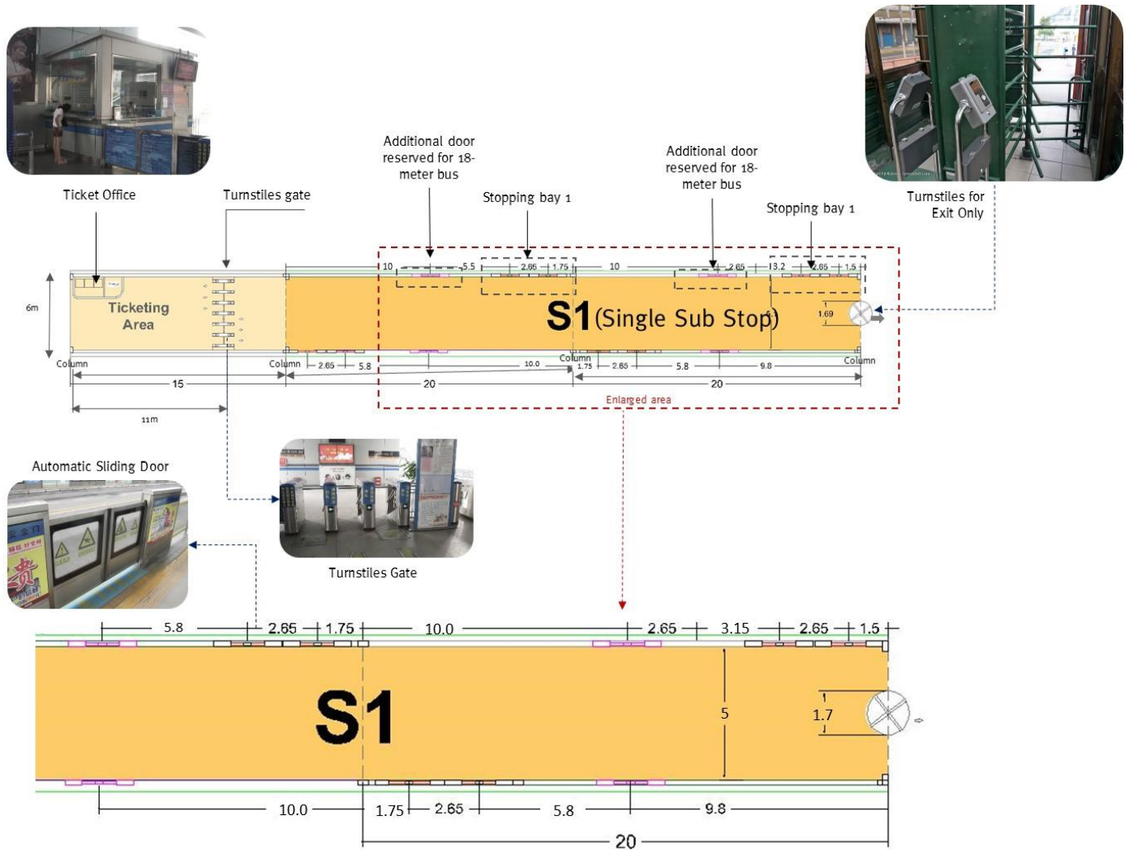
Cross Section.

The station is designed in modular, with 1 a 20-meter-long module, i.e. distance between columns is 20 meters. In station Type 1 with 1-subtop, the station length is 55 meter, with 5 meter width. It has two construction modules for the sub-stop and a 15 meter long ticketing area. In this Station Type, for each direction, 2 buses can stop in two stopping bays adjacent to each other. At the beginning, only 9-meter and 12-meter buses that can stop at this station type, but at the later stage, once the demand grows, 18-meter bus will be able to stop at this station, where additional station doors will be provided at reserved area at the back of the 12-meter and 9-meter doors. In this sub-stop, no buses can overtake the bus standing in front, despite having enough distance to overtake, and buses going into the station will go on first-come-first-serve basis for stopping bays. i.e. the first bus coming to station should use the first bus, regardless of the bus route.

Although this station type only has 1 ticketing area, both sides of stations can be used for exit, with extra rotating door provided at the other end of the station to allow exit, as shown in the picture below.

Type 1: One Sub-Stop (55-meter)

Figure 5. 8 One Sub-Stop Station Configuration.



In addition to 1 sub-stop station type, there are other four types of stations with 2 sub-stops, with each has different dimension and different purpose.

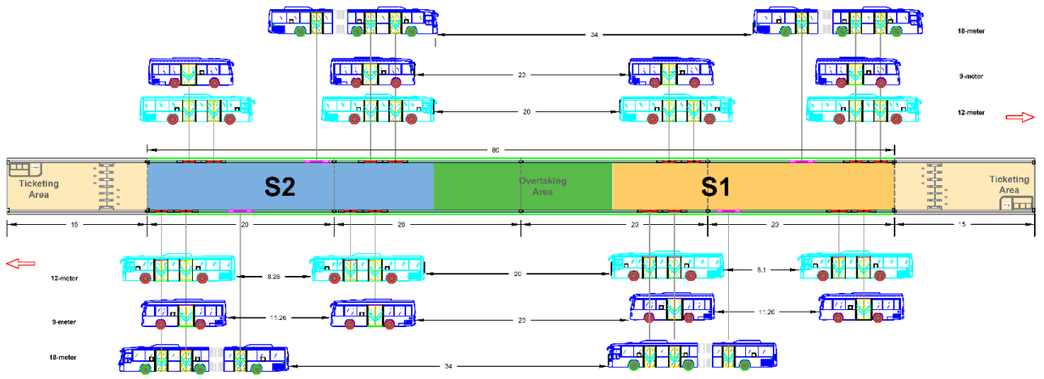
1. Two sub-stop (110 meter) – Type 2
2. Two sub-stop offset (205 meter) – Type 3
3. Two sub-stop split (150 meter) – Type 4

Type 2: Two Sub-Stop (110-meter)

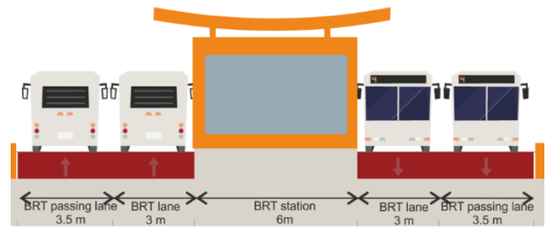
The first type of station with two sub-stops has dimension of 110 meters long and 6 meters wide. In both sub-stops, all 3 types of buses are allowed to stop. The ticketing area is provided at both end of station, with a length of 15-meter each.

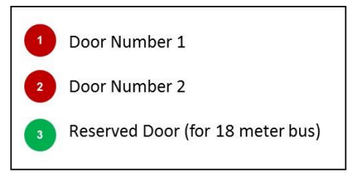
The overtaking area provided between the first and second sub-stops is used for buses to overtake. The minimum distance of the overtaking area, i.e. the area marked in green between S1 and S2 will provide a minimum of 20 to 34 meters distance between buses on different sub-stop to overtake, which will still enable bus to dock properly on the stopping bays.

Figure 5. 9 Two Sub-Stop Station Configuration.

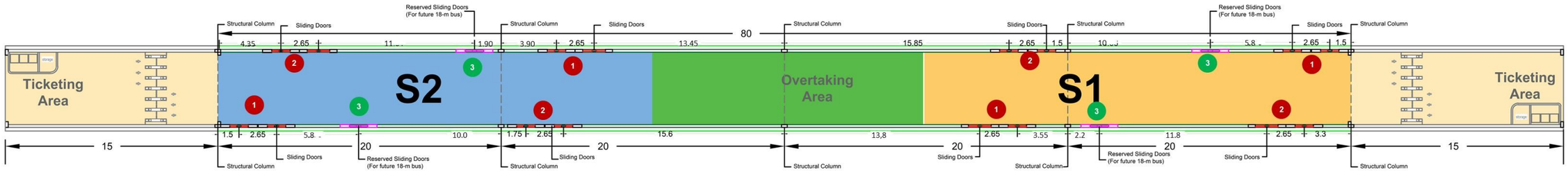


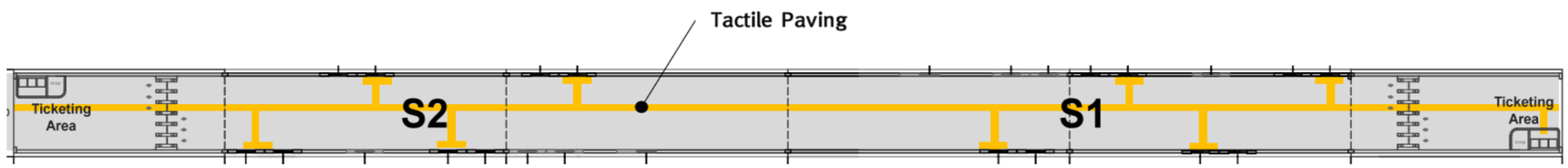
Cross Section





2 Sub Stop Station





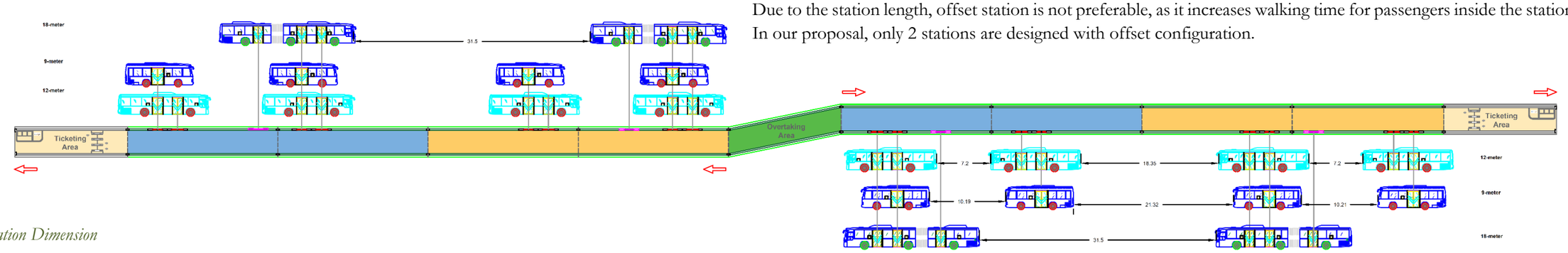
Tactile paving map for the visually impaired passengers are shown below. For these passengers, the tile will guide them to the front door of each stopping bay. This is to make the driver aware if there are any visually impaired passengers boarding the bus, so that drivers can allow additional dwelling time for safety reason.

Type 3: Two Sub-Stop with offset configuration (205-meter)

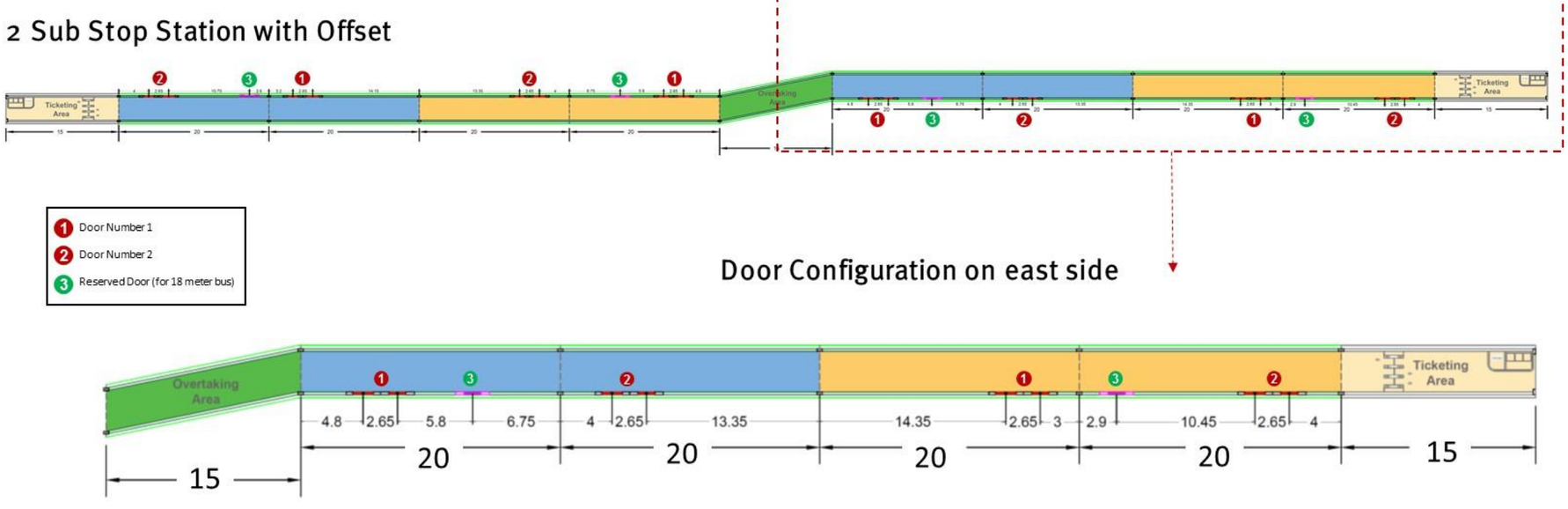
Figure 5. 10 Two Sub-Stops Station Configuration with offset Module.

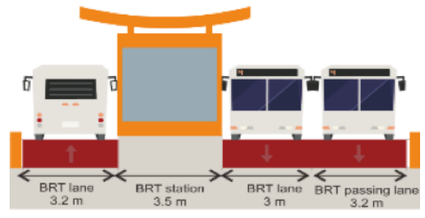
Offset station will only be placed on the locations where space might be an issue, such as on Saddar Road. With offset configuration, space required for station area will be less in width than normal station configuration, but increases in length. In offset configuration, buses on different direction will stop at different stopping locations, or in other words, each direction will have 2 sub-stops located separately. Thus adding the total sub-stop required for this station type to 4 sub-stops in total for both directions.

Due to the station length, offset station is not preferable, as it increases walking time for passengers inside the station. In our proposal, only 2 stations are designed with offset configuration.



Station Dimension

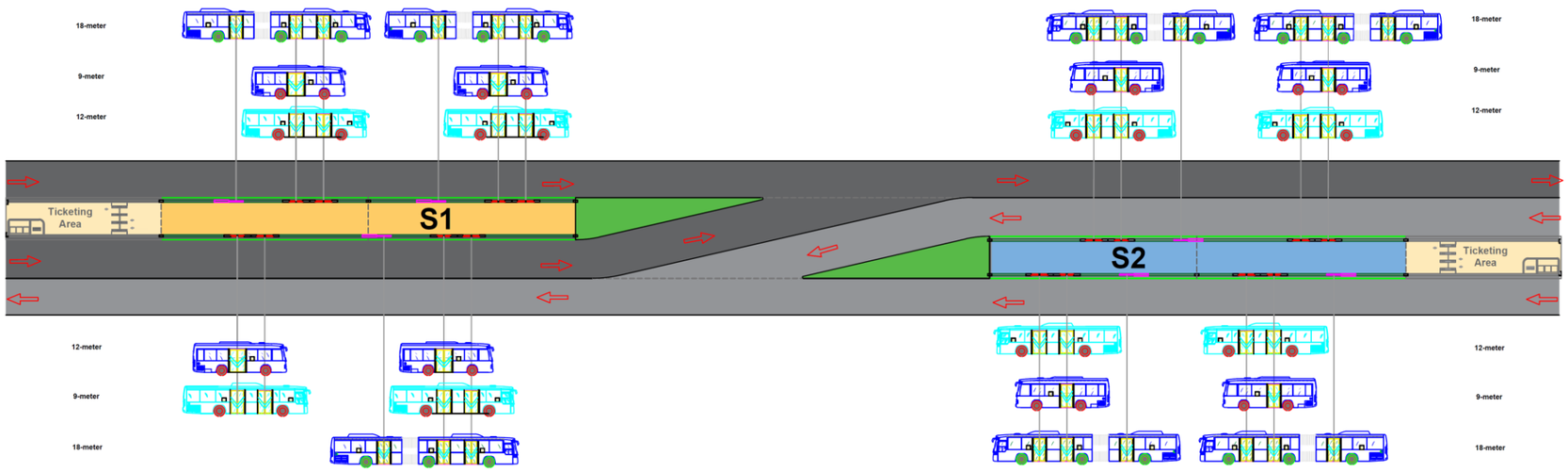


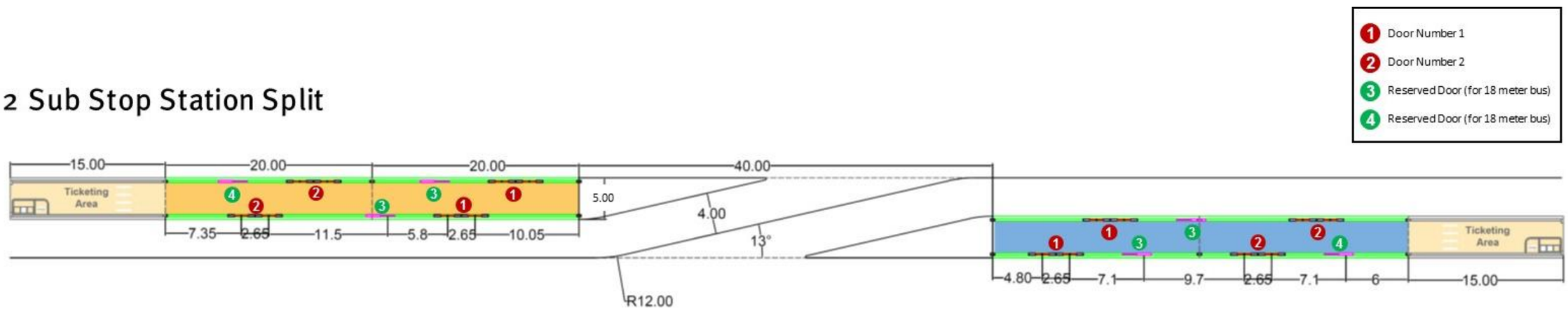


Cross Section

Type 4: Two Sub-Stop with split configuration (150-meter)

Figure 5. 11 Two Sub-Stops Station Configuration with split Module.





Where the road is neither wide enough for standard station nor long enough for offset station, split configuration will be used. With split configuration, the space required for station area will be less in length than offset configuration, but this innovation include a novel movement set up for buses (picture on the left) which would require clear signage to avoid any confusion.

In this configuration, all passengers going into one direction will use one sub-stop and the other sub-stop will be used for passengers going towards the other direction. This could potentially lead to two problems, overcrowding in each station during each peak period and difficulties in transferring between the two directions.

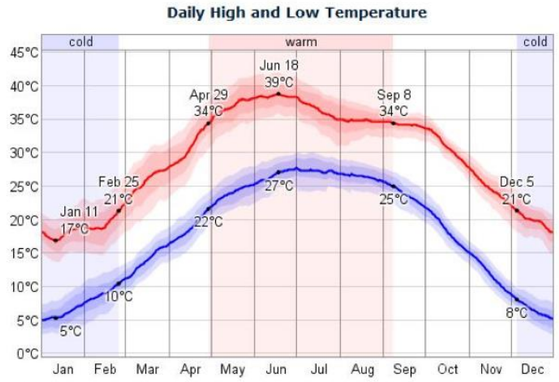
In our proposal, only 1 station is designed with split configuration, the Hospital Road station.

Figure 5. 12 Example of Split Station in Chinese BRT systems in Lanzhou (left) and Yichang (right)

5.3 Station Architectural Design

5.3.1 Background Climate Condition

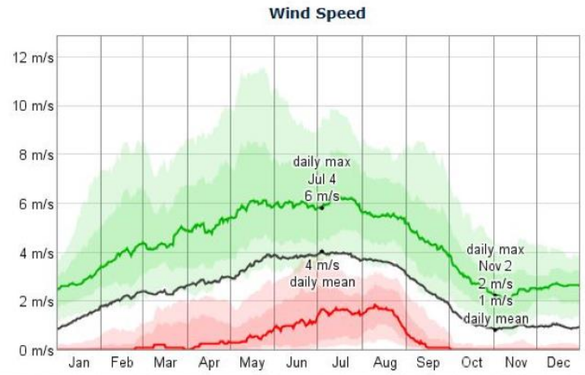
AVERAGE TEMPERATURE & WIND



The daily average low (blue) and high (red) temperature with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

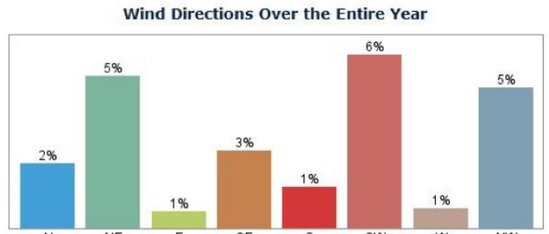
The *warm season* lasts from April 29 to September 8 with an average daily high temperature above 34°C. The hottest day of the year is June 18, with an average high of 39°C and low of 27°C.

The *cold season* lasts from December 5 to February 25 with an average daily high temperature below 21°C. The coldest day of the year is January 2, with an average low of 5°C and high of 18°C.



The average daily minimum (red), maximum (green), and average (black) wind speed with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

Over the course of the year typical wind speeds vary from 0 m/s to 6 m/s (calm to moderate breeze), rarely exceeding 12 m/s (strong breeze).



The fraction of time spent with the wind blowing from the various directions over the entire year. Values do not sum to 100% because the wind direction is undefined when the wind speed is zero.

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m²/day	2.95	3.67	4.77	6.14	7.26	7.70	6.88	6.09	5.72	4.76	3.54	2.80
Clearness, 0 - 1	0.57	0.56	0.57	0.62	0.66	0.67	0.61	0.59	0.64	0.66	0.64	0.59
Temperature, °C	2.48	4.26	9.02	15.25	20.60	24.30	23.67	21.86	19.33	14.83	10.01	5.19
Wind speed, m/s	6.31	6.32	7.03	7.82	6.59	5.58	5.11	5.15	6.24	8.26	7.94	6.64
Precipitation, mm	29	43	74	48	26	8	44	69	22	11	13	25
Wet days, d	4.2	6.7	10.4	10.0	6.5	3.7	7.0	7.6	4.2	3.0	2.6	3.7

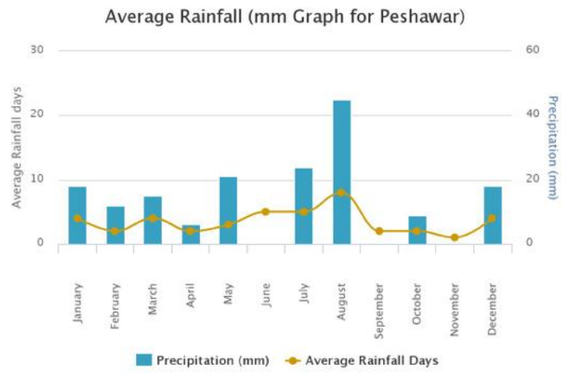
These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center; New et al. 2002

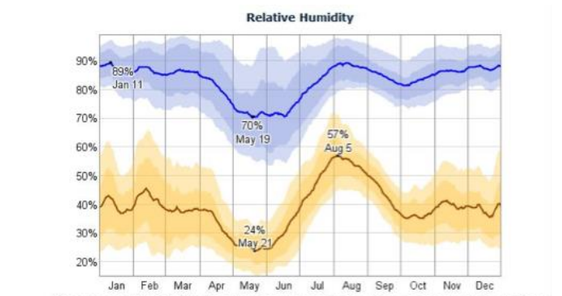
Figure 5. 13 Background Climate conditions in Peshawar.

Peshawar's climate is very dry, with little rainfall. It can rain at any time of the year but the rain does not last long. As well as being arid, the climate is extremely hot in the summer but slightly cooler in the winter months. There is no monsoon period. Throughout the year, temperatures fall dramatically at night, sometimes by as much as 20°C.

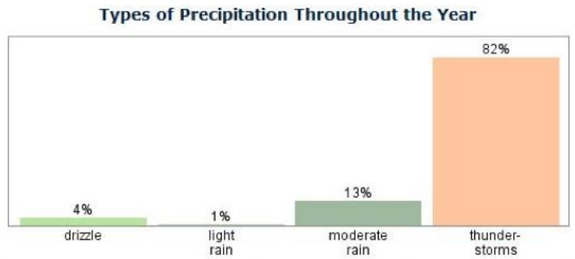
Peshawar has a hot semi-arid steppe climate. The area within 40 km of this station is covered by *croplands* (67%), *shrublands* (29%), and *built-up areas* (3%).

AVERAGE RAIN & HUMIDITY





The average daily high (blue) and low (brown) relative humidity with percentile bands (inner bands from 25th to 75th percentile, outer bands from 10th to 90th percentile).



Relative frequency of various types of precipitation over the course of a typical year.

The relative humidity typically ranges from 24% (dry) to 89% (very humid) over the course of the year, rarely dropping below 15% (dry) and reaching as high as 99% (very humid).

The air is *driest* around May 21, at which time the relative humidity drops below 29% (dry) three days out of four; it is *most humid* around January 11, exceeding 85% (humid) three days out of four.

5.3.2 Design Concept

Figure 5. 14 Peshawar BRT Station Design Concept.

Figure 5. 15 Detail Section of Peshawar BRT Station.

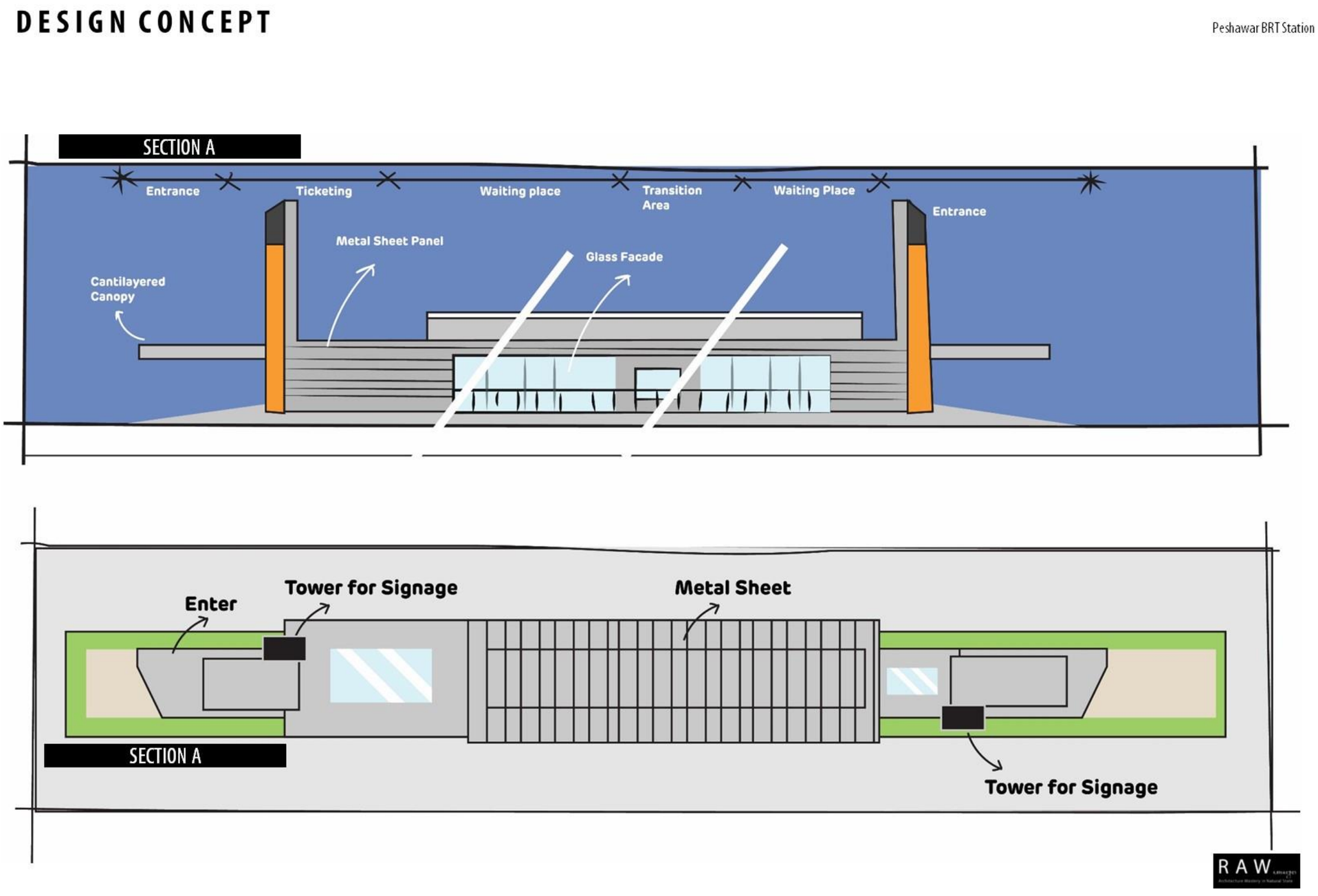
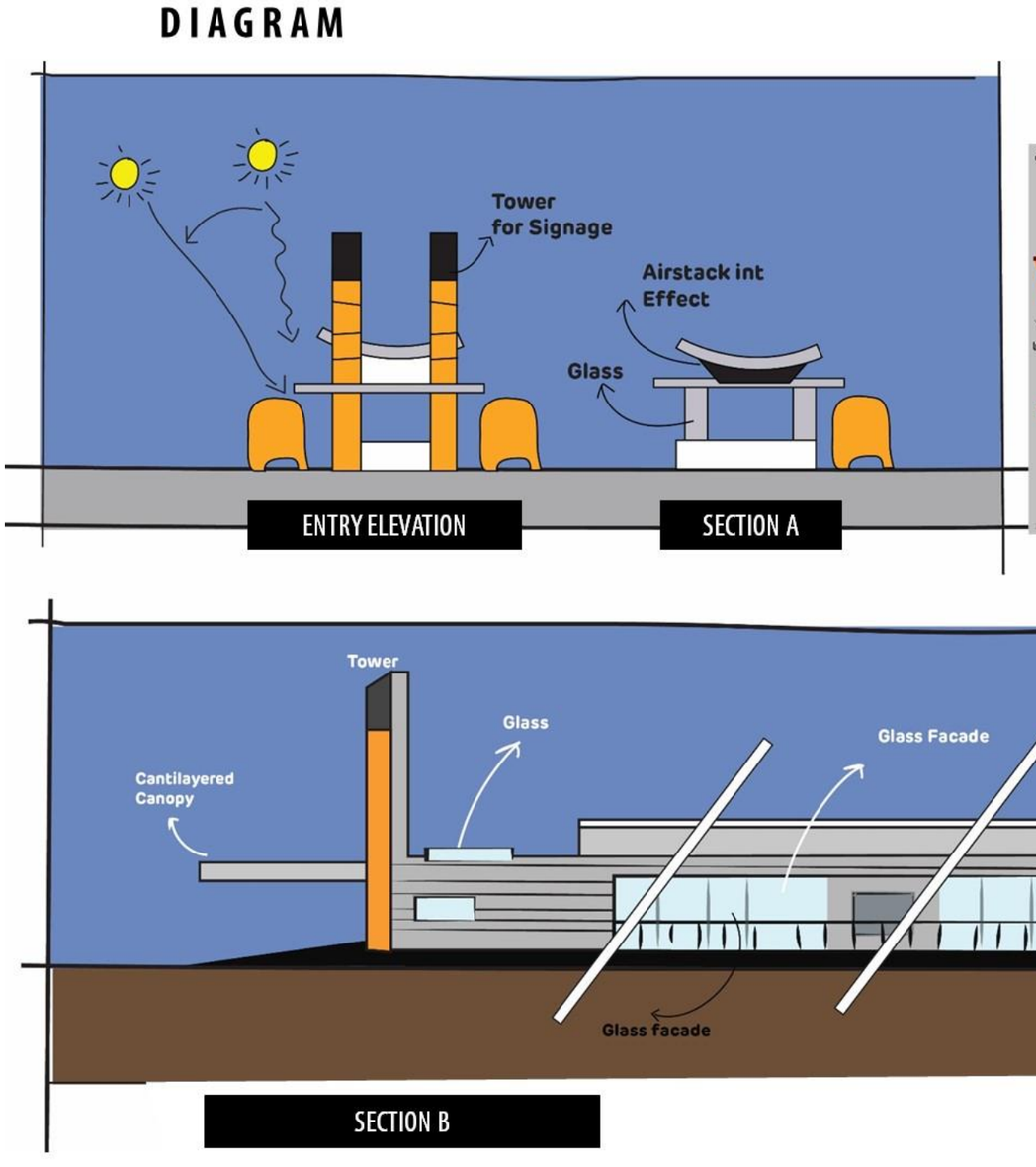
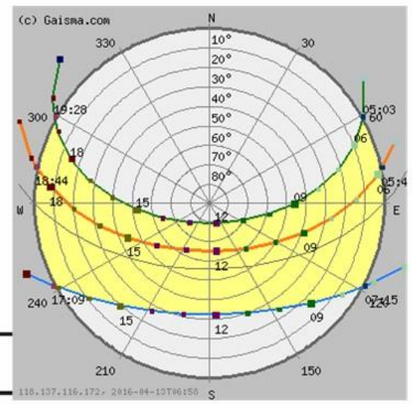


Figure 5. 16 Cross Section and Longitudinal Section of Peshawar BRT Station.





Peshawar BRT Station

The number of hours during which the Sun is visible (black line), with various degrees of daylight, twilight, and night, indicated by the color bands. From bottom (most yellow) to top (most gray): full daylight, solar twilight (Sun is visible but less than 6A° from the horizon), civil twilight (Sun is not visible but is less than 6A° below the horizon), nautical twilight (Sun is between 6A° and 12A° below the horizon), astronomical twilight (Sun is between 12A° and 18A° below the horizon), and full night.

5.3.3 Station Detail – at grade

Figure 5. 17 Station detail area

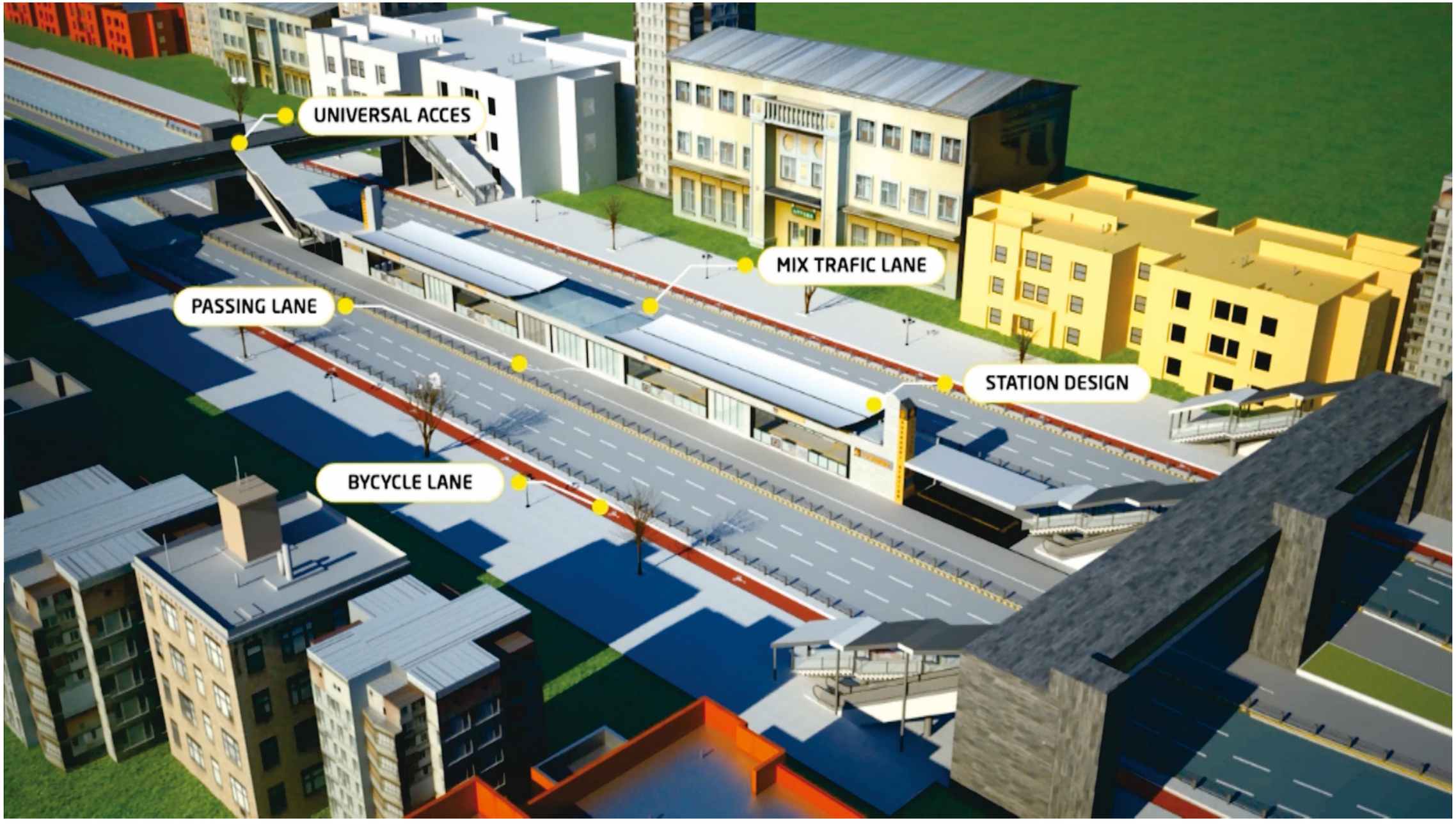
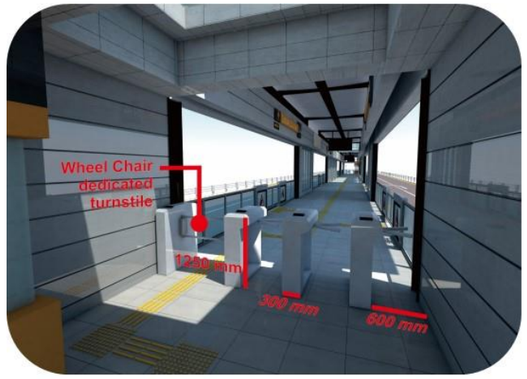
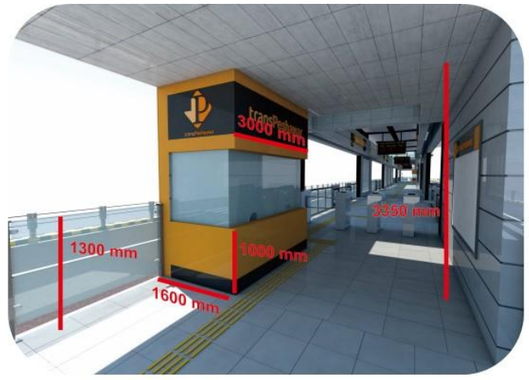


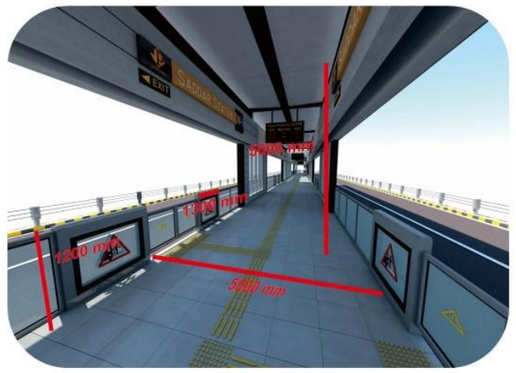
Figure 5. 18 Station Dimension



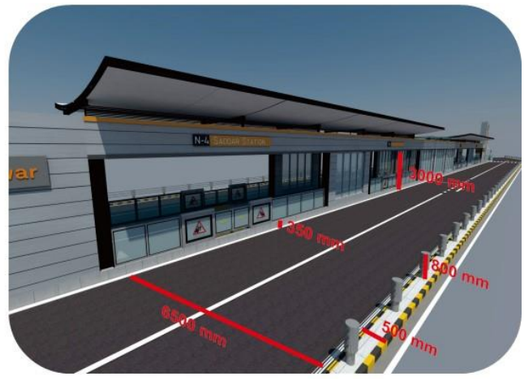
Station Entrance



Station Entrance



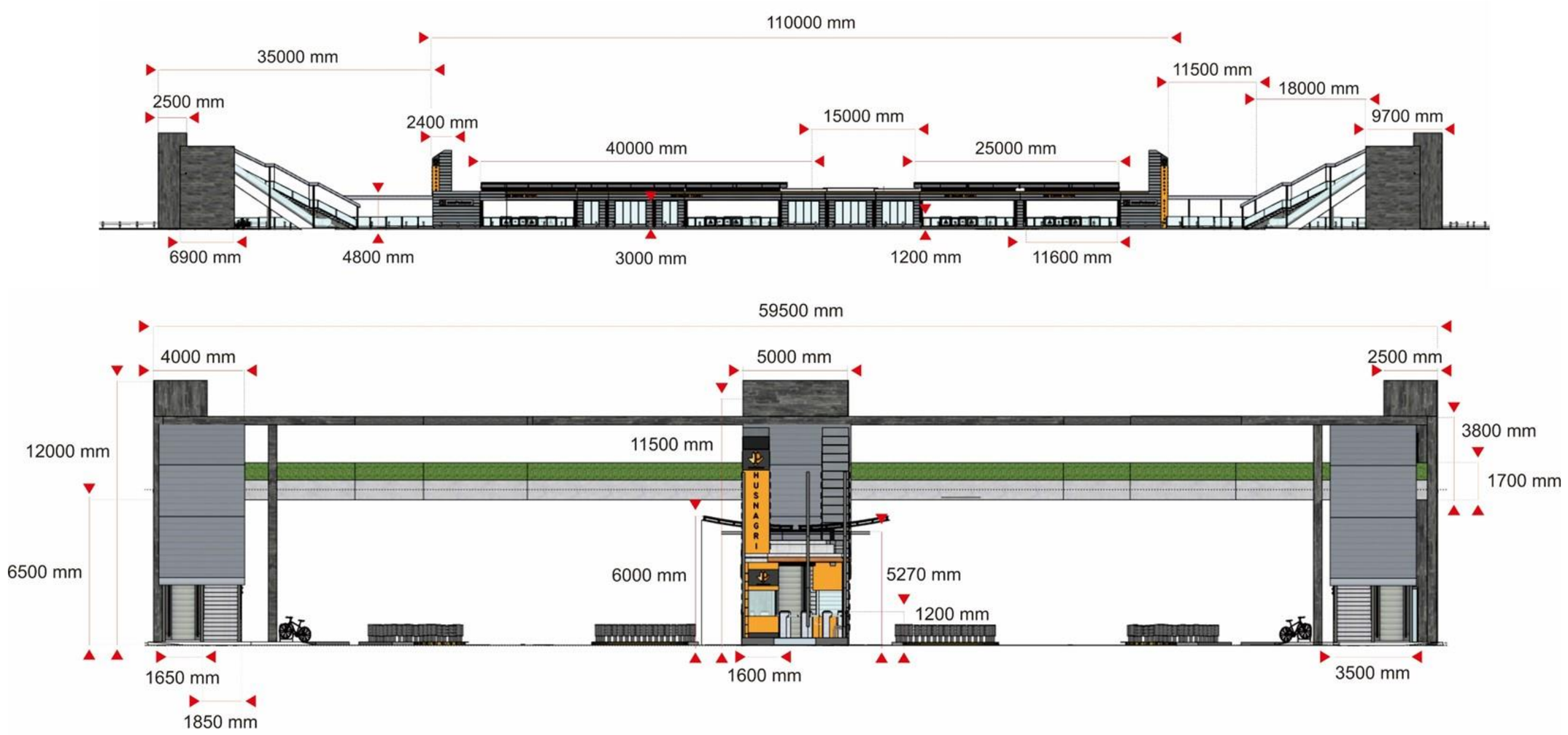
Station Interior Dimension



Station Exterior Dimension

Station Structural Dimension

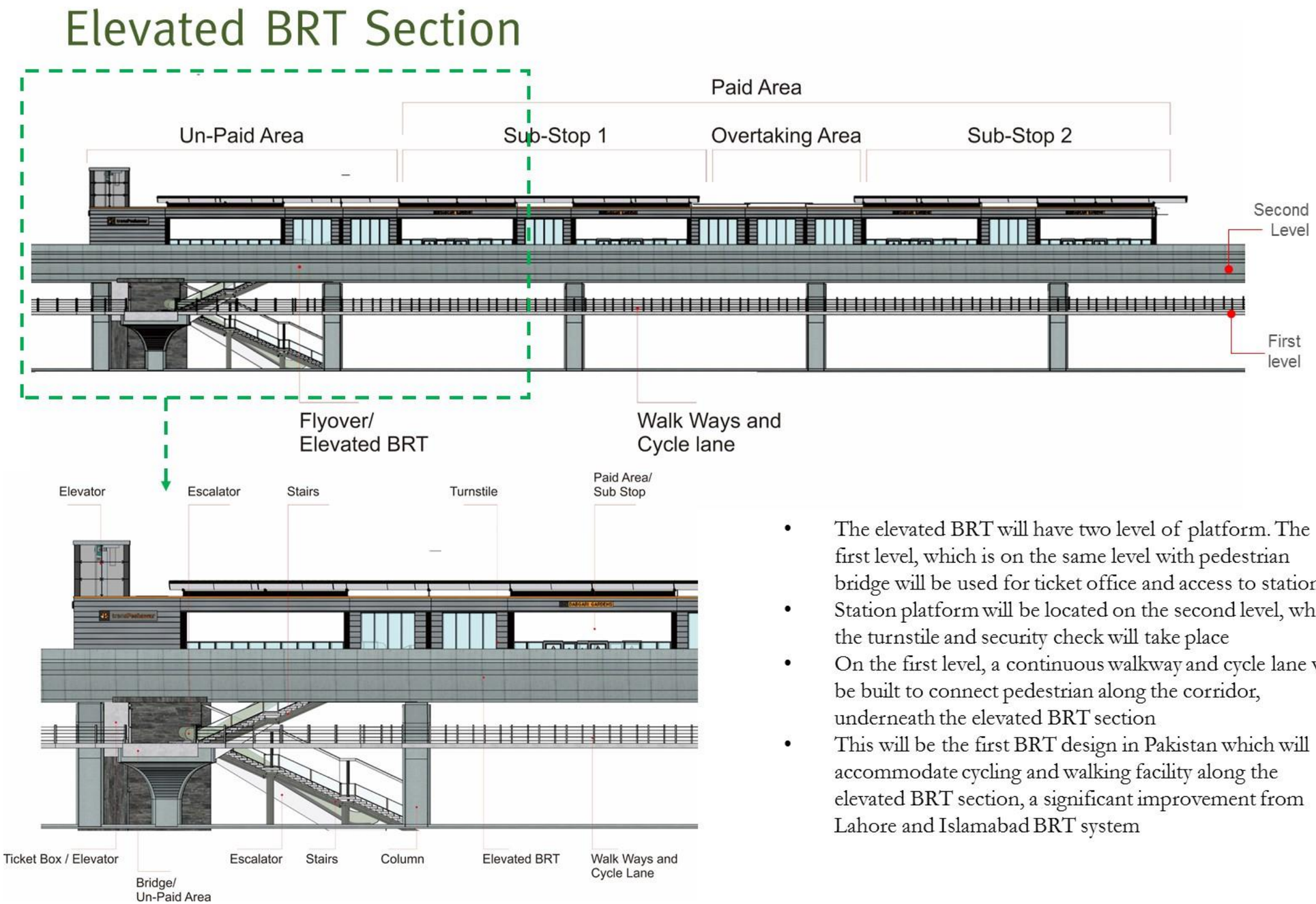
Figure 5. 19 Station Dimension for at-grade station.



- Access to station will be provided from both sides, and for some locations where pedestrian tunnel already exist, the BRT station will be connected to the nearest pedestrian tunnel for access
- Each station each equiped with escalators to go up, stairs and escalator for wheelchair and passengers with limited ability

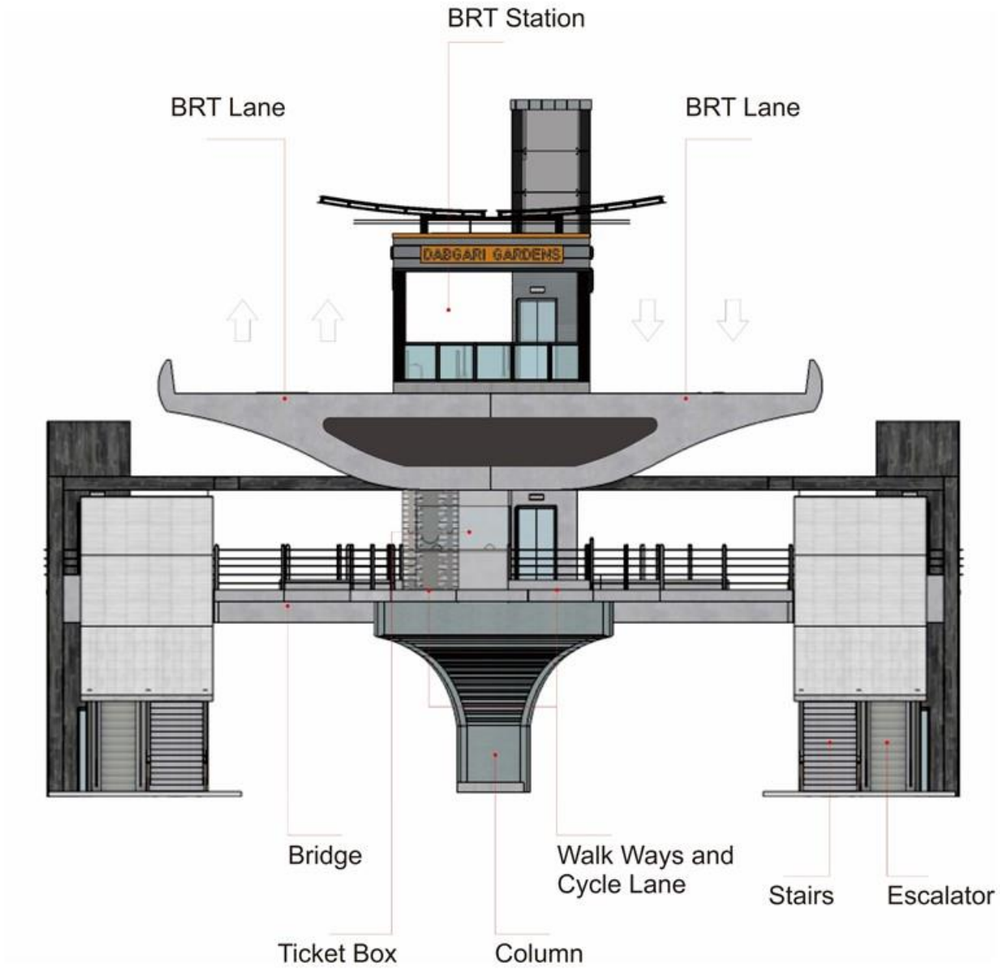
5.3.4 Station Detail – Elevated Section

Figure 5. 20 Station Detail for Elevated BRT.

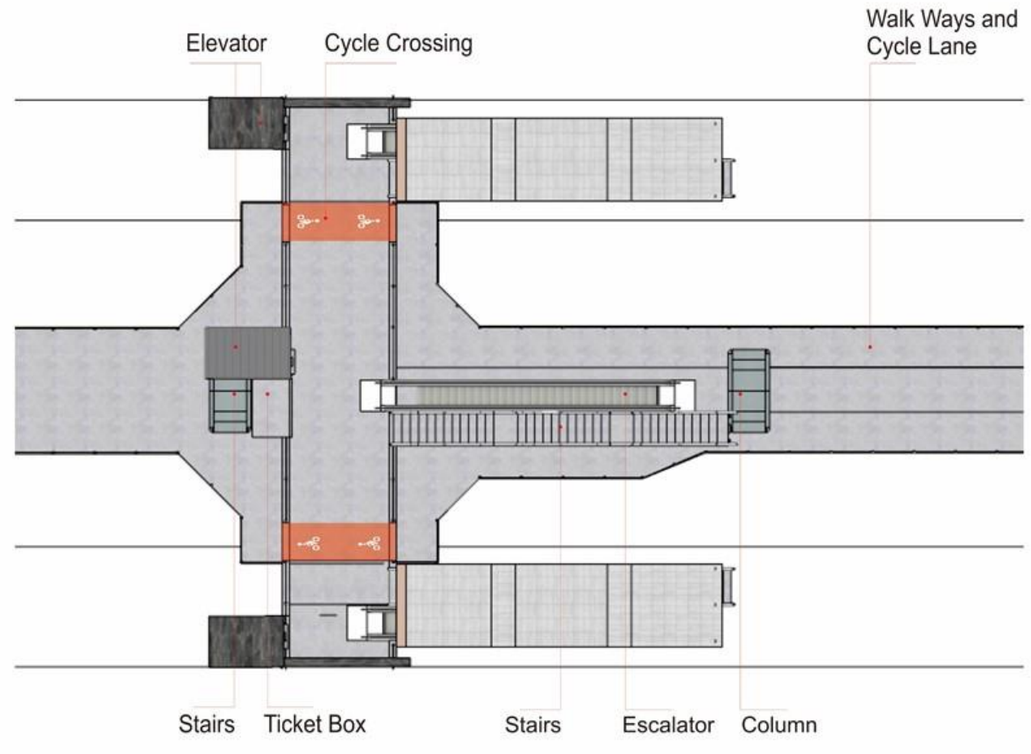


- The elevated BRT will have two level of platform. The first level, which is on the same level with pedestrian bridge will be used for ticket office and access to station
- Station platform will be located on the second level, where the turnstile and security check will take place
- On the first level, a continuous walkway and cycle lane will be built to connect pedestrian along the corridor, underneath the elevated BRT section
- This will be the first BRT design in Pakistan which will accommodate cycling and walking facility along the elevated BRT section, a significant improvement from Lahore and Islamabad BRT system

Figure 5. 21 Cross Section & layout of Elevated BRT Station.



Cross Section



1st Floor Layout
(Walkway and ticket office)

Figure 5. 22 Existing Condition Chamkani (BS-01).

Figure 5. 23 Rendering Image of BRT Station Chamkani (BS-01).

Figure 5. 24 Existing Condition Hushnagri (BS-07).

Figure 5. 25 Rendering Image of BRT Station Hushnagri (BS-07).

Figure 5. 26 Existing Condition Saddar Rd (BS-15).

Figure 5. 27 Rendering Image of BRT Station Saddar Rd (BS-15).

Figure 5. 28 Existing Condition Tehkal (BS-19).

Figure 5. 29 Rendering Image of BRT Station Tehkal (BS-19).

Figure 5. 30 Existing Condition Tambuwan Tents (BS-20).

Figure 5. 31 Rendering Image of BRT Station Tambuwan Tents (BS-20) .

Figure 5. 32 Existing Condition PDA Hayatabad (BS-30).

Figure 5. 33 Rendering Image of BRT Station PDA Hayatabad (BS-30).

Figure 5. 34 Illustration of Elevated BRT station at Khyber Bazaar.

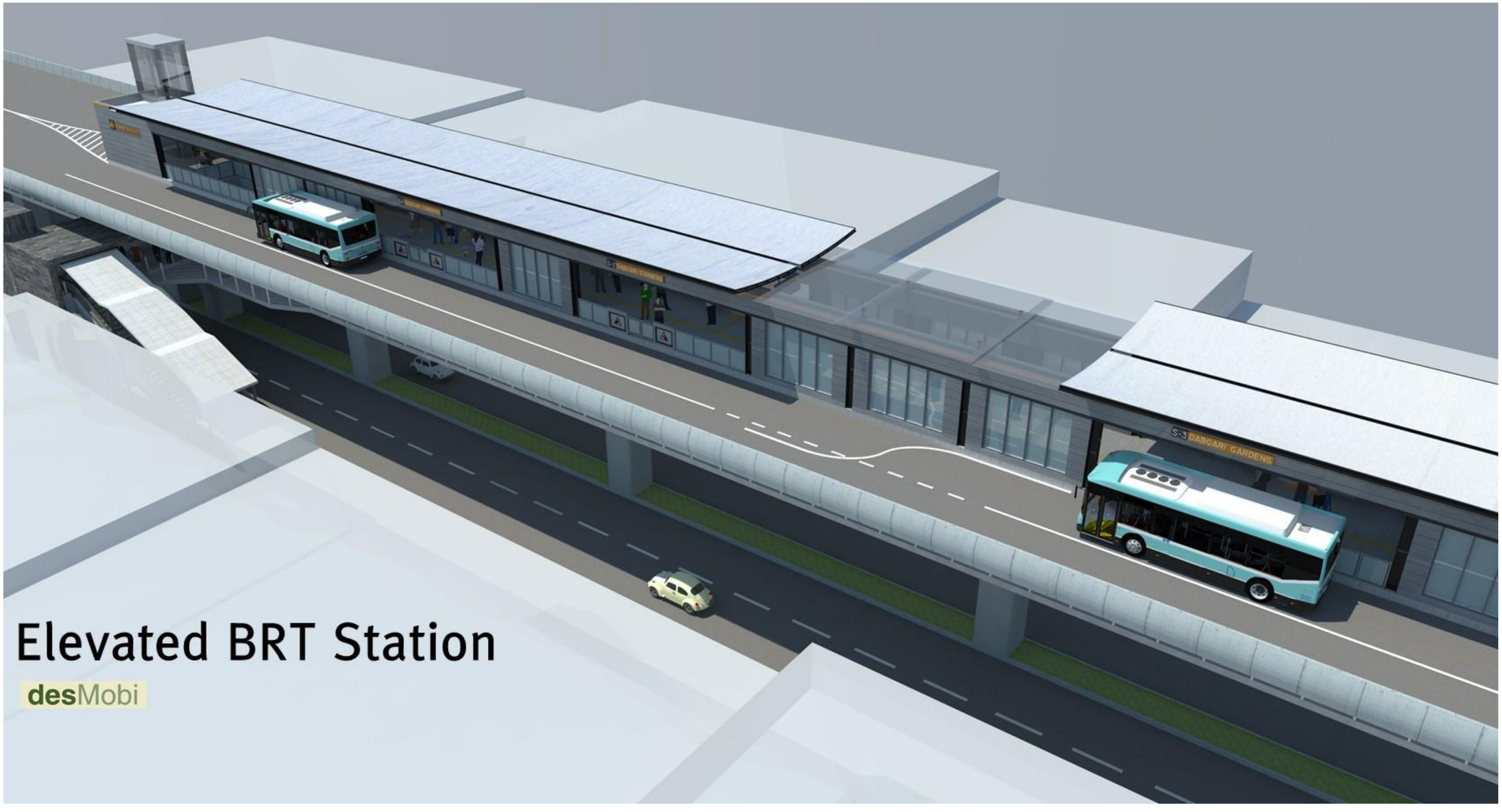
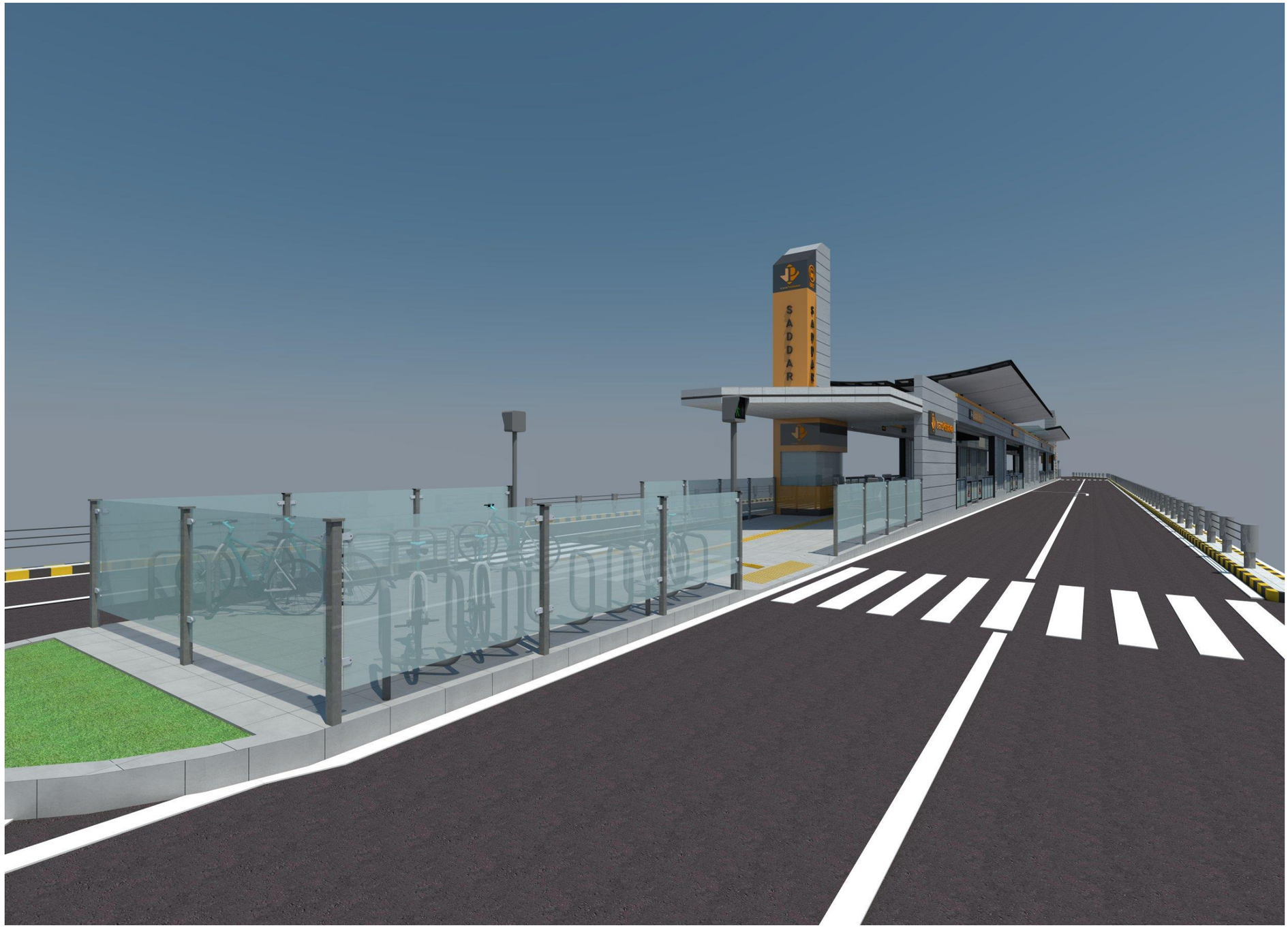


Figure 5. 35 Walkway and Cycle lane on Station Concourse Level.

Figure 5. 36 Cycle Crossing at Concourse Level.

Figure 5. 37 Bike Rack at BRT Station.



5.4 Station Access & Pedestrian Facility

5.4.1 Station Access

Access to station is very important to improve the connectivity from the BRT station to the surrounding area. On most stations, access is provided at both end of the station, except at few elevated stations, where space might be limited. Universal access is also promoted in Peshawar BRT, where all type of access, such as stairs, escalator and elevators are provided for all users with different abilities. On some stations, stairs from the sidewalk is also provided with guiding rails for bicycles, to allow bicycles to use the stairs to cross the road via bridge, mainly on GT road.

To access the station, passengers are provided with pedestrian an overpass bridge, pedestrian tunnel or at-grade crossing with pedestrian signal, but also on few locations, a combination between any of those options. For example, at Board Bazar Regi Station (BS-25), at one end, pedestrian bridge will be provided, and at the other end, an existing tunnel will be improved for access to the station. The decision of choosing different type of access is determined with the site's space availability, as well as the road width. Most of the access on the at-grade section of the city center part (Saddar Road) will use at-grade crossing with pedestrian signal, since the width of road to cross is less than 30 meters wide.

Different BRT Access Types.

At Grade Crossing

- Natural for pedestrian
- People tends to walk where there is a short distance to cross rather than to be pushed to climb the bridge or tunnel.
- The best option for short distance (2-3 lanes)

Component:

- Island
- Zebra Crossing

Pedestrian Bridge

- For highway
- More than 3 lanes
- Quicker for construction period, so it would not interfere the traffic
- Highway pavement weight is not suitable for tunnel construction (layering issue)

Component:

- Ramp (universal access)
- Stairs (shorter)
- Escalator (up)

Tunnel

- With weather condition in Peshawar, tunnel access is more feasible since it can be equipped with fan/ventilator and safer to cross.
- Has vibrant ambience from shops inside the tunnel
- Placed near attraction area (bazaar/bus stop/university) which could generate people to come

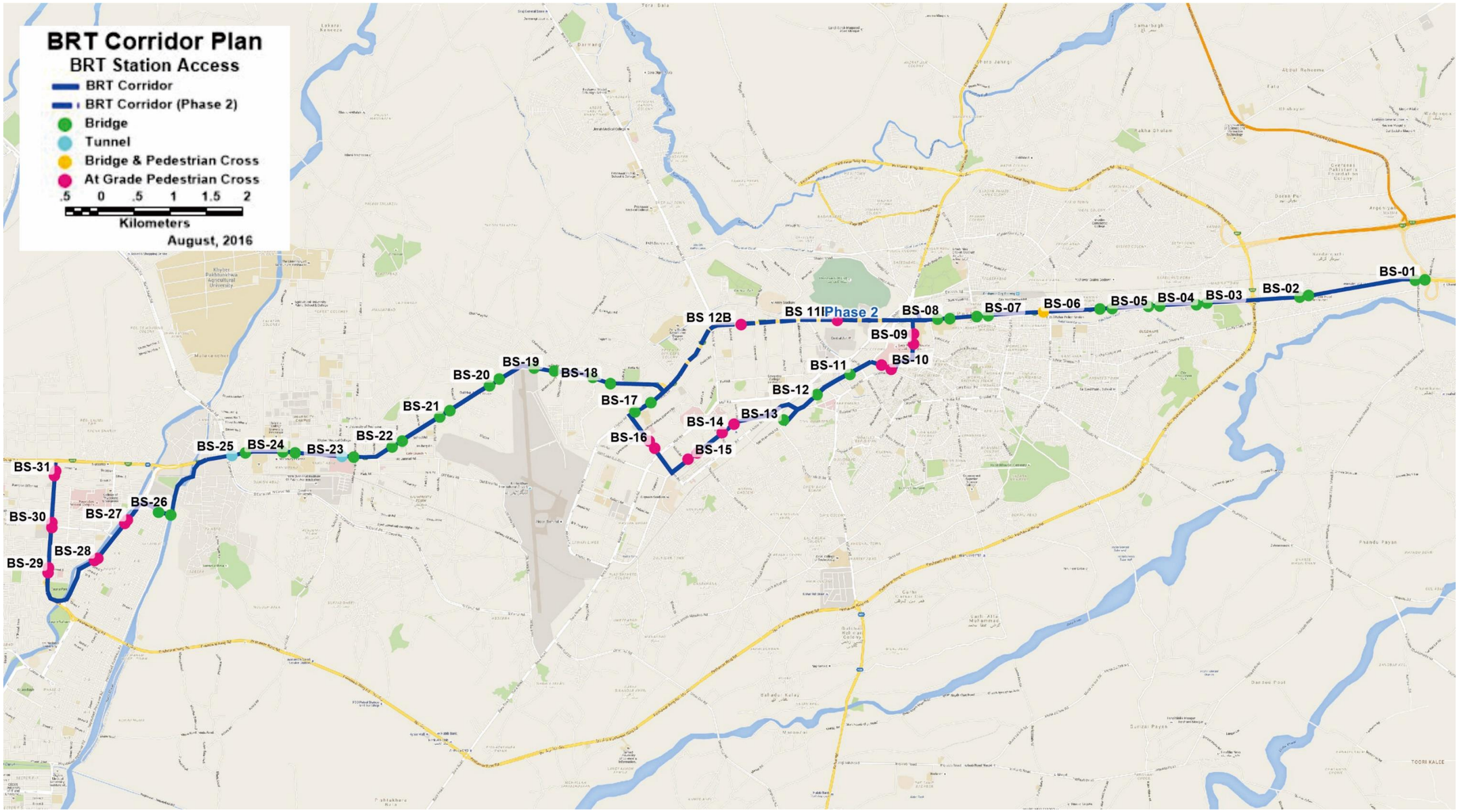
Component:

- Stairs
- Escalator
- Universal Access
- Shops

Figure 5. 38 Different Types of Access in BRT.

Figure 5. 39 Bicycle Guiding Rail (left) and Cycle Lane next to BRT Corridor (right).

Figure 5. 40 BRT Access Type along Corridor.



5.4.2 Pedestrian Facility

Figure 5. 41 Existing Pedestrian Crossing Facility

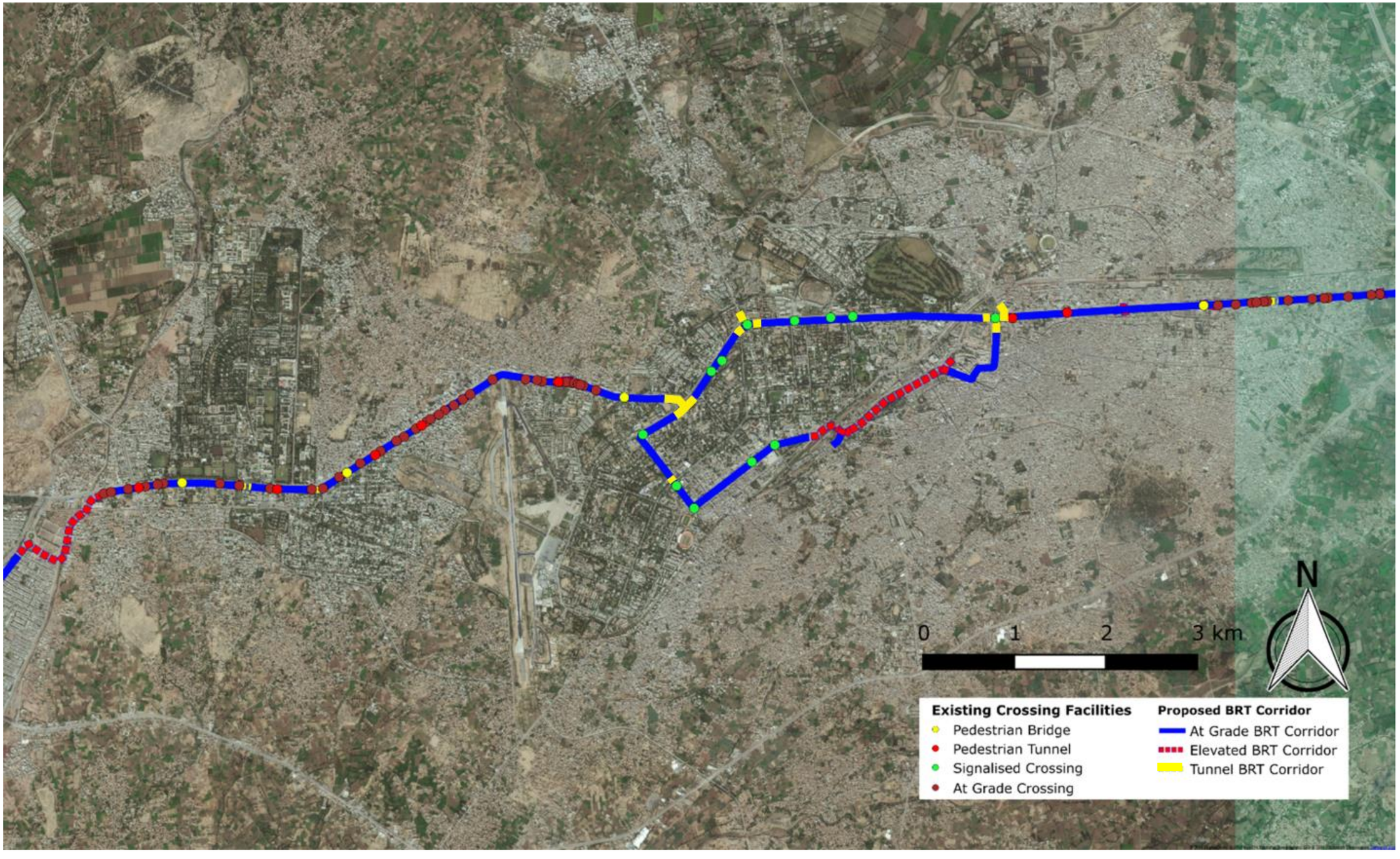


Figure 5. 42 Existing and Proposed Pedestrian Crossing Facility

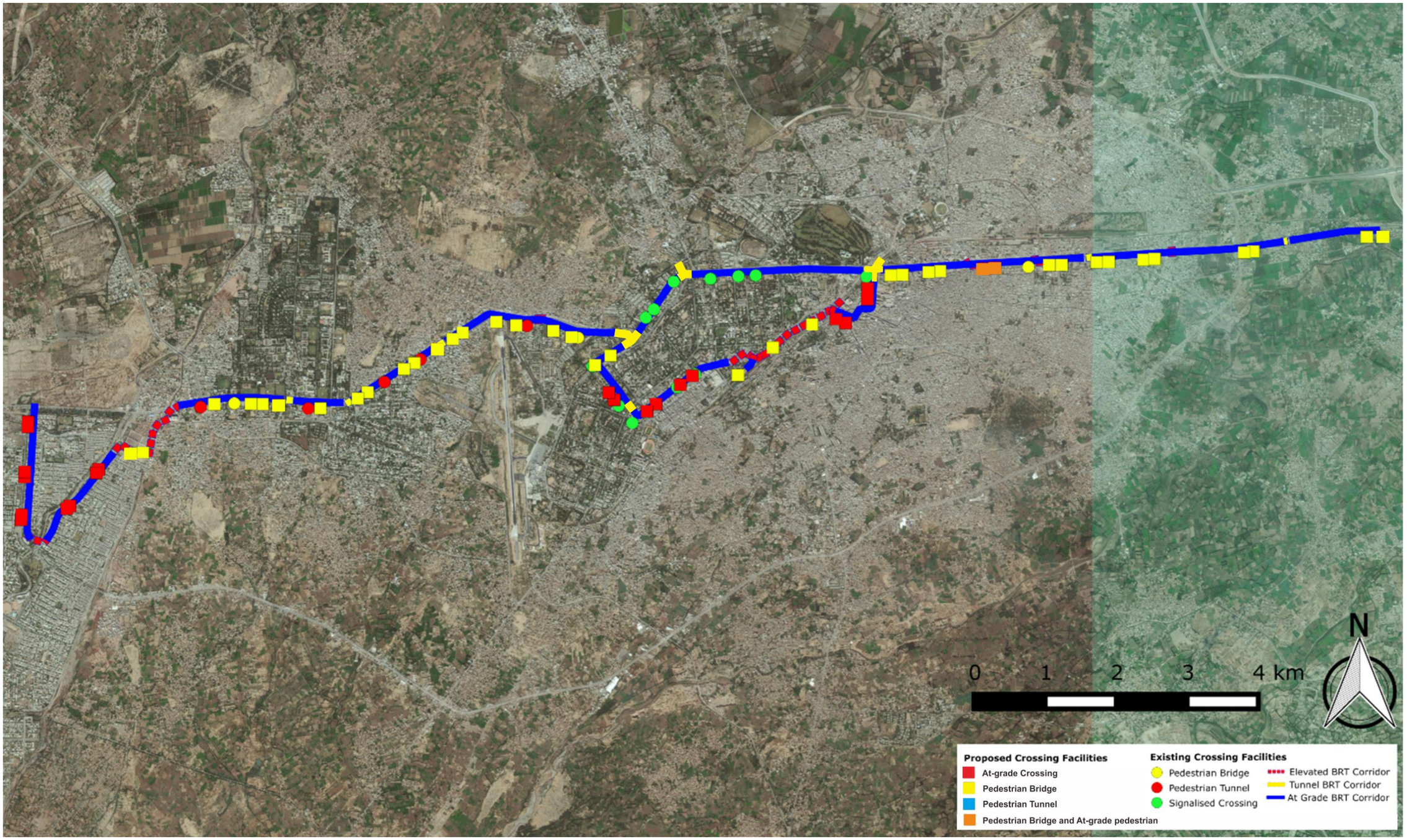


Figure 5. 43 Overlay map between existing and proposed pedestrian crossing facility

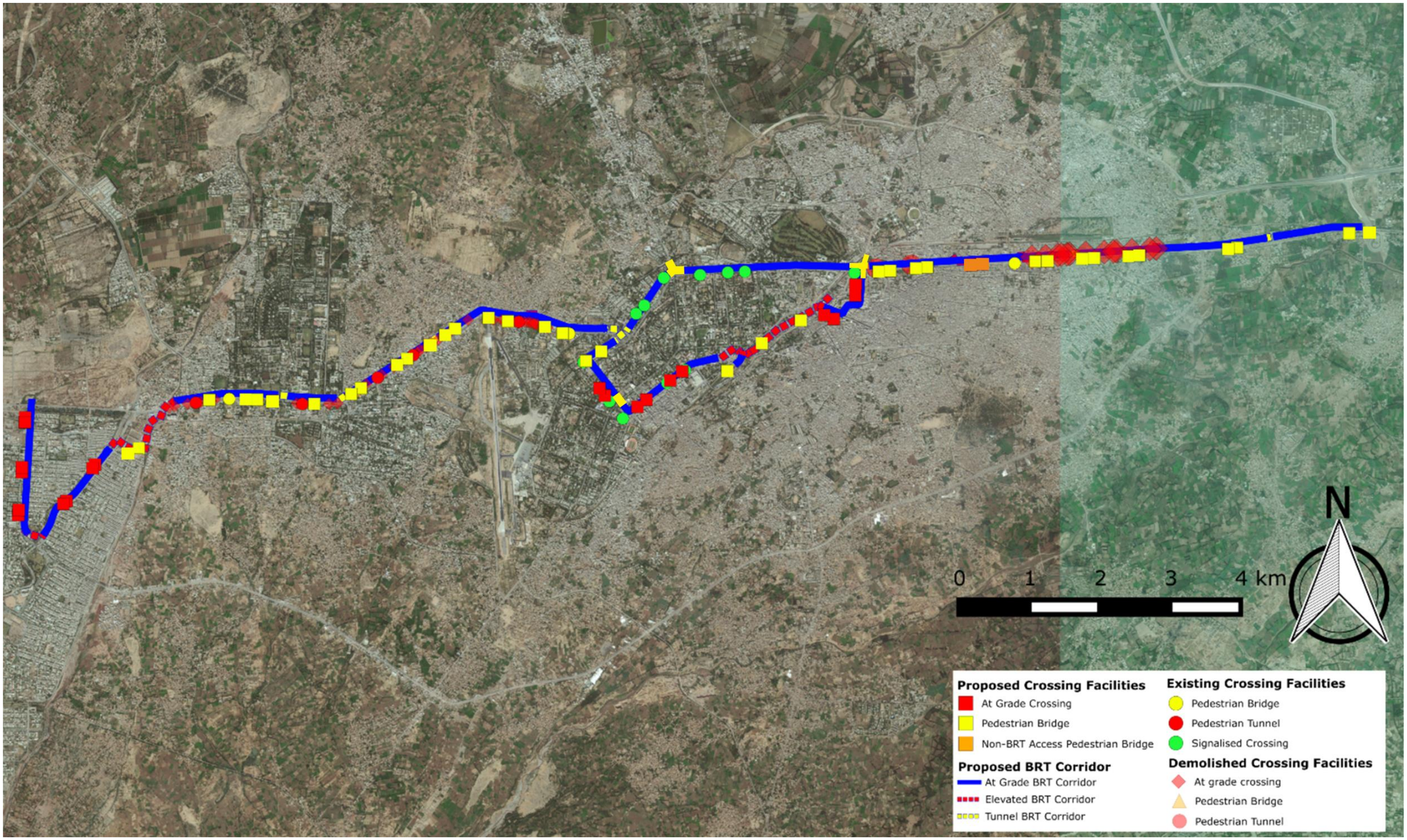
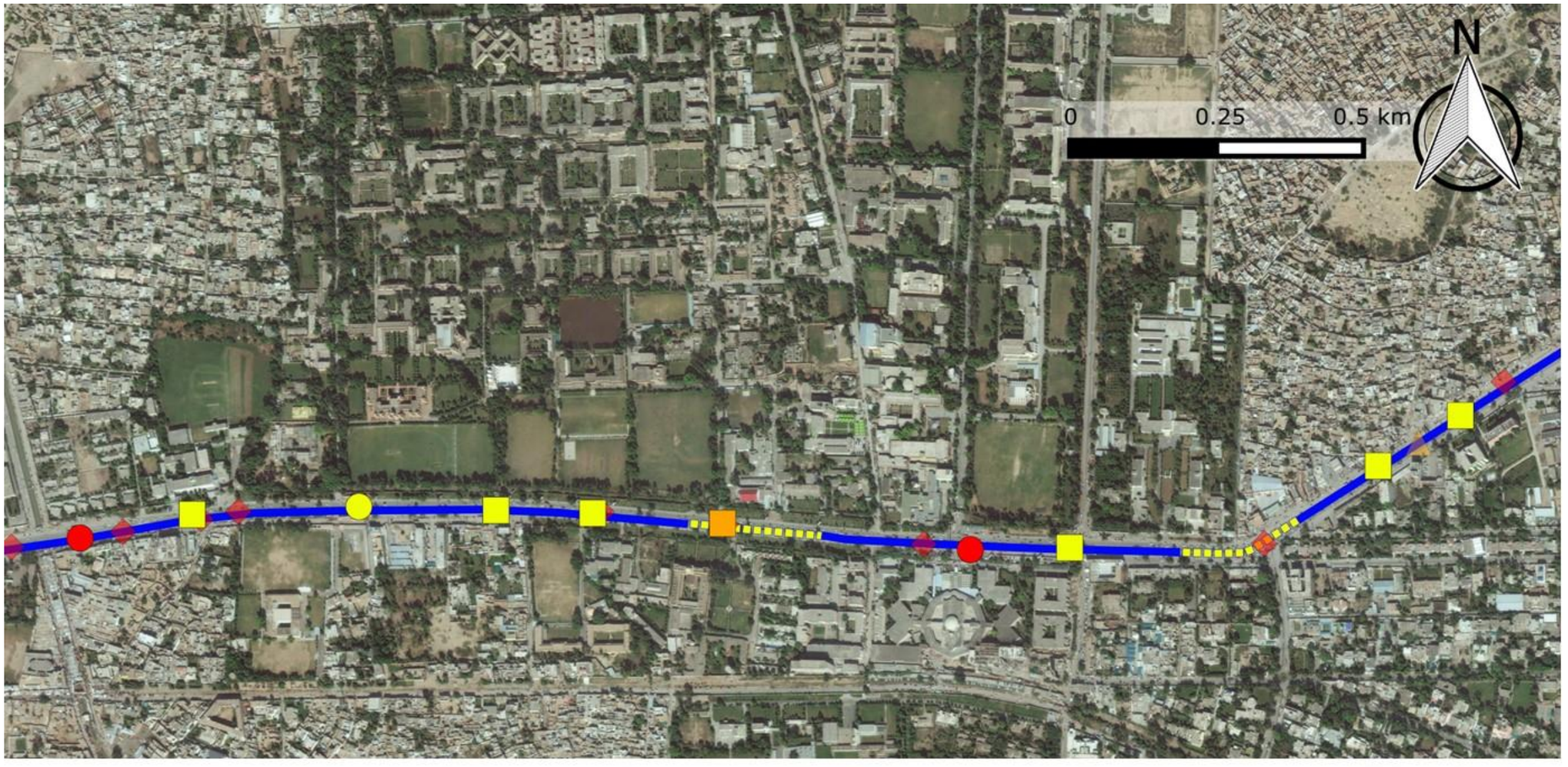
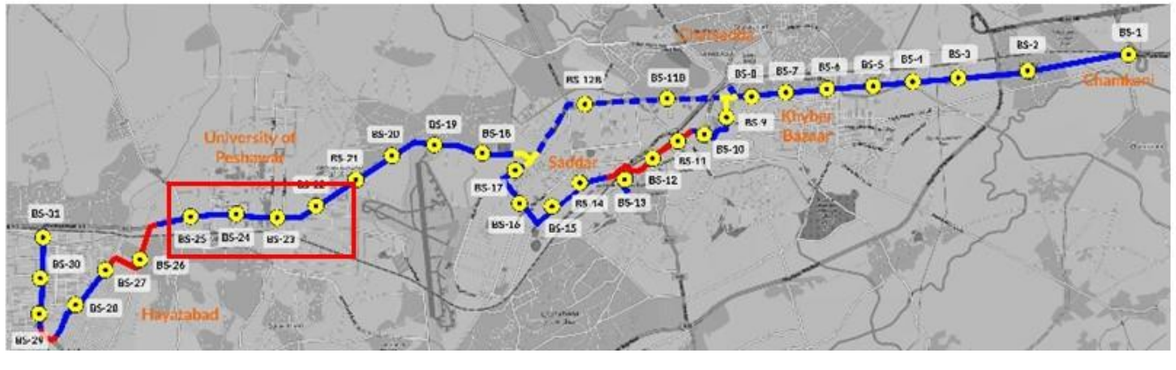


Figure 5. 44 ***Proposed Pedestrian Crossing Facility (SECTION A)***





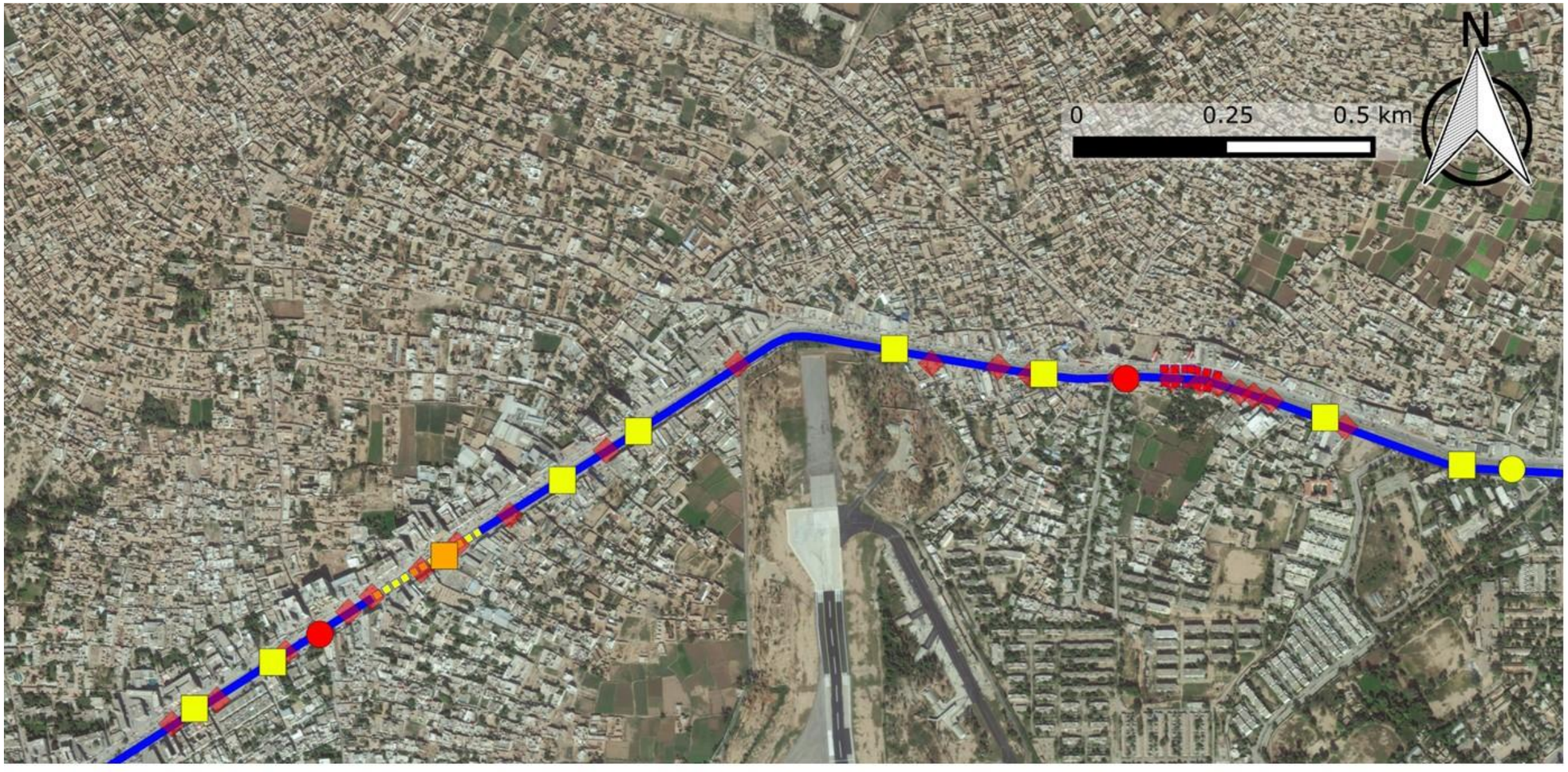
Proposed Crossing Facilities
- At Grade Crossing
- Pedestrian Bridge
- Non-BRT Access At Grade Crossing
- Non-BRT Access Pedestrian Bridge

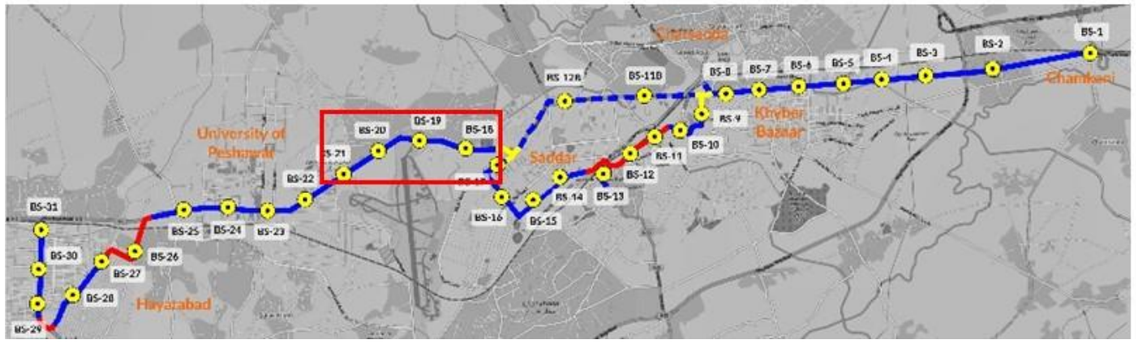
Proposed BRT Corridor
- At Grade BRT Corridor
- Elevated BRT Corridor
- Tunnel BRT Corridor

Existing Crossing Facilities
- Pedestrian Bridge
- Pedestrian Tunnel
- Signalised Crossing

Demolished Crossing Facilities
- At grade crossing
- Pedestrian Bridge

Figure 5. 45 **Proposed Pedestrian Crossing Facility (SECTION B)**





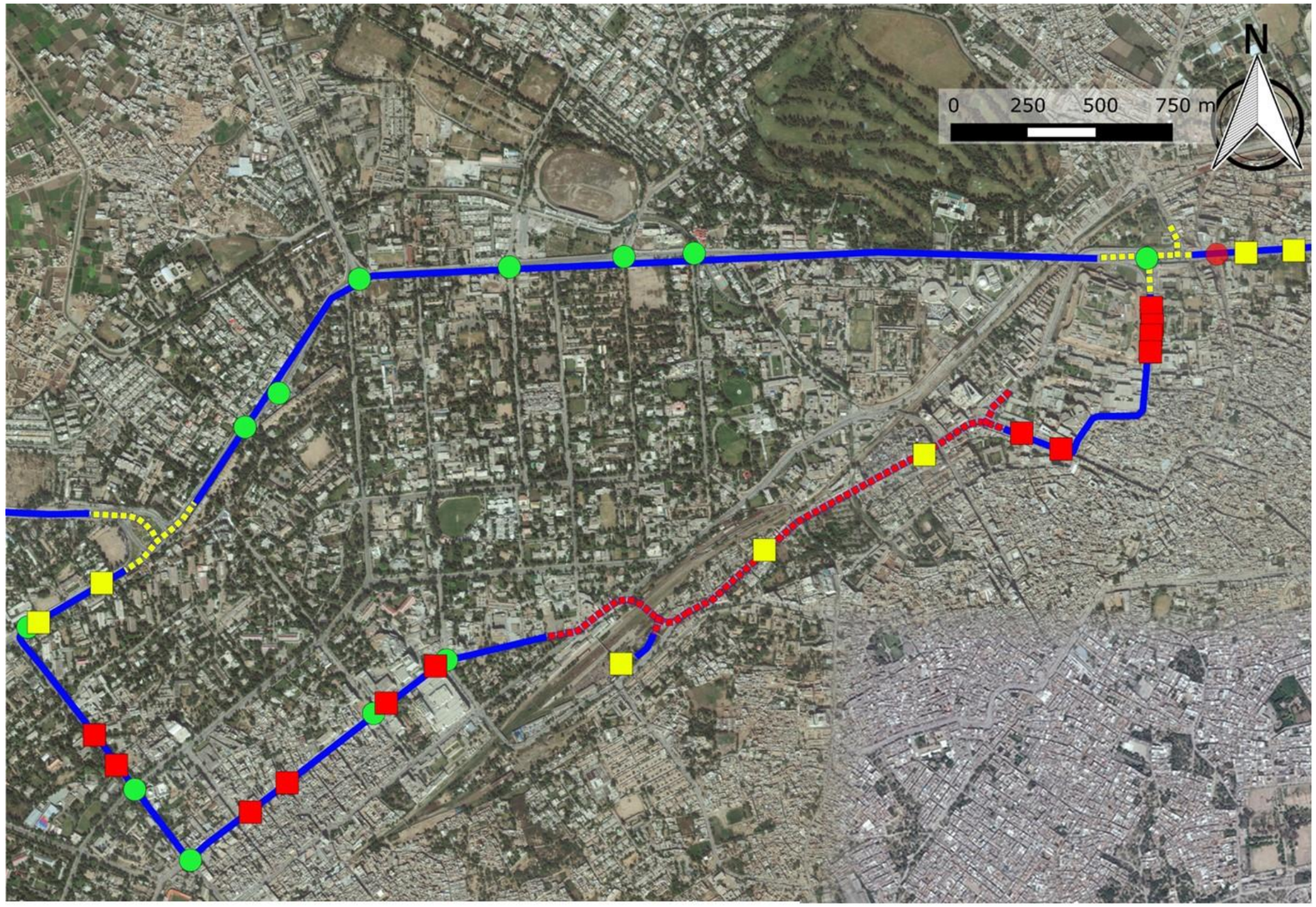
Proposed Crossing Facilities
- At Grade Crossing
- Pedestrian Bridge
- Non-BRT Access At Grade Crossing
- Non-BRT Access Pedestrian Bridge

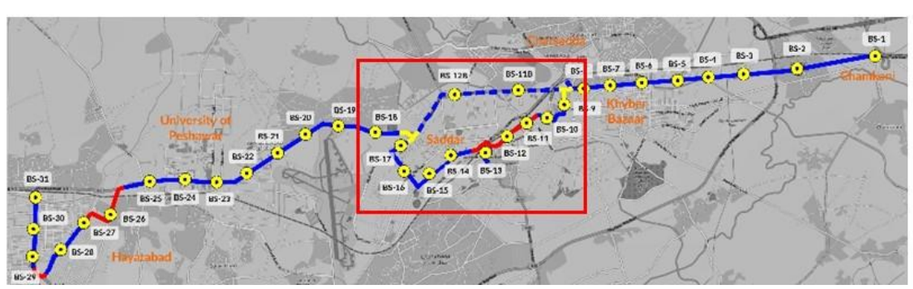
Proposed BRT Corridor
- At Grade BRT Corridor
- Elevated BRT Corridor
- Tunnel BRT Corridor

Existing Crossing Facilities
- Pedestrian Bridge
- Pedestrian Tunnel
- Signalised Crossing

Demolished Crossing Facilities
- At grade crossing
- Pedestrian Bridge

Figure 5. 46 Proposed Pedestrian Crossing Facility (SECTION C)





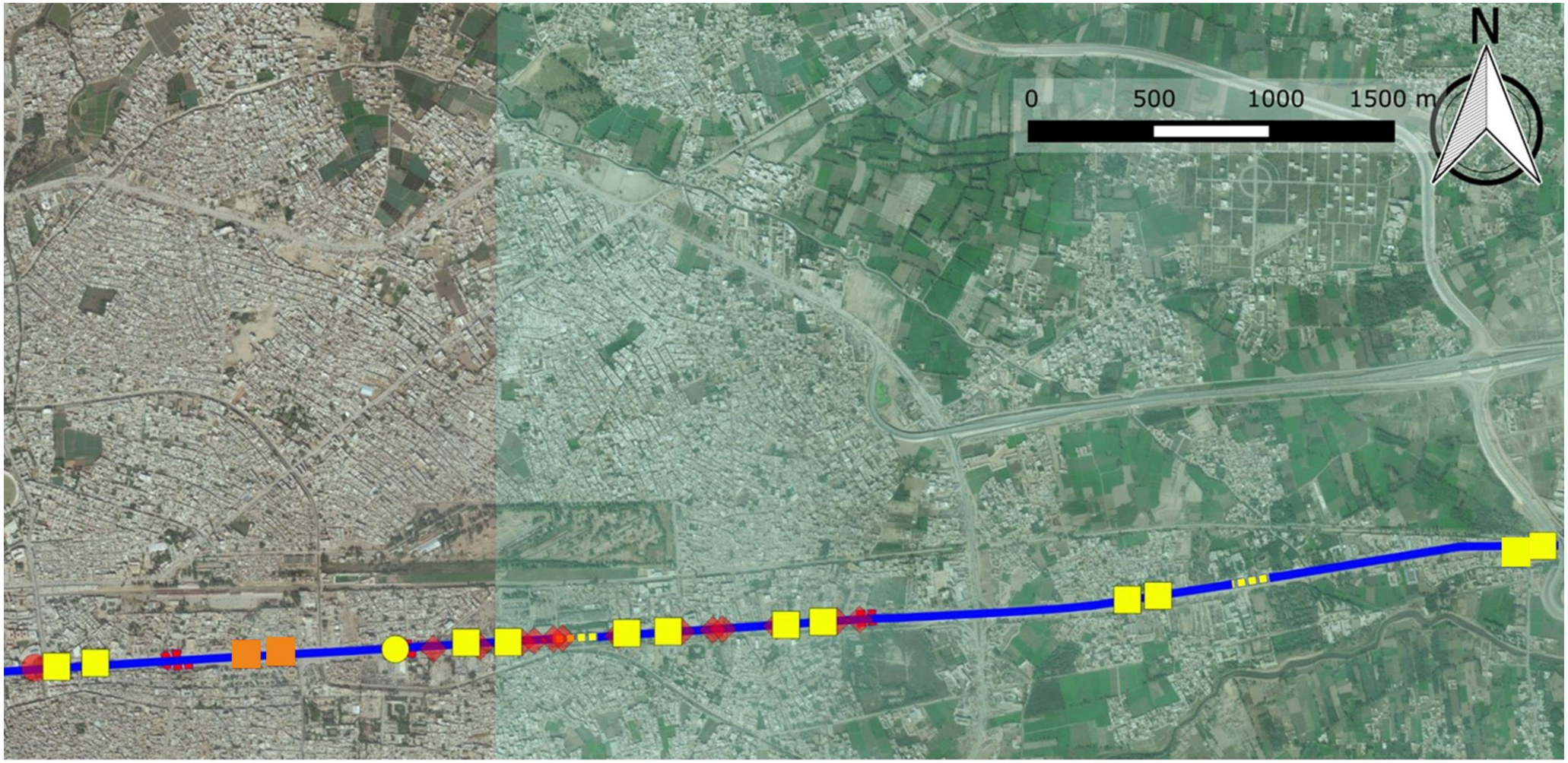
Proposed Crossing Facilities
- At Grade Crossing
- Pedestrian Bridge
- Non-BRT Access At Grade Crossing
- Non-BRT Access Pedestrian Bridge

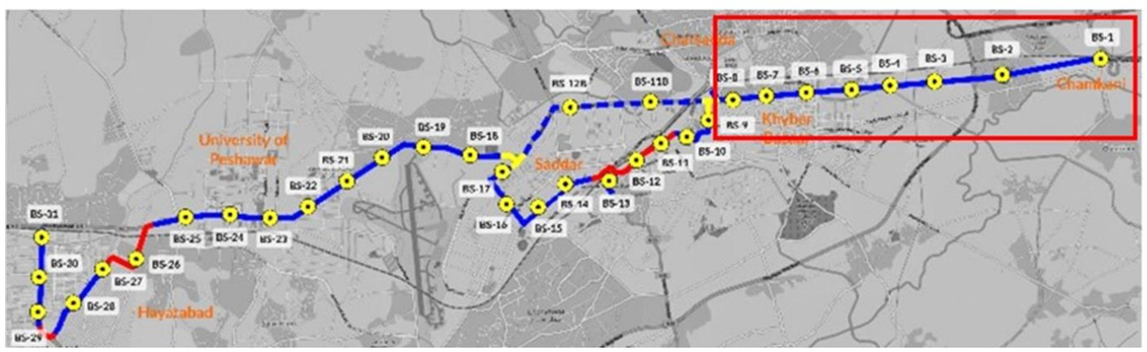
Proposed BRT Corridor
- At Grade BRT Corridor
- Elevated BRT Corridor
- Tunnel BRT Corridor

Existing Crossing Facilities
- Pedestrian Bridge
- Pedestrian Tunnel
- Signalised Crossing

Demolished Crossing Facilities
- At grade crossing
- Pedestrian Bridge

Figure 5. 47 Proposed Pedestrian Crossing Facility (SECTION D)





Proposed Crossing Facilities
- At-grade Crossing
- Pedestrian Bridge
- Pedestrian Tunnel
- Pedestrian Bridge and At-grade pedestrian

Proposed BRT Corridor
- At Grade BRT Corridor
- Elevated BRT Corridor
- Tunnel BRT Corridor

Existing Crossing Facilities
- Pedestrian Bridge
- Pedestrian Tunnel
- Signalised Crossing

Demolished Crossing Facilities
- At grade crossing
- Pedestrian Bridge

In the proposed pedestrian crossing facilities, three pedestrian tunnels need to be demolished, mainly due to BRT-only tunnel that will be built on those locations. Since these pedestrian tunnels/market currently have many shop owners renting the space and needs to be relocated/compensated, we propose to shift them to the nearest pedestrian bridge accessing the BRT station. Tunnels that needs to be relocated are as follows:

1. Pedestrian tunnel demolition of Hushnagri Underpass Market (Noor Market) near BS-7. There are 34 shops owned or on rent by private investors. The existing shops will be moved to new pedestrian tunnel only on west (accommodate 51 shops) of BRT station. [Figure 5. 48 Hashtnagri Underpass MarketFigure 5. 48]

2. Pedestrian tunnel demolition of Firdous Cinema Underpass Market (Gul Market) near BS-8. This will close 36 shops. The existing shops will be moved to new pedestrian tunnel only on the west (able to accommodate 39 shops) of the BRT station. [Figure 5. 49]

The proposed pedestrian bridges would be 8-meter wide (3 meter for shops, 5 meter for pedestrian movement). The shops on the new pedestrian bridges will have 2.5 m x 3 m (80 sqft) per shops. A total of 95 shops will be provided at the BRT station pedestrian bridge, with total area dedicated for shops are 637.5 Sqm, or 6861 sqft. The detail information and dimension on Appendix G.

The proposed shops on pedestrian bridges will look like the Golden Bridge in Singapore and in Sukumvhit area in Bangkok, with access to MRT.

Figure 5. 48 Hashtnagri Underpass Market

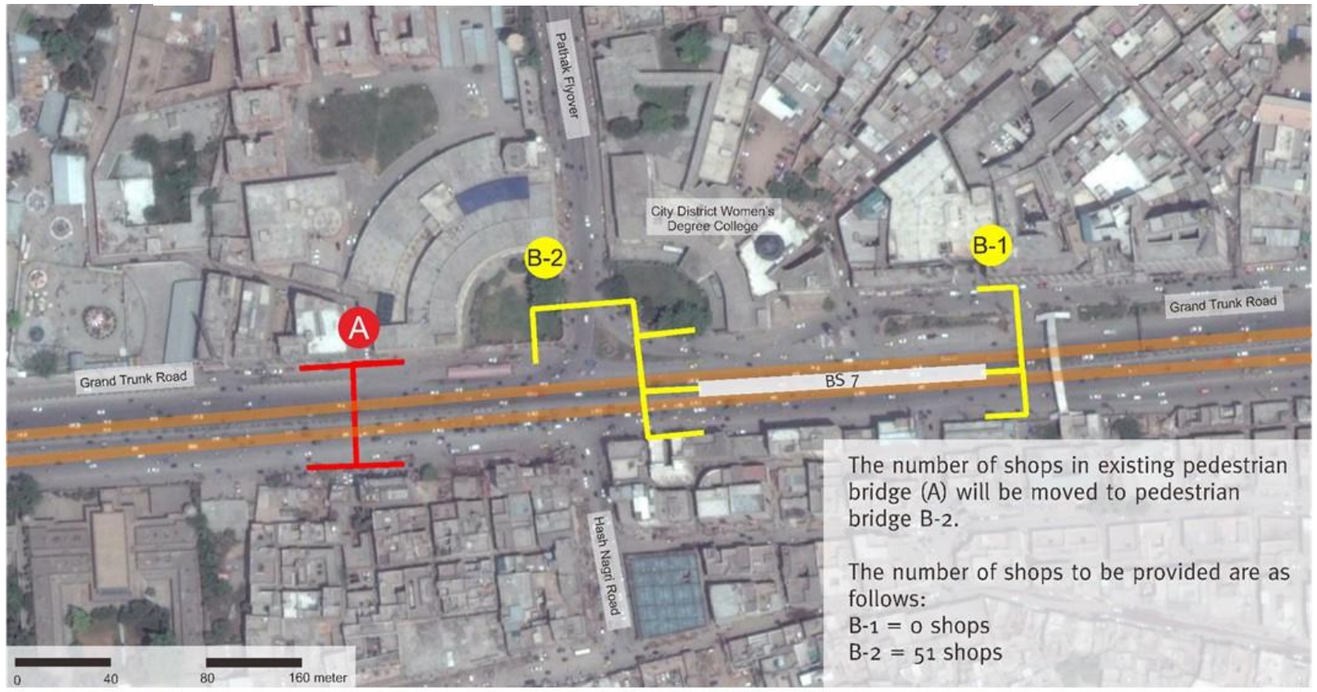


Figure 5. 49 Firdous Cinema Underpass

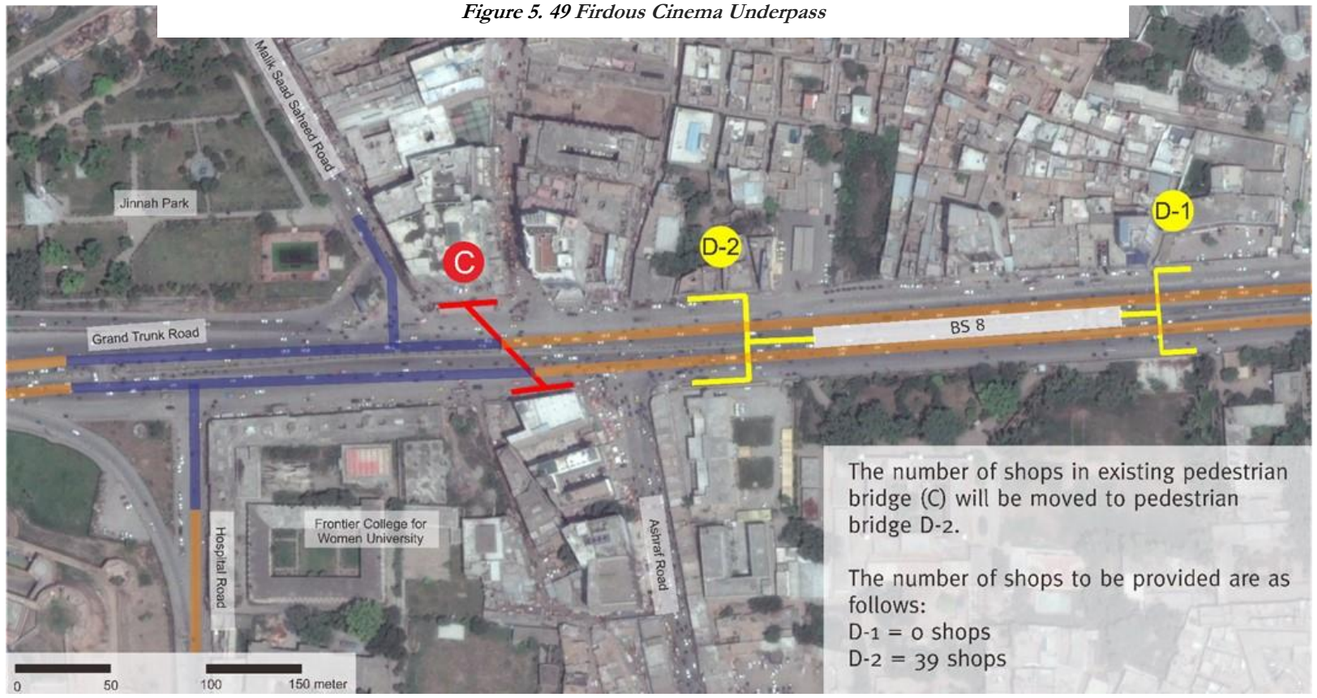


Figure 5. 50 Illustration of shops on pedestrian bridge

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5.5 Bus Depot

5.5.1 Depot Facilities

A large number of buses for the Peshawar BRT operation require bus depot facility to enable operation efficiency in the BRT system. They have indirect effects of improving passenger convenience and increase the overall performance of the BRT. In order to serve the system well, bus depots should have at least the following facilities:

- A large area for parking buses
- Good pavement quality
- Sufficient space for bus marking and maneuver area
- Re-fueling facility, cleaning and washing system
- Maintenance and repair area (workshop)
- Administrative office for operators, and employee facilities.

The facilities above should be placed properly in a depot to ensure smooth flow and maneuver of buses. Selection for the location, layout, and management of this depot facility will significantly affect the overall system efficiency. Ideally, depots should be located adjacent to the terminals so buses can start service quickly without having to travel long distances between those two facilities. Travel between the depot and terminal areas create "dead kilometers" since fuel and other expense are consumed without generating any passenger revenues.

Figure 5. 51 Depot Locations in Bogota.

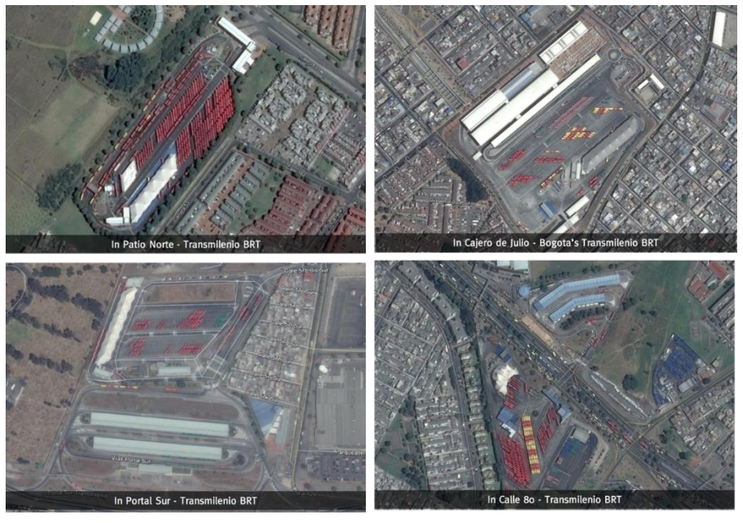


Figure 5. 52 Depot and Terminal Location at Bogota Transmilenio.

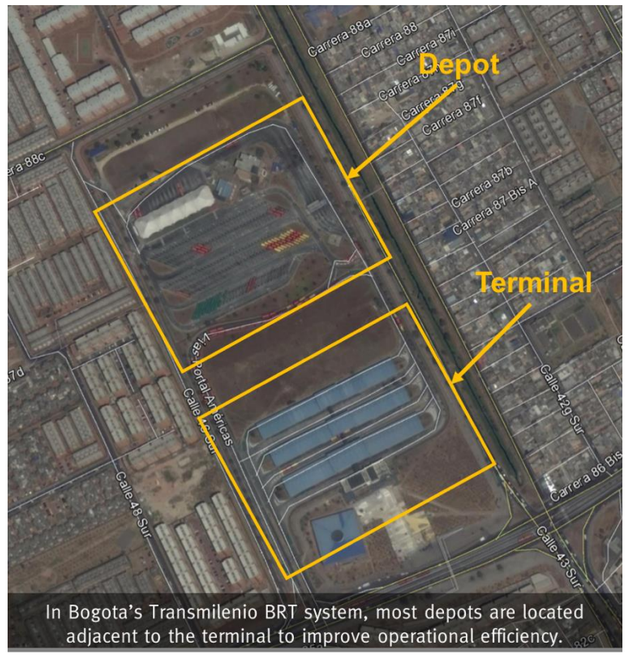


Figure 5. 53 Bus Washing Facility in Depot in Bogota.

5.5.2 Standard Depot Layout

The standard depot design shown Figure 5. 54 provides a good in-and-out flow so the buses can enter certain or all facilities smoothly without having difficulties in maneuvering or blocking other buses.

After vehicles enter the depot area, they are visually inspected at point 1 (entrance gate) and will be classified as "green" (operational), "yellow" (in need of minor repairs), or "red" (in need of major repairs).

If the bus is classified as "green", the first move is to the refueling area. Here fuel levels and vehicle kilometers are checked. It is a way of monitoring usage and operating costs. From the refueling area, the vehicle will likely be washed and then placed in a parking bay.

If the bus is classified as "yellow", the first move is to the minor maintenance area, from which the vehicle may return to service the same day or by the next morning. This area also performs routine checks on the vehicle based on the total kilometers traveled. From the minor maintenance, the vehicle will move to refueling are and then the vehicle will likely be washed and placed in a parking bay. If the bus is classified as "red", it goes to the major maintenance area and is replaced by a stand-by vehicle.

5.5.3 Peshawar Bus Depot Location

Bus depots require a considerable amount of space, the location is often determined by land availability and value to acquire the property. In many cases, sufficient land is not always available near a terminal site as such site acquisition can be quite costly.

The size of the depots depends on the number of vehicle parking needed, and the number of vehicles likely to need repairs. The configuration of the parking area can be a trade-off between parking efficiency and ease of entry. A dense packed parking area may be relatively space efficient, but it can also lead to occasional damage to vehicles bumping into each other.

Depots consume large amounts of urban space and quite visible to public. Thus, a good visual aesthetics of the depot will affect the local population's image of the system. A well-designed work environment can have a positive impact on employee satisfaction and work effectiveness. The design should protect maintenance workers from adverse weather conditions, such as wind, rain, or strong sun. The maintenance area ceiling height should be sufficient to allow employees to comfortably perform maintenance on the topside of the BRT vehicles.

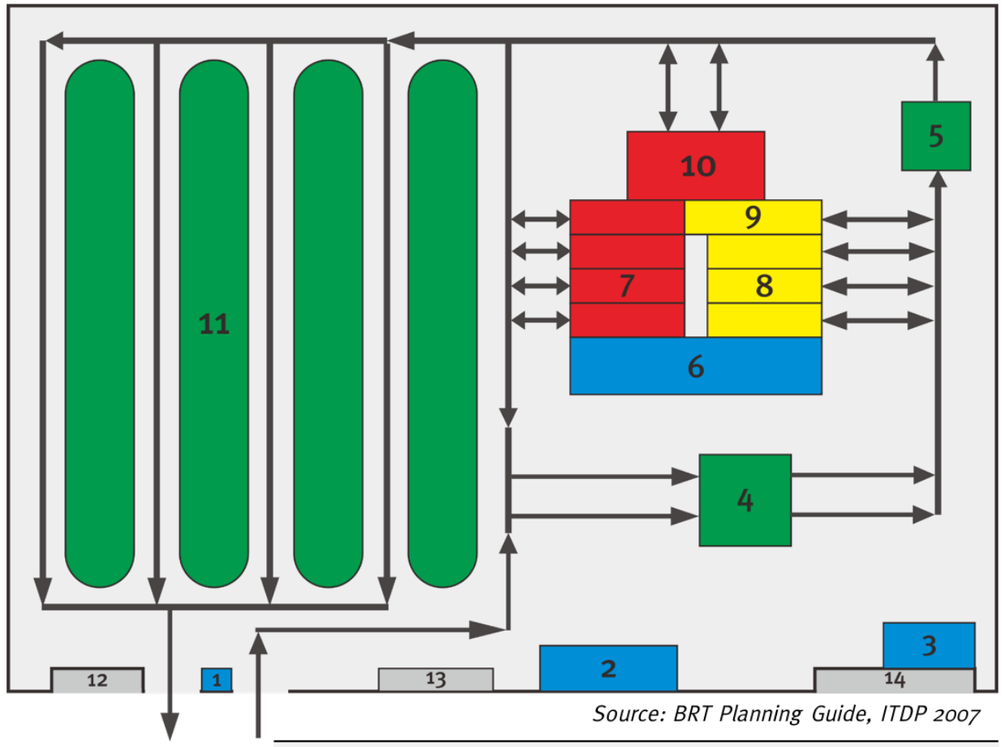
To match the requirement for BRT depot in Peshawar, an available space measuring roughly 32 canal on Hayatabd and 100 canal on Chamkani are the ideal location for the depot as they are close to the corridor, as shown in the following figures.

2 depot locations are proposed near both end of the corridors to ensure equal sizing of the fleet. Each depot is designed to accommodate up to 250 buses with different types of buses (9-meter, 12-meter and 18-meter).

Based on the request from KP Chief Minister, commercial areas are desired in every depot and staging facility. For Chamkani and Hayatabad, 1000 square meter of commercial area will be provided on each depot. This can accommodate around 50 shops. As for staging facility in Dabgari Garden, the current space available only allows around 30 shops to be provided in the vicinity.

However, since no market analysis is conducted to justify the feasibility of these commercial areas, we cannot guarantee the financial viability of such commercial areas, especially the ones in Hayatabad and Chamkani depot, since location-wise, these depots are not located near any busy commercial districts

Figure 5. 54 Standard Depot Layout.

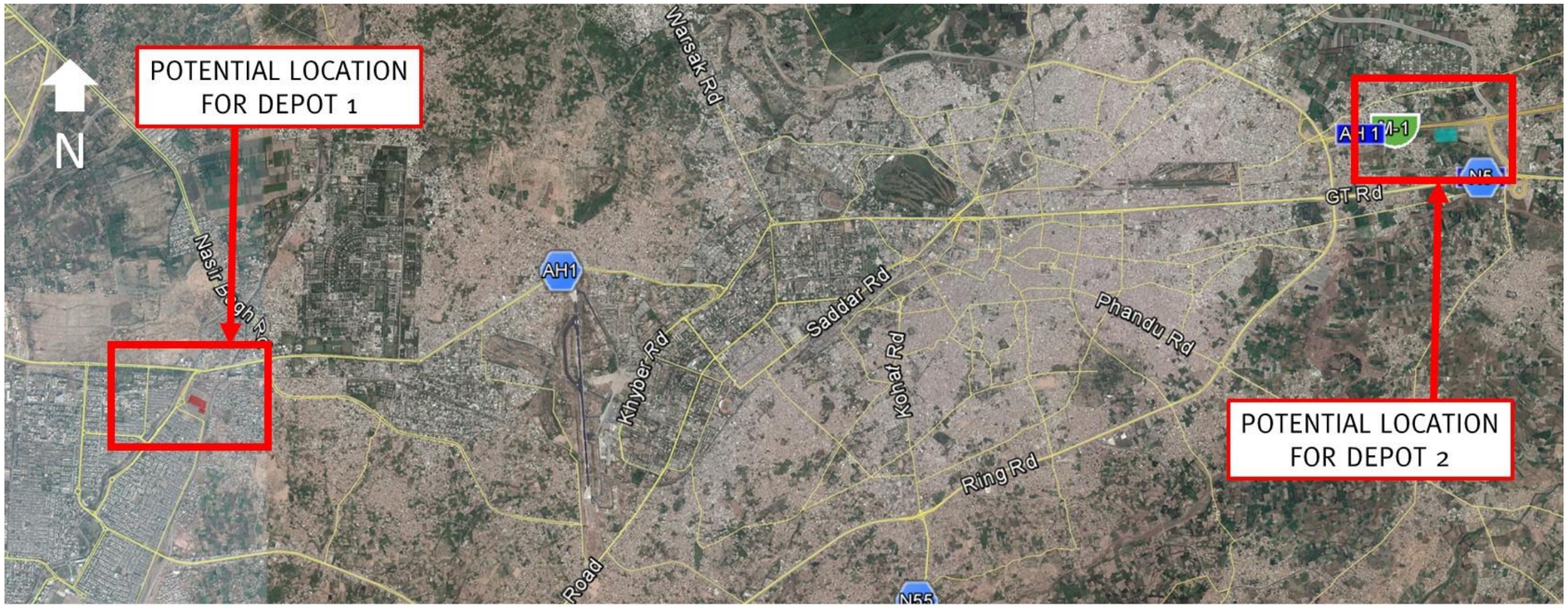


Source: BRT Planning Guide, ITDP 2007

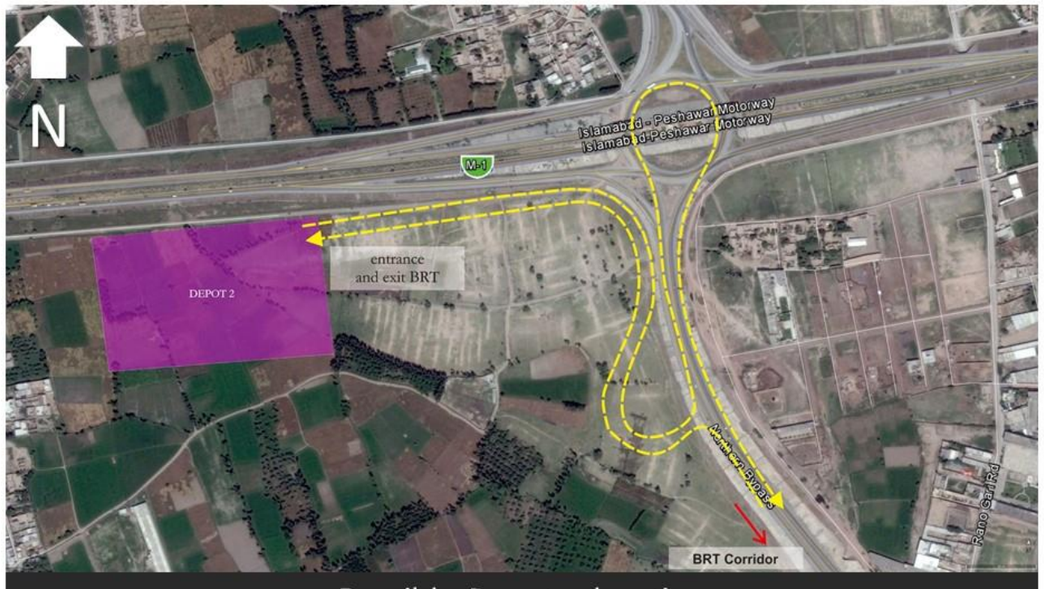
LEGEND			
1	Gate and visual inspection area	7, 10	Major repairs
2, 3, 6	Administrative offices for concessioned operators	8, 9	Minor repairs and maintenance
4	Refueling area	11	BRT vehicle parking
5	Vehicle washing and cleaning area	12, 13, 14	Private vehicle parking

Green	Operational vehicles
Yellow	Vehicles requiring minor or routine maintenance
Red	Vehicles requiring major repairs

Figure 5. 55 Peshawar BRT Depot Location.

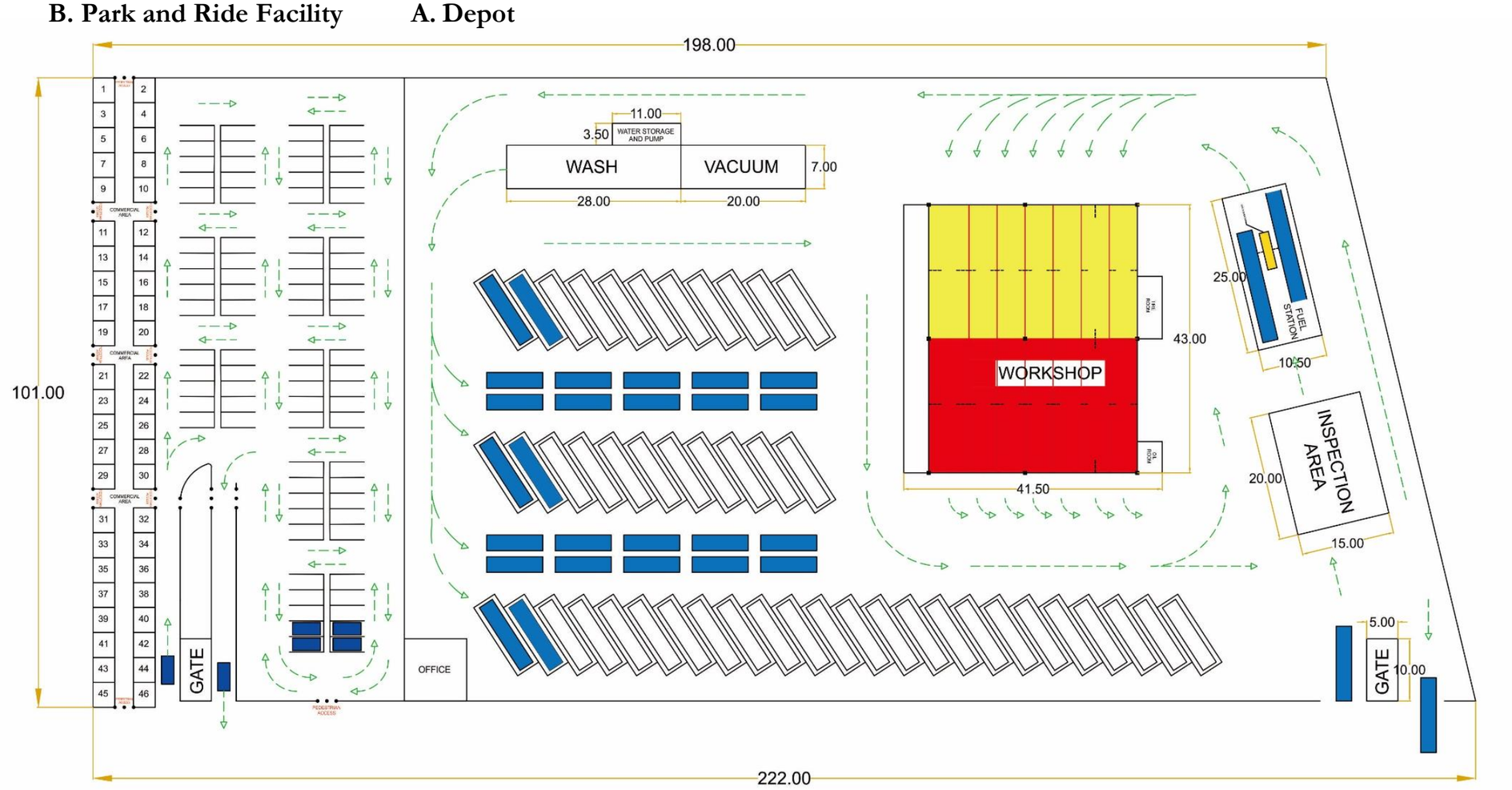


Possible Depot 1 location



Possible Depot 2 location

Figure 5. 56 Depot 1 Hayatabad Layout.



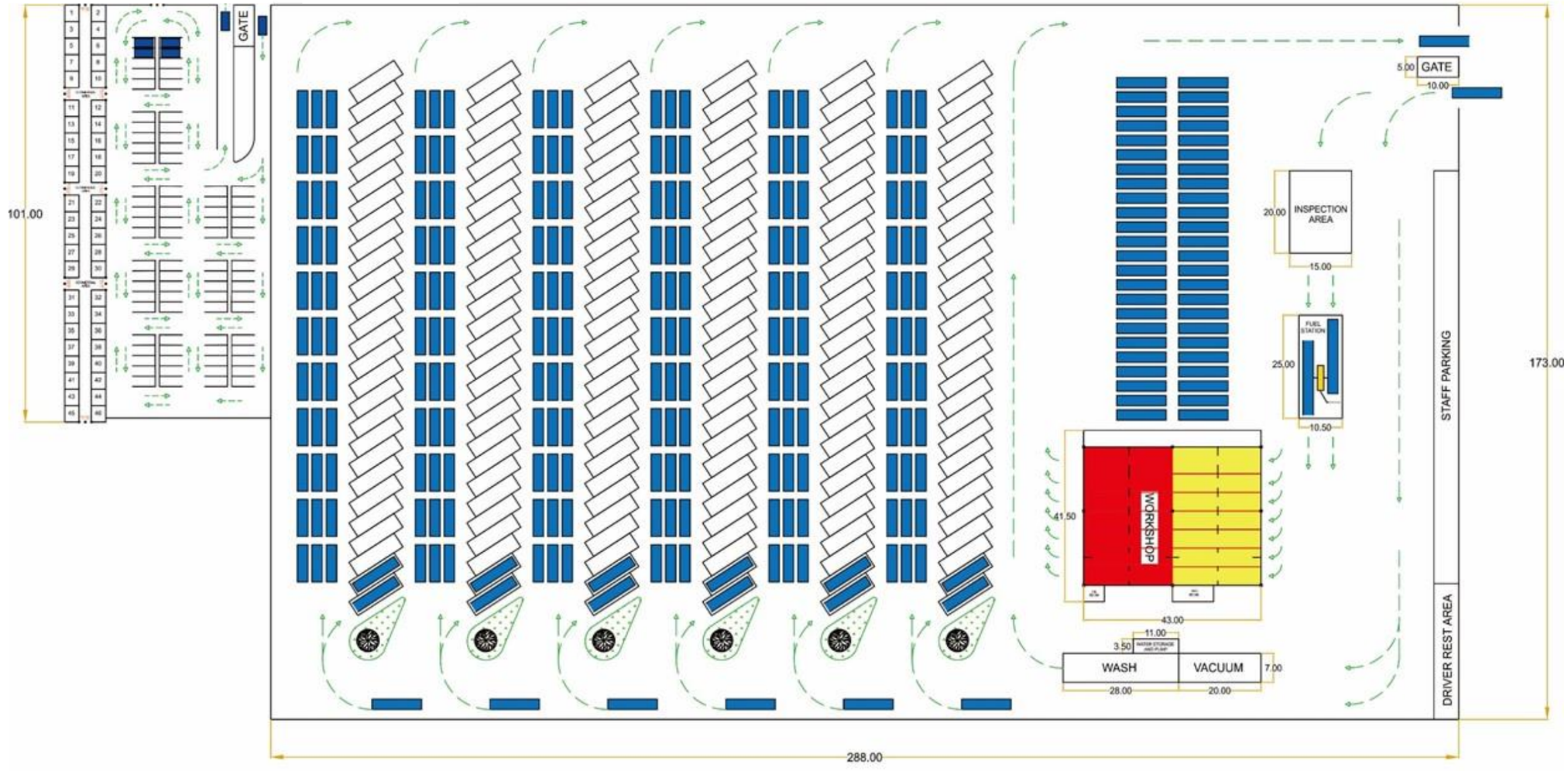
- This depot is located near Peshawar Ring Road across Al Haram Model Town, with an area of roughly 1.6 hectares and can accommodate up to 66 buses, including 46 12-m buses parking spaces and 20 9-m buses spaces.
- A park and ride facility with an area of 0.4 hectare is located next to the depot. It can facilitate up to 80 cars and has connection with BS 26.
- A commercial area with around 50 shops.

Item	Hayatabad	
	Bus Depot	Park n Ride
Size (kanal)	32	8
Capacity	46 (12-m)	80
	20 (9-m)	
Total	66	

Figure 5. 57 Depot 2 Chamkani Layout.

B. Park and Ride Facility

A. Depot



This depot, which is located on the east end of the corridor, adjacent with Peshawar Motorway and can be accessed from Northern Bypass, is roughly 5 hectares big and can accommodate up to 408 buses parking spaces including 210 12-m buses and 198 9-m buses. This is also including a parking space for 48 buses standby as substitute for a bus which is needed a major maintenance and around 50 shops on the west part of depot.

Item	Chamkani		
	Bus Depot	Park n Ride	TP Office
Size (kanal)	100	8	-
Capacity	210 (12-m)	80	-
	198 (9-m)		
Total	408		

Staging Facility

In addition to the depot, a staging facility needs to be provided in the middle of the corridor. This facility will be used during off-peak hour, when some portion of the fleet will be put off-service on a stand-by mode, ready to be deployed during the evening peak hour. This facility will be located in Dabgari Garden, along with TransPeshawar office and Park and Ride facility. Multi-storey building will be constructed on the 20-kanal land, with Bus parking located on ground floor (road level), park and ride will be on 2nd floor, and TransPeshawar office on the 3rd Floor.

Figure 5. 58 Staging Facility Location.

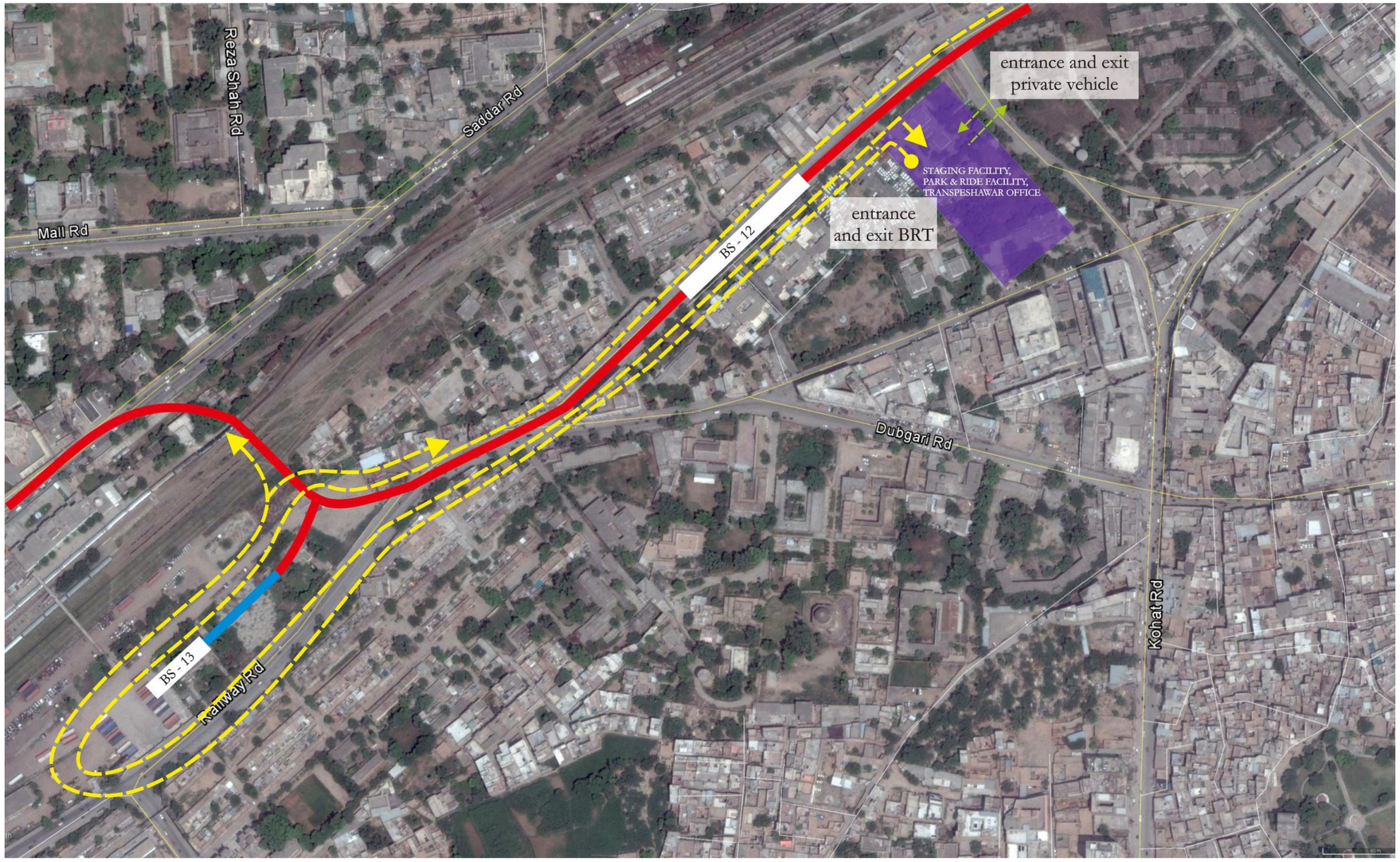
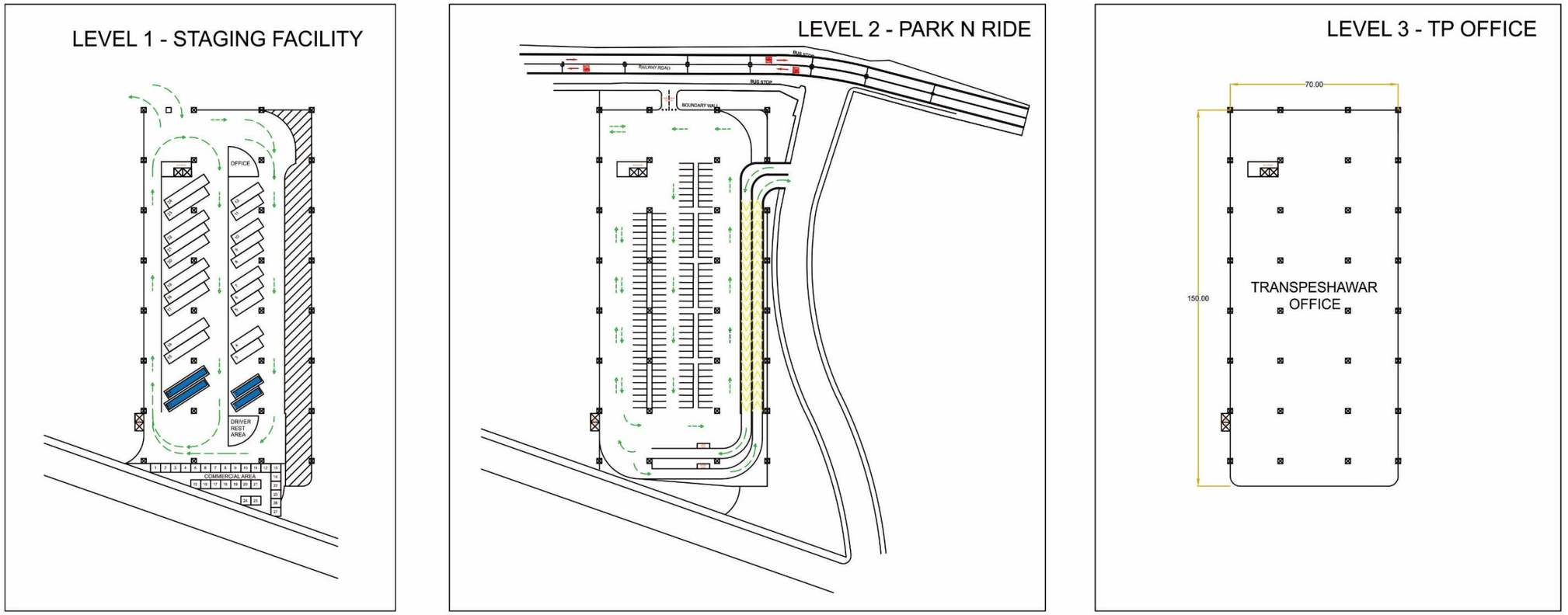


Figure 5. 59 Staging Facility Dabgari Layout.



- One building structure with 1 hectare area (20 kanals) is proposed in Dabgari. The structure consists of three levels:
- Level 1 (at-grade): staging facility
- Level 2 (+5.5): park and ride
- Level 3 (+11.0): TransPeshawar office
- Staging facility is used as bus parking facility during the off-peak. With this facility, some of the buses that are not operated during off-peak hour can stay for few hours, before they go into operation at the evening peak. Ideally the staging facility should be located in the middle of the corridor, so that buses can go straight pick up passengers, without wasting the 'dead' mileage.
- With this size, it can accommodate up to 24 buses (12-m and 18-m buses). In the staging facility, small bus dispatching office and driver rest area will also be built. It should be noted that this facility will not be treated as depot, as no big maintenance facility will be provided at the site, and any major maintenance should be done at the workshop located at the depot.
- A park and ride facility is located on the second level and can accommodate up to 126 cars. Ramps are provided to be accessible by cars. This park and ride is integrated with BS 12.
- The current space available only allows around 30 shops to be provided in the vicinity.

Item	Dabgari			
	Staging Facility	Park n Ride	TP Office	All in one structure
Size (kanal)	20	20	20	
Capacity	12 (9-m or 12-m)	126	-	
	12 (18-m)			
Total	24			

5.5.4 Workshop Layout

The following should be considered when designing a workshop: facilities to be provided; layout; vehicle circulation; and tools & equipment. The remaining facilities provided in this design are as follows:

On 1st floor

- Spare parts room, to store the spare parts stocks
- Mechanic room, is used by mechanics to gather or have a meeting
- Oil warehouse, to store oil used to periodic maintenance
- Tire room, to store tires and things related to tire changing
- Compressor room and equipment warehouse, is a room to place the compressor as the center of air distribution and to store supporting equipment
- Overhaul room to do major repairs, such as engine dismount, transmission change, and other bus parts which requires mode than 1-day to finish
- Air and water installation, is located in certain places in the workshop to support the maintenance process.

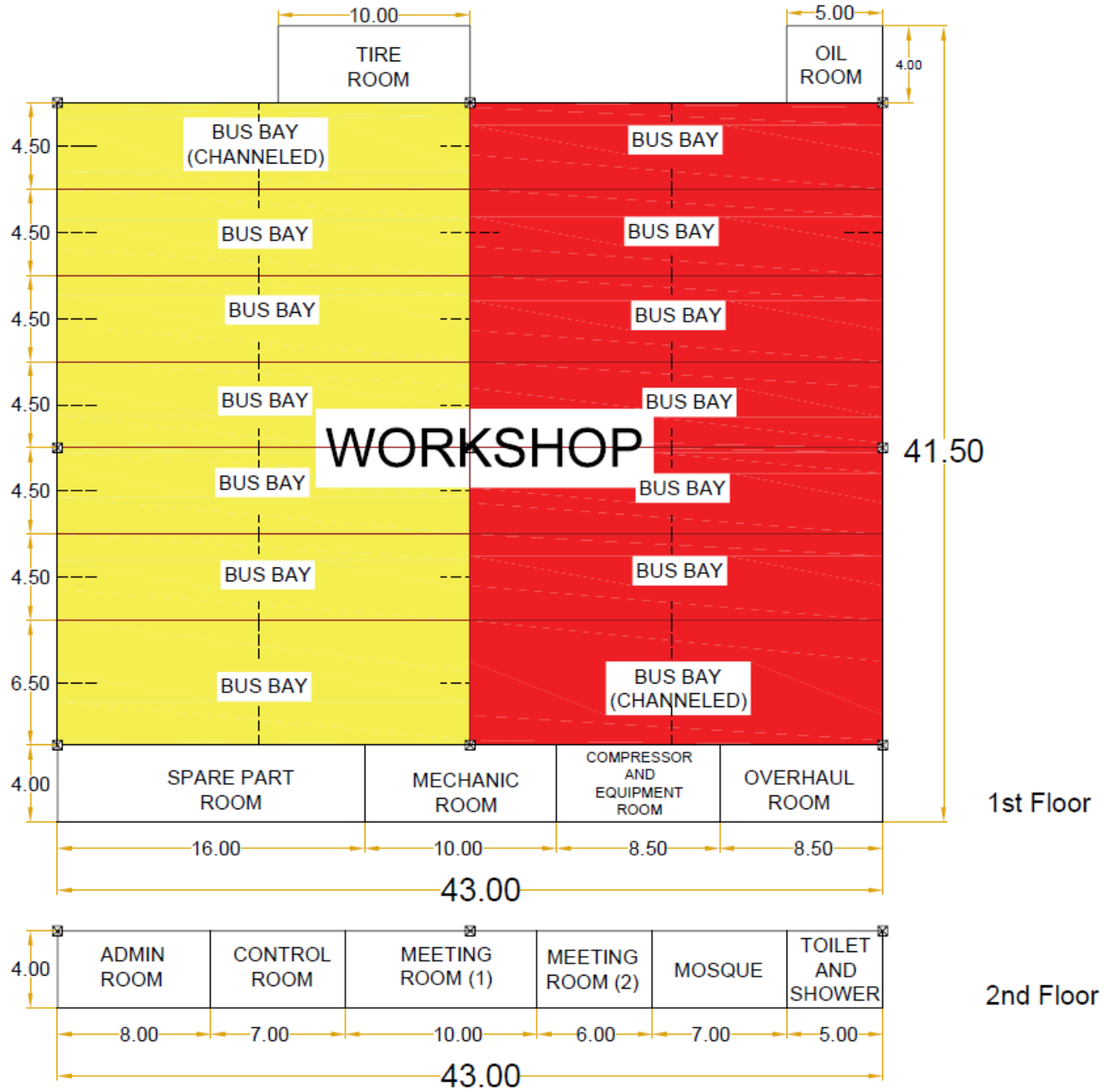
On 2nd floor

- Admin room, to store documents, files, and all related to administration
- Control room, for foreman or mechanics to receive order according to the system applied
- Meeting room, for management
- Mosque, for prayer
- Toilet and shower.

The workshop design can accommodate up to 14 buses at the same time and there are two channeled work space at the underground level to allow mechanics to easily access the vehicle chassis for inspection and maintenance under the bus.

Figure 5. 61 BRT Workshop at Transmilenio System

Figure 5. 60 Workshop Layout



5.5.5 Depot Costing

The estimate for the infrastructure cost to build a standard bus depot in Hayatabad and Chamkani is PKR 820.973.859. This cost is associated with the construction only, assuming the land is already acquired and no site clearing or demolition is required. The cost for site clearing and demolition varies according to the land condition, but in general, it is estimated between 5 – 10% of the total infrastructure. Detail cost for the depot is shown in the Appendix.

5.6 TransPeshawar Office

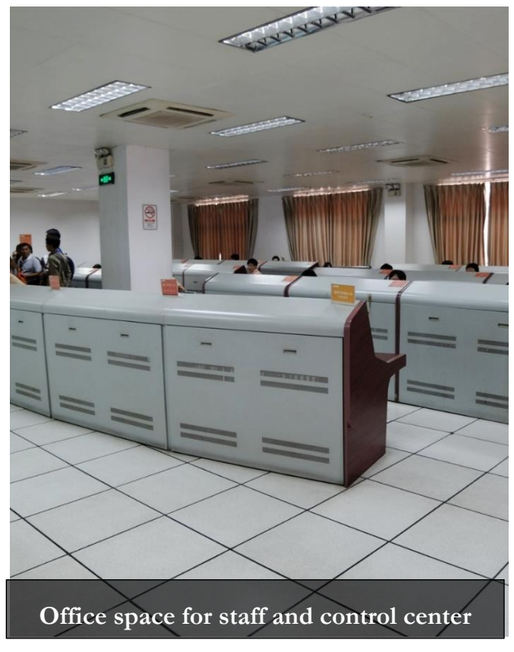
As part of the project, an office building for TransPeshawar will be built. This office building will also host the control center for BRT operation, as well as managing the operation and administration part of BRT. At the time of writing, no detail information has been provided on the exact staffing required for this office, but based on the staff size information provided by the institutional expert, the required space for TransPeshawar office is around 10,000 sqm. However, the cost calculation estimated for TransPeshawar office does not include the land acquisition cost, as it is assumed this cost will be borne by the KPK government.

Some facilities that will be provided in TransPeshawar office are the following:

- Office space for staff
- Control center, complete with staff from bus operator and traffic police
- Meeting room facilities
- Auditorium for staff training
- Prayer room
- Employee and guest parking space

Figure 5. 62 Guangzhou BRT Management Office and Control Centre

Office Building on 2nd floor, depot and staff parking on 1st floor


Office space for staff and control center


Office space for staff and control center

6 Station Location & Cross Section

6.1 Station List

Table 6. 1 Station Detailed Information

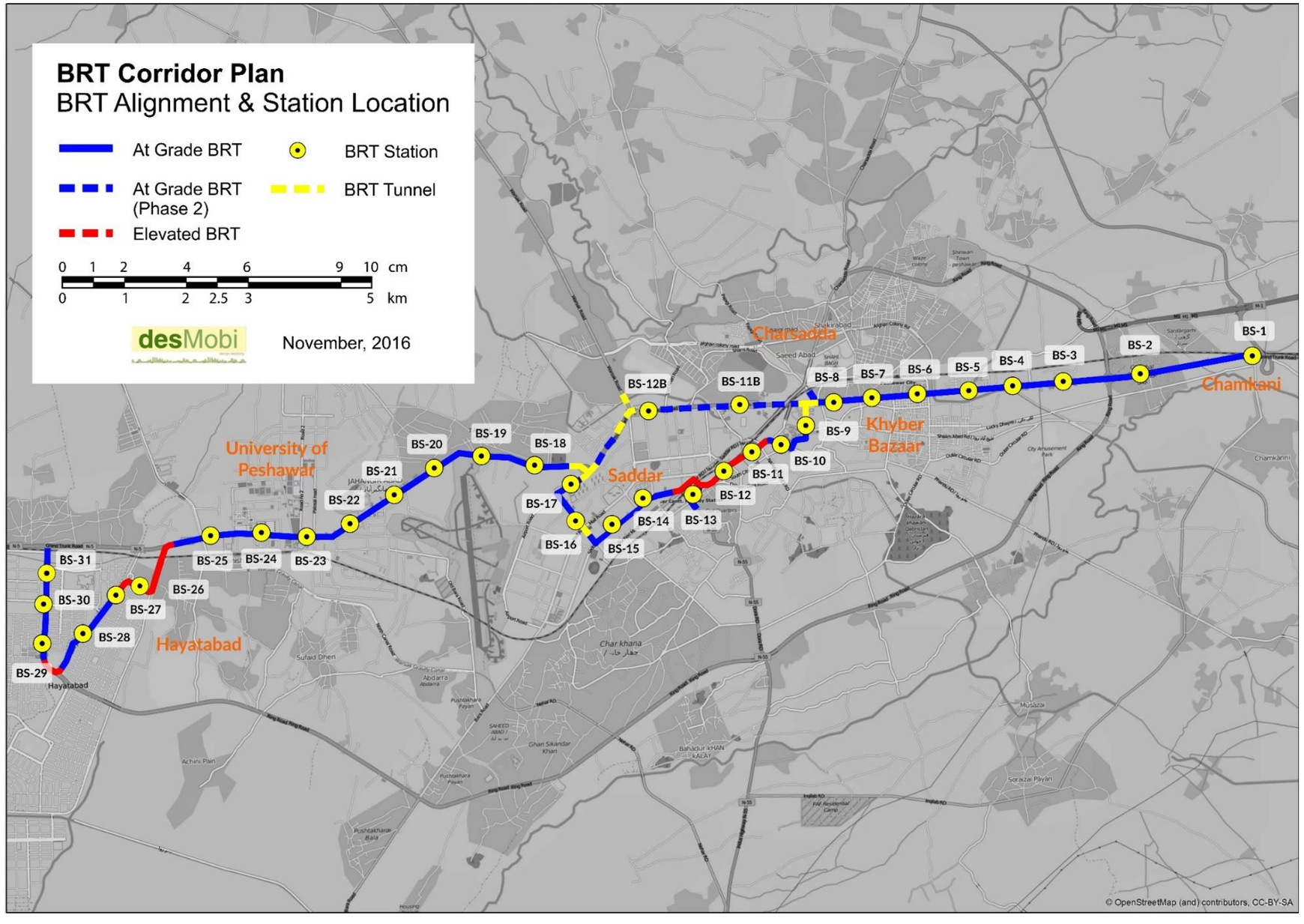
Peshawar BRT Station Design – Preferred Option												
No.	Station Name	Bus Stop ID	Elevation	Distance to Next Station	Access		Sub Stop Type	Station Dimension (length x width)	Detail Station Dimension (ticketing area + sub-stop area + ticketing area) x width	Coordinate Center Point		Max	
					West/South	East/North				Latitude	Longitude	Frequency	Saturation
1	Chamkani Chowk	BS-01	at grade	1620m	Bridge	Bridge	1	70mx8m	(15+40+15)m x 8m	34° 1'10.47"N	71°38'48.90"E	41	0.15
2	Chughal Pura	BS-02	at grade	1400m	Bridge	Bridge	1	70mx8m	(15+40+15)m x 8m	34° 1'3.31"N	71°37'46.80"E	41	0.14
3	Dr. Zareef Memorial School	BS-03	at grade	655m	Bridge	Bridge	2	110mx6m	(15+80+15)m x 6m	34° 0'59.93"N	71°36'52.16"E	76	0.26
4	Sethi Town	BS-04	at grade	660m	Bridge	Bridge	2	110mx6m	(15+80+15)m x 6m	34° 0'58.69"N	71°36'26.85"E	76	0.31
5	Sikandar Town	BS-05	at grade	915m	Bridge	Bridge	2	110mx6m	(15+80+15)m x 6m	34° 0'57.38"N	71°36'0.85"E	76	0.43
6	Gulbahar Square	BS-06	at grade	790m	Bridge & PedCross	Bridge & PedCross	2	110mx5m	(15+80+15)m x5m	34° 0'56.08"N	71°35'25.06"E	61	0.24
7	Noor Market	BS-07	at grade	530m	Bridge	Bridge	2	110mx5m	(15+80+15)m x5m	34° 0'54.41"N	71°34'54.34"E	61	0.28
8	Gul Market	BS-08	at grade	700m	Bridge	Bridge	2	110mx5m	(15+80+15)m x5m	34° 0'52.76"N	71°34'31.91"E	61	0.31
9	Hospital Road	BS-09	at grade	590m	At Grade PedCross	At Grade PedCross	4	2 x (55mx5m)	(40+15)m + (40+15)m x5m	34° 0'42.56"N	71°34'17.41"E	72	0.32
10	Khyber Bazaar	BS-10	at grade	550m	At Grade PedCross	At Grade PedCross	2	110mx5m	(80+15)m x5m	34° 0'31.35"N	71°34'3.97"E	72	0.29
11	Soekarno Square Secretariat	BS-11	elevated	640m	-	Bridge	2	90mx5m	(80+10)m x 5m	34° 0'29.03"N	71°33'44.43"E	72	0.34
12	Dabgari Gardens	BS-12	elevated	550m	-	Bridge	2	90mx5m	(80+10)m x 5m	34° 0'17.99"N	71°33'24.25"E	72	0.26
13	Railway Station	BS-13	at grade	1050m	-	Bridge	1	55mx6m	(15+40)m x 6m	34° 0'7.82"N	71°33'7.65"E	35	0.19
14	State Bank of Pakistan	BS-14	at grade	620m	At Grade PedCross	At Grade PedCross	3	195mx4m	(10+175+10)m x 4m	34° 0'4.16"N	71°32'38.05"E	107	0.41
15	Saddar Bazar	BS-15	at grade	840m	At Grade PedCross	At Grade PedCross	2	125mx5m	(15+95+15)m x 5m	33°59'51.44"N	71°32'18.61"E	107	0.49
16	Mall Road	BS-16	at grade	690m	At Grade PedCross	At Grade PedCross	2	110mx5m	(15+80+15)m x 5m	33°59'57.34"N	71°31'57.48"E	87	0.34
17	Khyber Road Airport	BS-17	at grade	1270m	Bridge	Bridge	3	205mx5m	(15+175+15)m x 5m	34° 0'13.63"N	71°31'52.35"E	87	0.30
18	Gora Qabristan - Christian Cemetery	BS-18	at grade	780m	Bridge	Bridge	3	205mx4m	(15+175+15)m x 4m	34° 0'25.49"N	71°31'31.18"E	92	0.32
19	Tehkal	BS-19	at grade	780m	Bridge	Bridge	3	205mx4m	(15+175+15)m x 4m	34° 0'30.26"N	71°31'1.41"E	92	0.34
20	Tambuwaan - Tents	BS-20	at grade	800m	Bridge	Bridge	2	110mx5m	(15+80+15)m x 5m	34° 0'24.80"N	71°30'33.10"E	92	0.32
21	Abdara Road	BS-21	at grade	790m	Bridge	Bridge	2	110mx5m	(15+80+15)m x 5m	34° 0'10.81"N	71°30'6.58"E	92	0.37
22	University Town	BS-22	at grade	760m	Bridge	Bridge	2	110mx5m	(15+80+15)m x 5m	33°59'57.54"N	71°29'40.86"E	92	0.33
23	KTH University of Peshawar	BS-23	at grade	850m	Tunnel	Bridge	2	110mx6m	(15+80+15)m x 6m	33°59'51.73"N	71°29'14.54"E	92	0.41
24	Islamia College	BS-24	at grade	730m	Bridge	Bridge	2	110mx5m	(15+80+15)m x 5m	33°59'53.65"N	71°28'41.72"E	92	0.35

Peshawar BRT Station Design – Preferred Option												
No.	Station Name	Bus Stop ID	Elevation	Distance to Next Station	Access		Sub Stop Type	Station Dimension (length x width)	Detail Station Dimension (ticketing area + sub-stop area + ticketing area) x width	Coordinate Center Point		Max
					West/South	East/North				Latitude	Longitude	Frequency	Saturation
25	Board Bazar Regi	BS-25	at grade	1250m	Tunnel	Bridge	2	110mx6m	(15+80+15)m x 6m	33°59'52.52"N	71°28'13.82"E	92	0.41
26	Taj Abad	BS-26	elevated	920m	Bridge	Bridge	2	110mx5m	(15+80+15)m x 5m	33°59'30.02"N	71°27'40.93"E	72	0.26
27	Hayatabad Model School	BS-27	at grade	670m	At Grade PedCross	At Grade PedCross	1	55mx5m	(40+15)m x 6m	33°59'22.97"N	71°27'15.89"E	72	0.25
28	Hayatabad Phase 3	BS-28	at grade	1450m	At Grade PedCross	At Grade PedCross	1	55mx6m	(40+15)m x 6m	33°59'43.99"N	71°26'37.38"E	72	0.26
29	Tatara Park	BS-29	at grade	630m	At Grade PedCross	At Grade PedCross	1	55mx6m	(40+15)m x 6m	33°59'1.41"N	71°26'33.80"E	12	0.05
30	PDA Hayatabad	BS-30	at grade	680m	At Grade PedCross	At Grade PedCross	1	55mx6m	(40+15)m x 6m	33°59'21.70"N	71°26'35.66"E	12	0.05
31	Cancer Hospital	BS-31	at grade		At Grade PedCross	At Grade PedCross	1	55mx6m	(40+15)m x 6m	33°59'1.41"N	71°26'33.80"E	12	0.05
Peshawar BRT Station Design - Phase 2													
1	Secretariat	BS-11B	at grade	1360m	-	At Grade PedCross	1	55mx5m	(15+40)m x 5m	34° 0'52.49"N	71°33'35.51"E	9	0.07
2	St. Marry High School	BS-12B	at grade	2320m	-	At Grade PedCross	1	55mx5m	(15+40)m x 5m	34° 0'50.67"N	71°32'42.50"E	29	0.21

There are 31 BRT stations in the preferred BRT alignment, with 3 stations built as elevated BRT stations. The station center point coordinates, dimension, access type, as well as the peak hour bus frequency data per station is listed in the above table. At the city center stations, the maximum peak hour frequency is 107 buses/hour/direction, and offset stations will be required due to limited space on Saddar Road. Although the average distance between station is 922 meters, but there are few stations that are only less than 700 meter apart, but on the other hand, several stations are also quite far from each other e.g. more than 1,000 meters. Normally, the physical condition of the site and low demand profile near the stations which determines that.

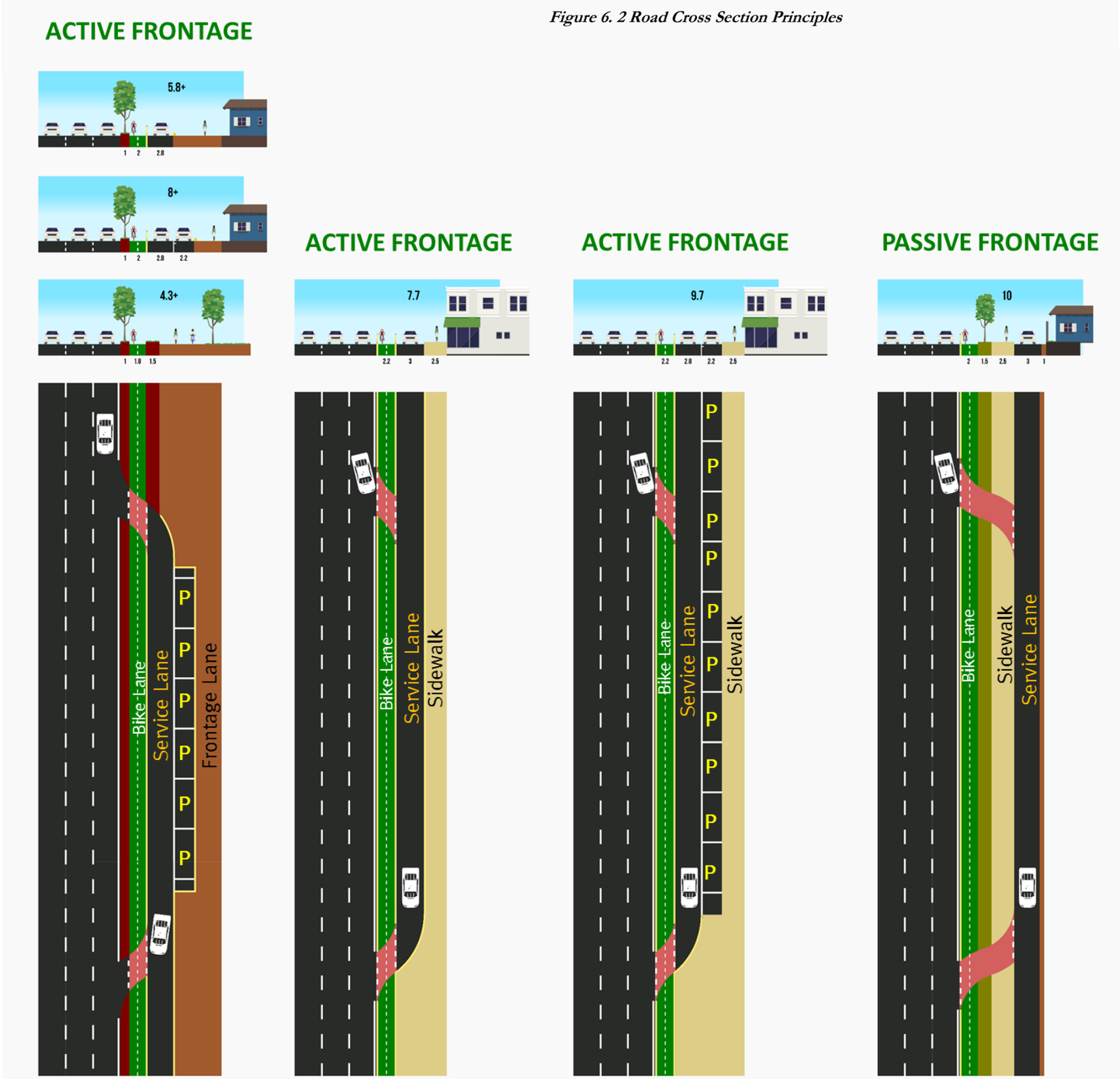
On Option 2 alignment, 5 additional elevated stations will be built, which adds up to 8 elevated BRT stations in total to be constructed from Soekarno Square Secretariat to Khyber Road Airport. On Khyber Road, 2 additional at-grade BRT stations will be required. Although it seems likely that at the initial phase the BRT stations and physical corridor might not be permitted to go there, but our design accommodates this corridor, in case the army allows the BRT to also be built on that corridor.

Figure 6. 1 BRT Station Location Map.



6.2 General Principles of Road Cross Section along BRT Corridor

Figure 6. 2 Road Cross Section Principles



In general, the cross sections are divided into two types depend of active and passive frontage. The components which should be facilitated on both of types are bike lane and sidewalk/frontage lane. In other hand, the all road types will have a service lane if they have enough space. Parking space will be provided in active frontage area which have on street parking in existing.

Component	Active Frontage		Passive Frontage	
	Wide road	Narrow road	Wide road	Narrow road
Bike Lane	✓	✓	✓	✓
Sidewalk	✓	✓	✓	-
Frontage Lane	(optional)	(optional)	(optional)	✓
Service Lane	✓	-	✓	-
Parking Space	✓	-	-	-

Wide Road:
- At station, ≥ 52.8 meter from wall to wall
- Between station, ≥ 34.4 meter from wall to wall

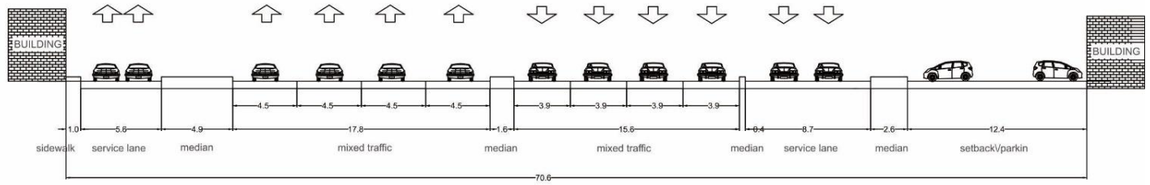
6.3 Selected Cross Section

The following images show the cross section and station placement for selected stations. The full cross section for each station are provided in the appendix, together with the Engineering Design

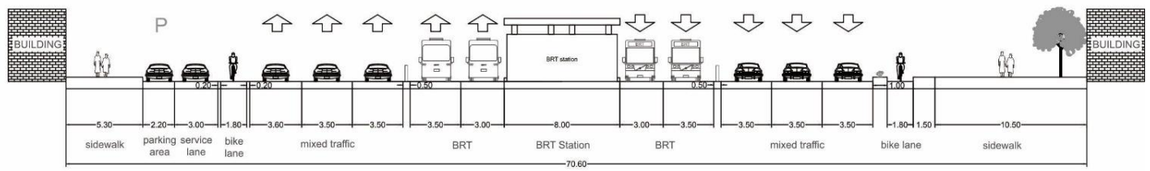
BS 02 – Chughal Pura

Legend:
- Platform
- Ticketing Area
- Stairs
- Footbridge

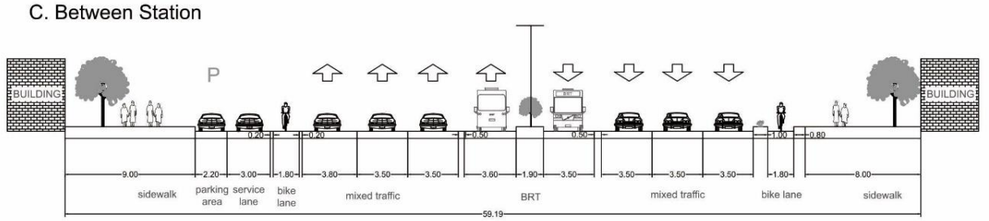
A. Existing



B. At Station

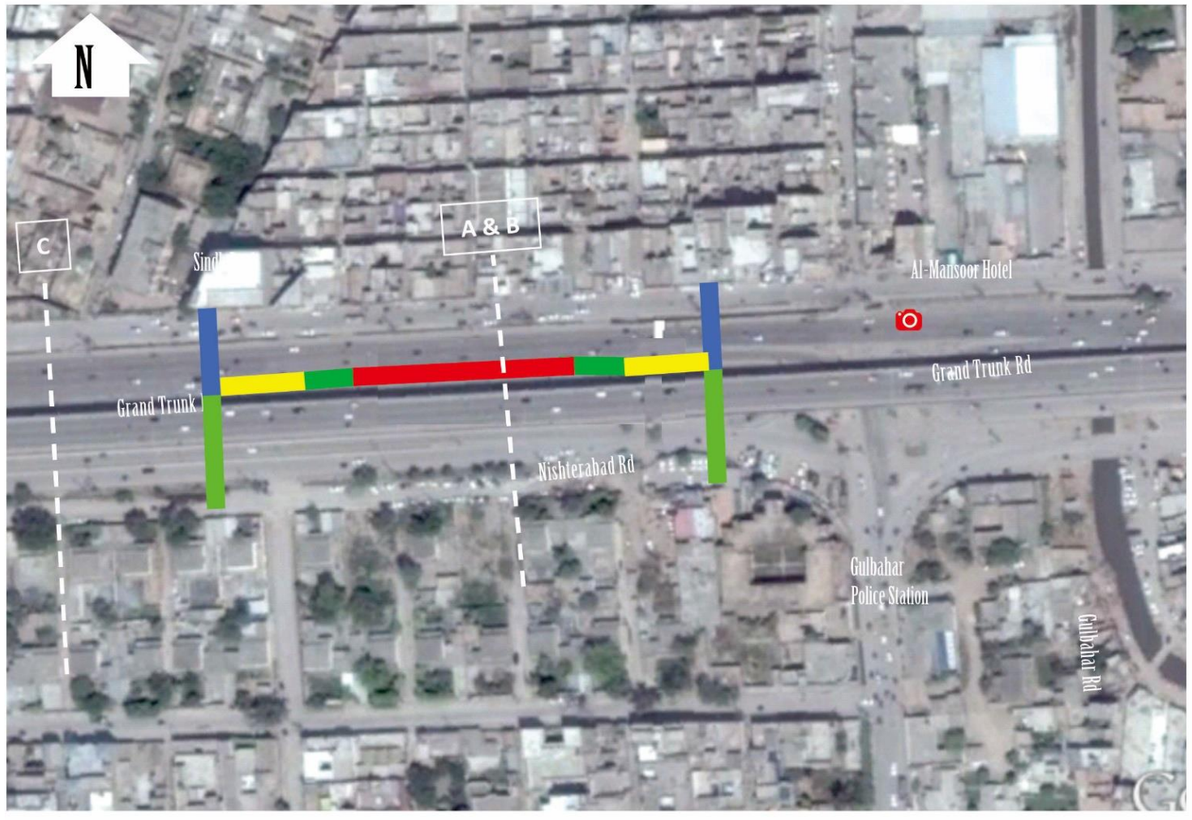


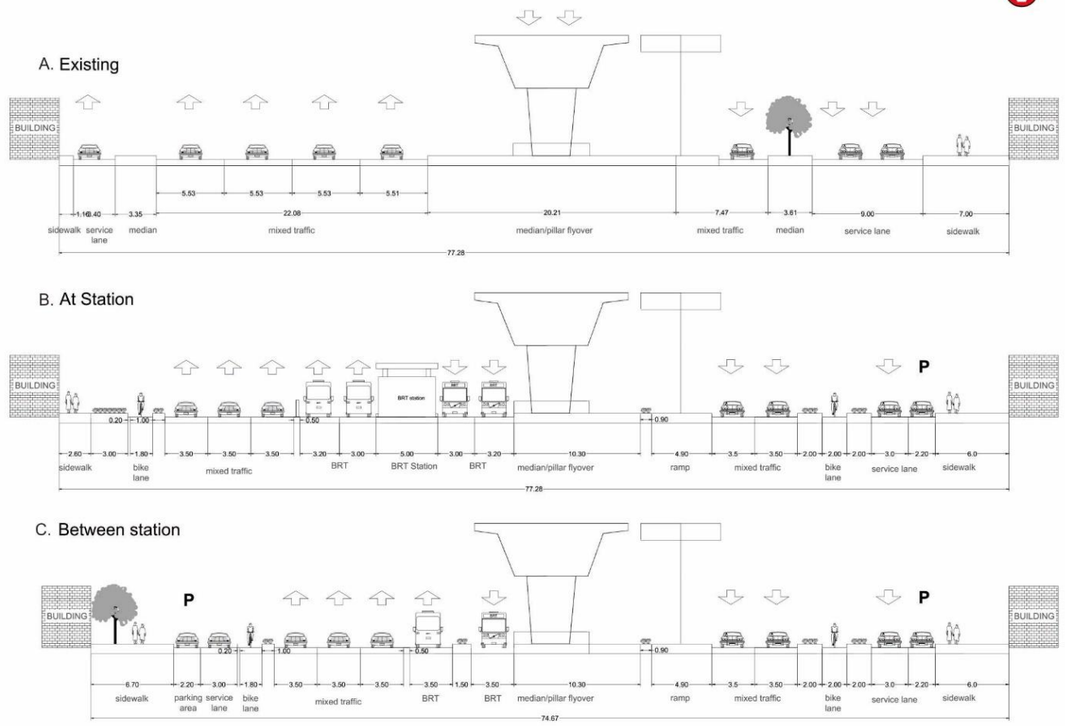
C. Between Station



Grand Trunk Rd
Looking east

BS 06 – Gulbahar Square





Legend:

- Platform
- Ticketing Area
- Footbridge
- At-Grade Crossing
- Stairs

Grand Trunk Rd

Looking west

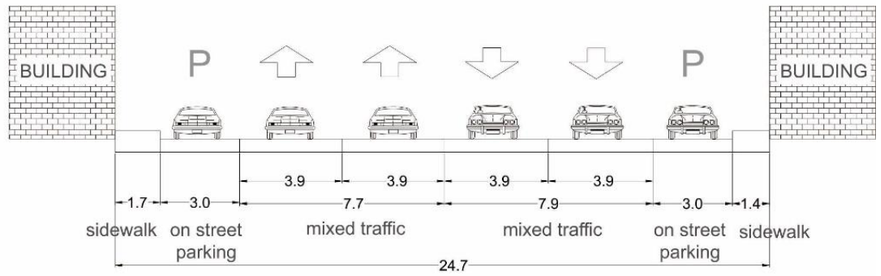
BS 10 – Khyber Bazaar

Legend:
- Platform
- Ticketing Area
- Stairs
- Footbridge

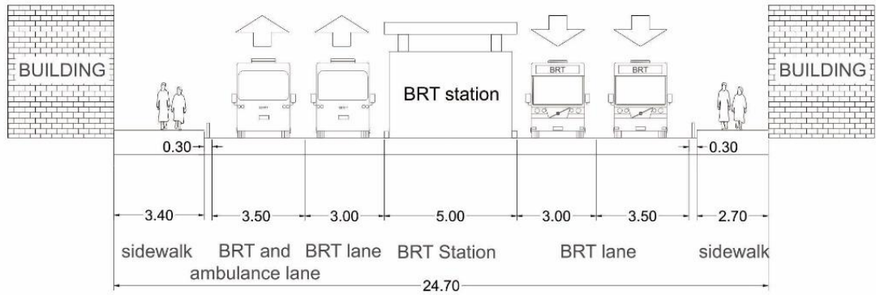
Khyber Bazaar Rd
Looking west

E

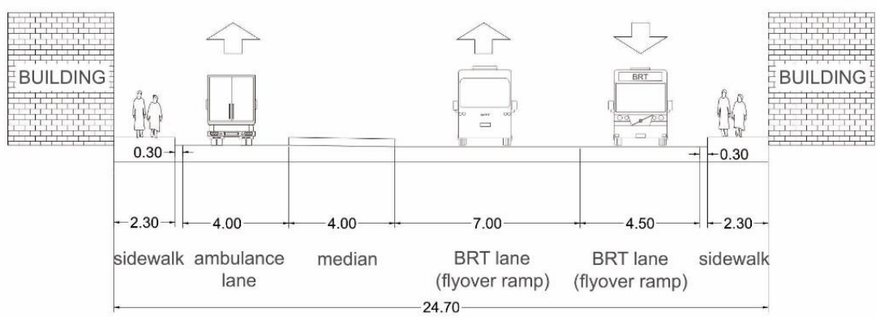
A. Existing



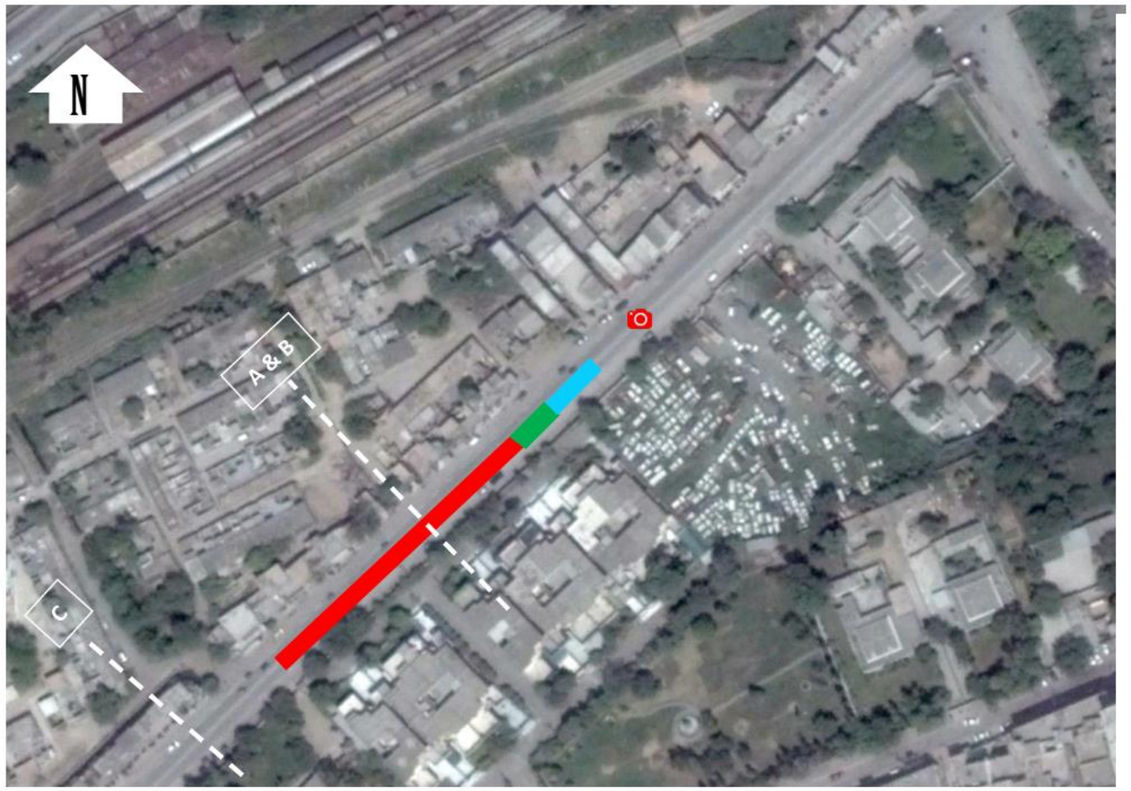
B. At Station



C. Between station (at flyover ramp)



BS 12 – Dabgari Gardens

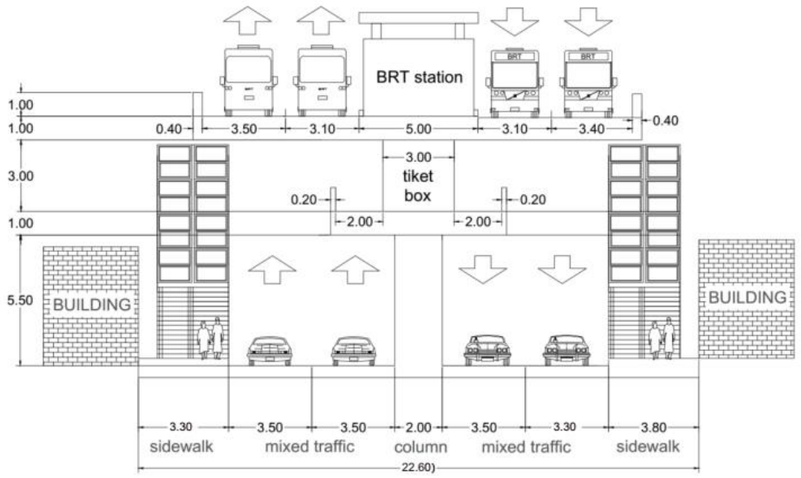


Legend:
- Platform
- Ticketing Area
- Turnstile

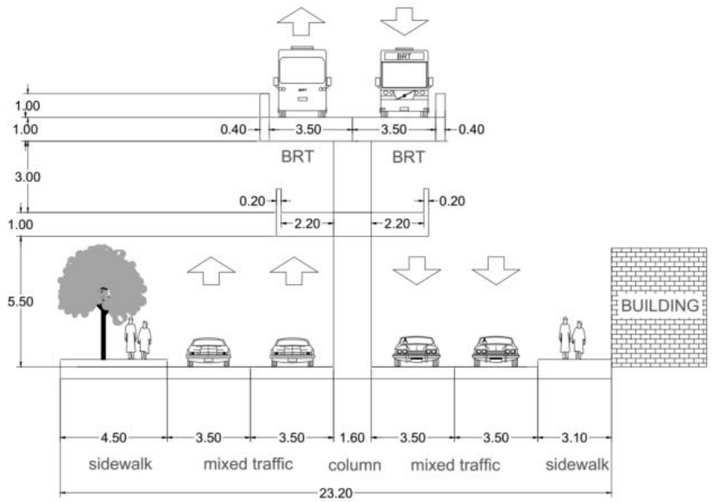
Railway Rd
Looking west

A. Existing

B. At station (elevated)

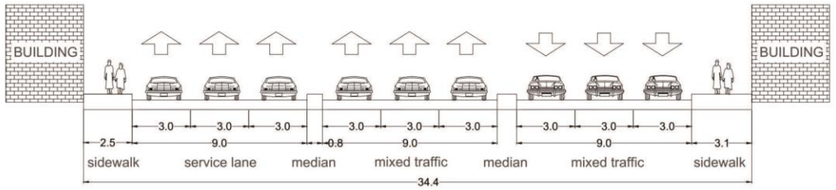


C. Between station (elevated)

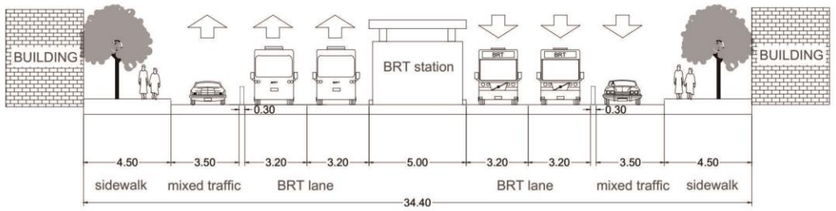


BS 15 – Saddar Bazar

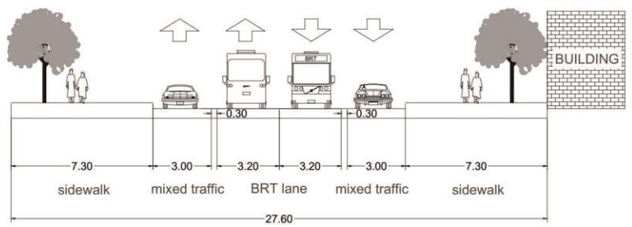
A. Existing



B. At station



C. Between station



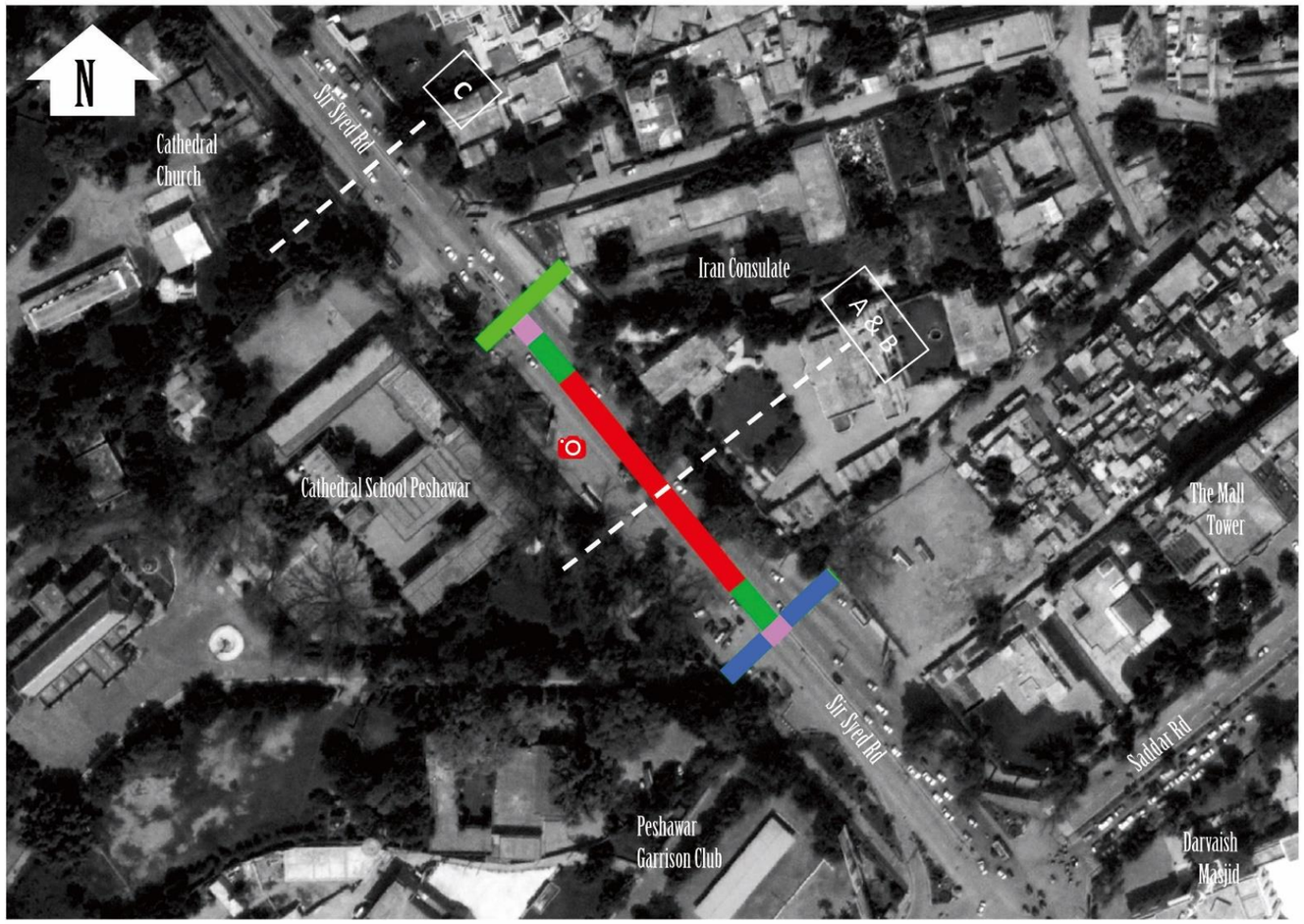
Legend:

- Platform
- Ticketing Area
- Ramp
- At-grade Crossing

Saddar Rd

Looking northeast

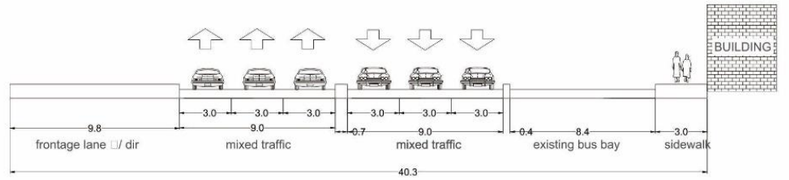
BS 16 – Mall Road



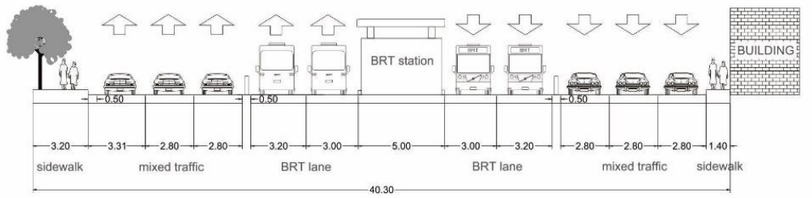
Legend:

- Platform
- Ticketing Area
- Ramp
- At-grade Crossing
- Footbridge

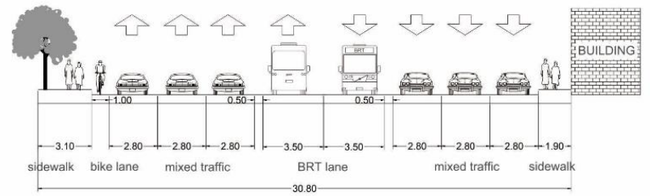
A. Existing



B. At station



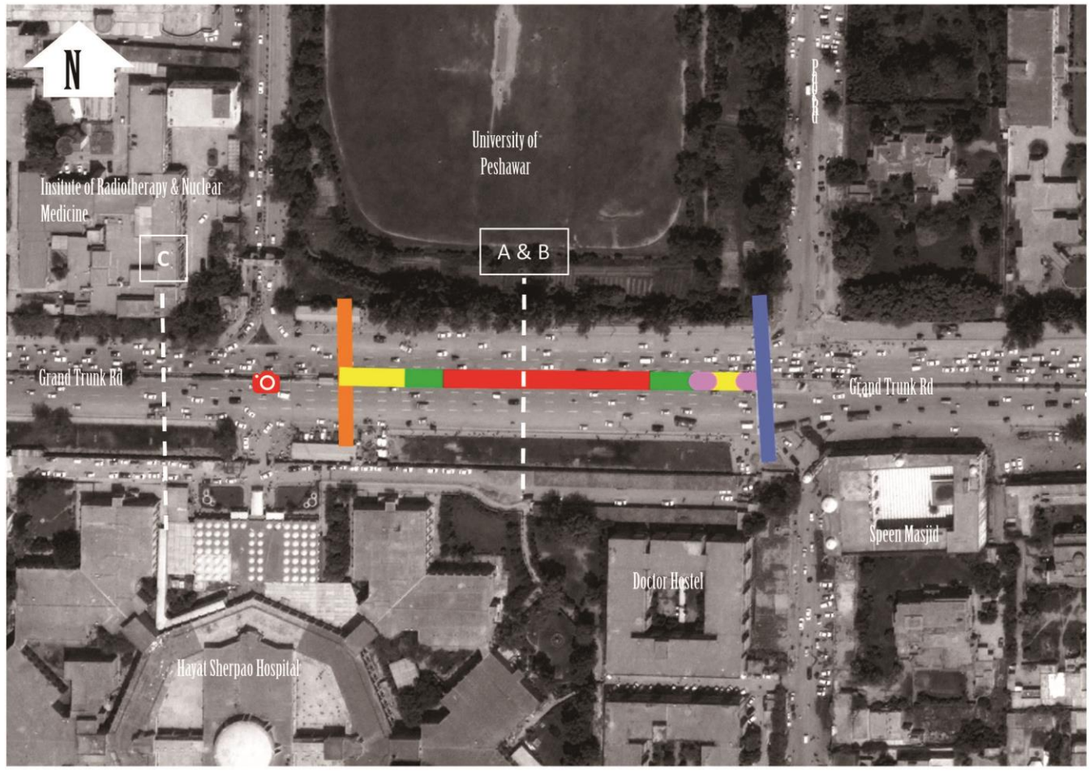
C. Between station



Sir Syed Rd

Looking southeast

BS 23 – KTH University of Peshawar

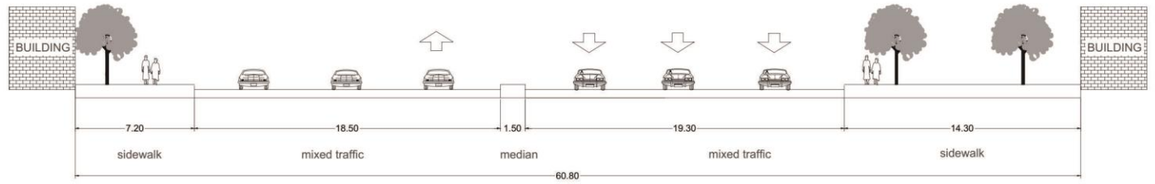


Legend:

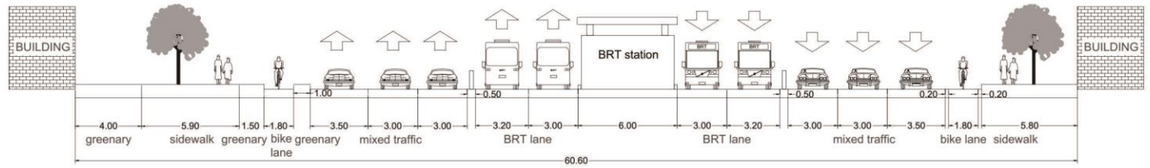
- Platform
- Ticketing Area
- Stairs
- Ramp and Stairs
- Tunnel

E

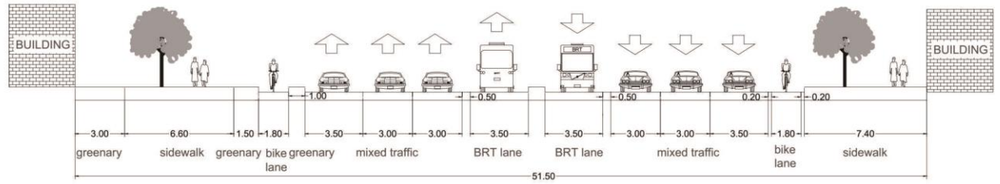
A. Existing



B. At station



C. Between station



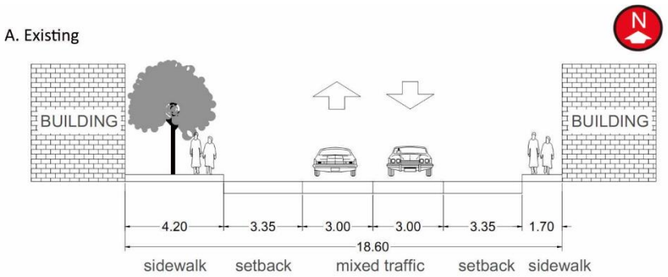
Grand Trunk Rd

Looking east

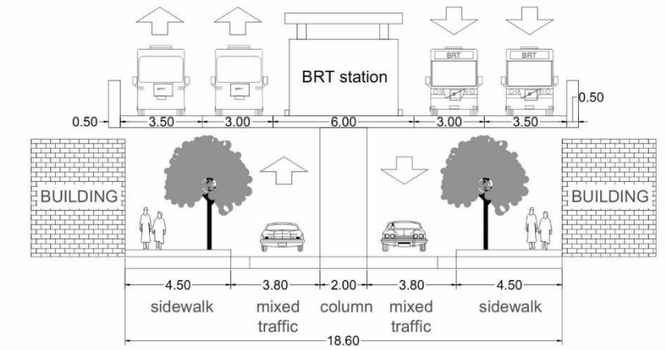
BS 26 – Taj Abad

Legend:
- Platform
- Ticketing Area
- Stairs
- Footbridge

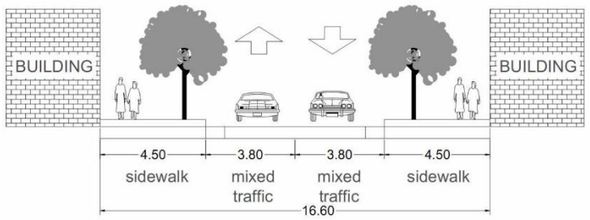
A. Existing



B. At station



C. Between station



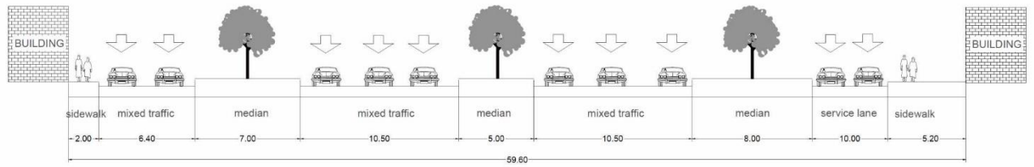
Kabul River Tributary

Looking east

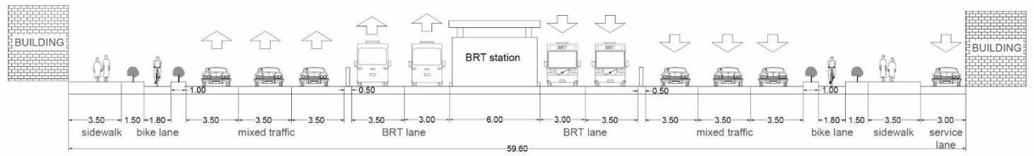
BS 31 – Cancer Hospital

Legend:
- Platform
- Ticketing Area
- Ramp
- At-Grade Crossing

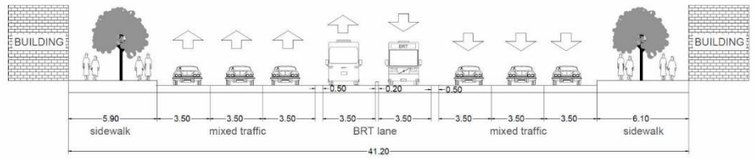
A. Existing



B. At station



C. Between station



Peshawar Ring Road

Looking south

7 BRT Demand and Operational Plan

It is essential in the planning of the BRT network to predict the demand. Knowing the volume of passengers using the service helps determining the needed fleet, frequency of the buses and overall operational plan to have a sustainable transport network.

7.1 BRT Demand

Compared to the current transportation options, the BRT will travel faster in the city of Peshawar. New BRT lines will replace current lines; hence passengers are expected to shift after the BRT implementation. The ridership of the future BRT is then based on the demand of the current transportation network in Peshawar.

Although the demand forecast was made in a way to be prepared for the worst situations and avoid failure, the figures obtained for the passenger volume could even be higher at the implementation, with people shifting from private vehicles to BRT. Furthermore, the ridership is likely to increase year after year of operations and acceptance from the locals.

7.1.1 Current transportation demand

The current transport demand was assessed with a large set of field surveys in Peshawar in the first half of 2016. In different strategic locations of the city, passengers boarding and alighting buses were counted, as well as the frequency and occupancy of those buses. In a matter of consistency, surveys were conducted at peak hours and off peak hours, in both directions (East bound and Westbound).

Table 7.1 Current transport demand

Route		Boarding per day (pax/day)		Total boarding (pax/day)
		Eastbound	Westbound	
Minibus	1	16,476	17,025	**33,501**
Minibus	2	31,053	38,376	**69,429**
Minibus	3	18,405	14,757	**33,162**
Minibus	4	16,502	12,536	**29,038**
Minibus	6	18,454	23,874	**42,328**
Wagon	10	49,212	53,313	**102,525**
Wagon	11	9,398	10,069	**19467**
Rocket Bus	Rocket 2	26,903	17,698	**44,601**
Rocket Bus	Rocket 3	12,389	16,636	**29,025**
Suzuki	4	35,567	35,567	**71134**
Suzuki	5	50,898	50,898	**101,796**
Suzuki	7	12,645	18,064	**30,709**
Total		**297,902**	**308,813**	**606,715**

Figure 7. 1 Public Transport Demand in Peshawar

This current demand is the foundation of our BRT plan. In order to determine the BRT demand, the ridership of current lines is transferred to future BRT lines which have matching routes, origins and destinations.

However, not all demand is transferred into the BRT forecast, such as the Wagon 11 demand. This is due to the mismatch in routes: Wagon 11 will not be replaced by any BRT route. It is likely to remain operational after the BRT implementation.

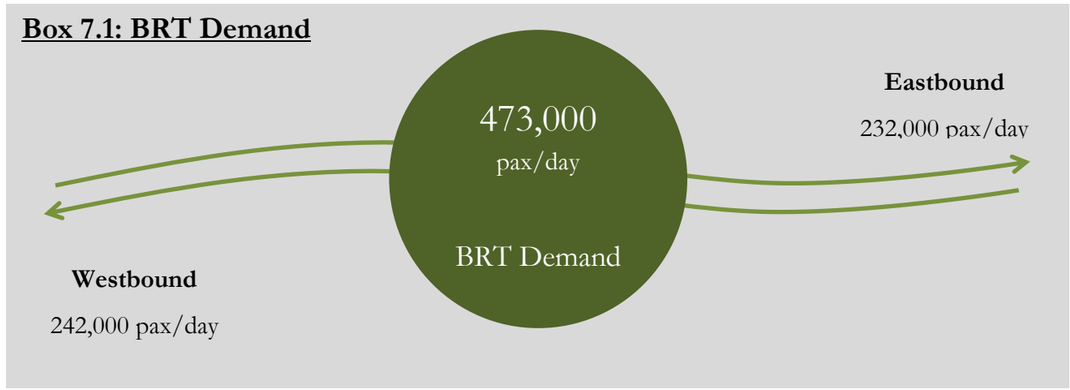
7.1.2 BRT daily passengers

BRT lines receiving current transport demand do so on certain segments of the network, hence the notion of origins and destinations is taken into account in this forecast.

Table 7.2 BRT demand

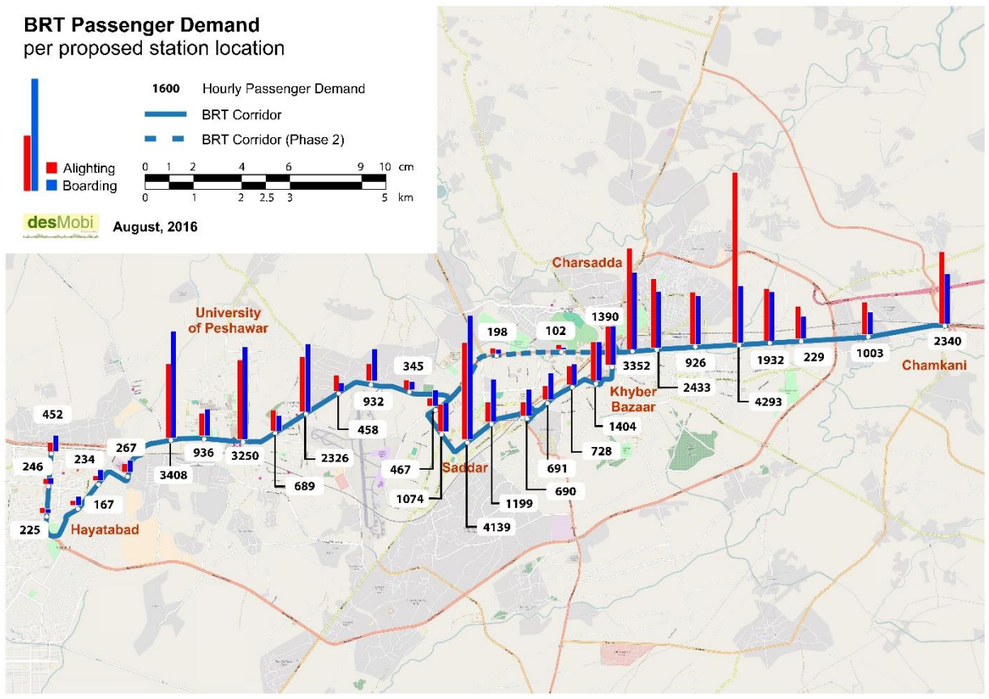
	BRT Route	Boarding per day (pax/day) Eastbound	Westbound	Total boarding (pax/day)
1A	**Silver line**	25,590	26,995	**52,585**
1B	**Purple Line**	20,065	18,054	**38,119**
1C	**Orange Line**	29,101	43,279	**72,380**
1D	**Green Line**	51,658	53,221	**104,879**
1E	**Yellow Line**	37,302	39,157	**76,459**
1F	**Red Line**	26,247	14,598	**40,845**
1G	**Blue Line**	8,891	15,816	**24,707**
1H	**Brown Line**	33,070	29,867	**62,937**
	Total	**231,925**	**240,987**	**472,912**

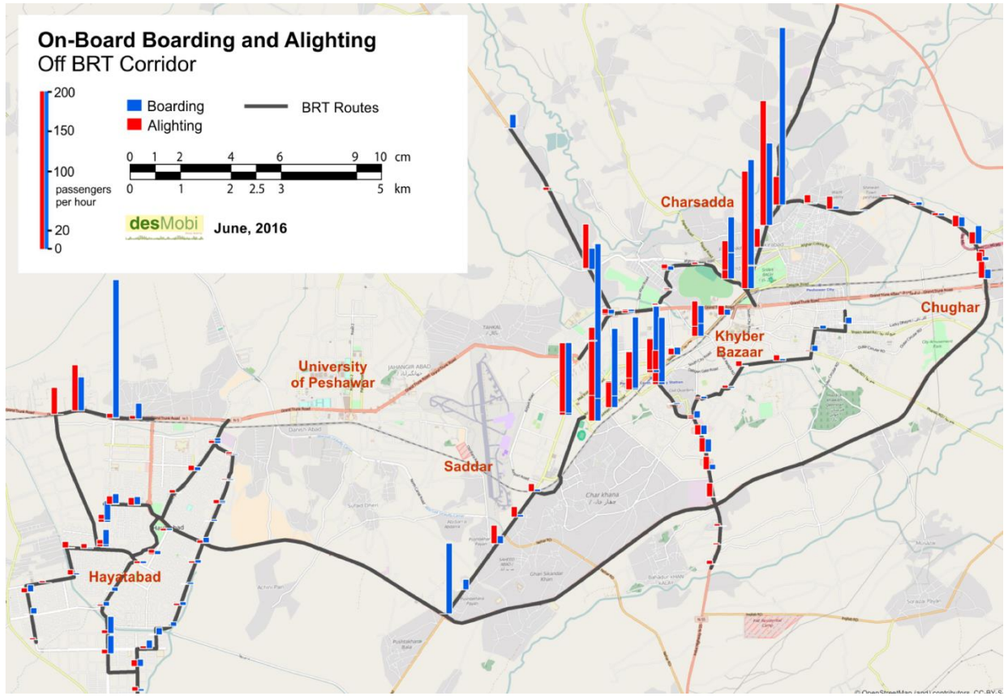
Figure 7. 2 BRT Demand Profile along Corridor.



The ridership is likely to evolve at an increasing pace in the first months of operations because of the modal shift. But in this preliminary design, the following summary should be accepted.

Figure 7. 3 BRT Demand Profile Outside Corridor.





7.2 Operational Plan & Fleet

The service plan of the system gathers information on the kilometers travelled, necessary fleet, spread ridership and completing elements of the operations. The cornerstone of operations is the passengers, being the focal point of the project. It enables developments to be directed towards comfort, efficiency and sustainability.

7.2.1 Route plan

The 8 specified BRT lines will travel in and outside the corridor, and depending on their routes, will use 9-m or 12-m buses. The selection of the bus type, as well as the daily ridership, determines the necessary bus frequency for passengers to be picked up without long waiting times.

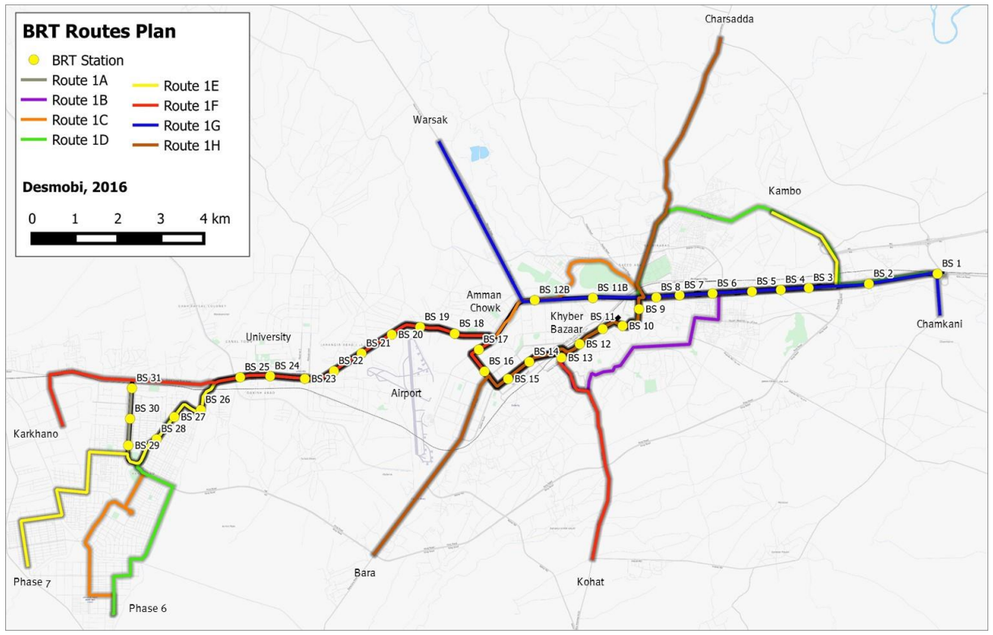
Route length and specifications

The following table sums up route lengths and bus types matching the configurations of their paths. Given the speeds inside and outside the corridor, the trip length is also calculated.

Table 7.3 Route length and details.

BRT	Route length (km)	Length in corridor (km)		Length off corridor (km)		One way time (min)	Bus type (m)
1A	27.5	27.5	100%	0	0%	61	12m
1B	12.9	6.2	48%	6.7	52%	41	9m
1C	25.8	14.98	58%	10.82	42%	77	12m
1D	29.3	15.88	54%	13.42	46%	89	12m
1E	28.4	20.4	72%	8.0	28%	77	12m
1F	20.5	10.2	50%	10.3	50%	64	9m
1G	14.8	7.3	49%	7.5	51%	46	9m
1H	15.8	4.5	28%	11.3	72%	55	9m
Average	**21.9 km**		**57%**		**43%**	**64 min**	

Figure 7. 4 BRT Routes Plan



With an average portion of 57% inside the corridor, the routes are obviously expected to travel faster in traffic-less lanes. Nonetheless, travelling outside the corridor will also be crucial in order to pick up passengers. In a matter of efficiency and comfort, the maximal peak hour headway is fixed to 5 minutes for all BRT routes.

Previous data analysis on the ridership and the maximal headway give the fleet requirement for each line.

Frequency and Fleet Requirement

Given the previous criteria and our calculated ridership and volumes, we can determine in the table below the needed fleet to insure full service of all passengers.

In order to provide better comfort and service, a few assumptions are necessary:

- Optimum occupancy is set at 85% from maximum capacity
- 90% of all buses should be operational (10% extra security margin for parts).
- Peak hour headway is set at maximum of 5 minutes per route
- 5-minutes layovers between trips for drivers.

And as a reminder the capacity of 9-m bus equals to 50 passengers/bus, for 12-m bus equals to 85 passengers/bus. Bus average travel speed inside the BRT corridor is assumed at 25 km/h, whereas for off corridor is assumed at 15 km/h. The fleet requirements are summarized in the following box, and the frequency map of BRT buses are shown below

Figure 7. 5 BRT Frequency and Fleet Requirement

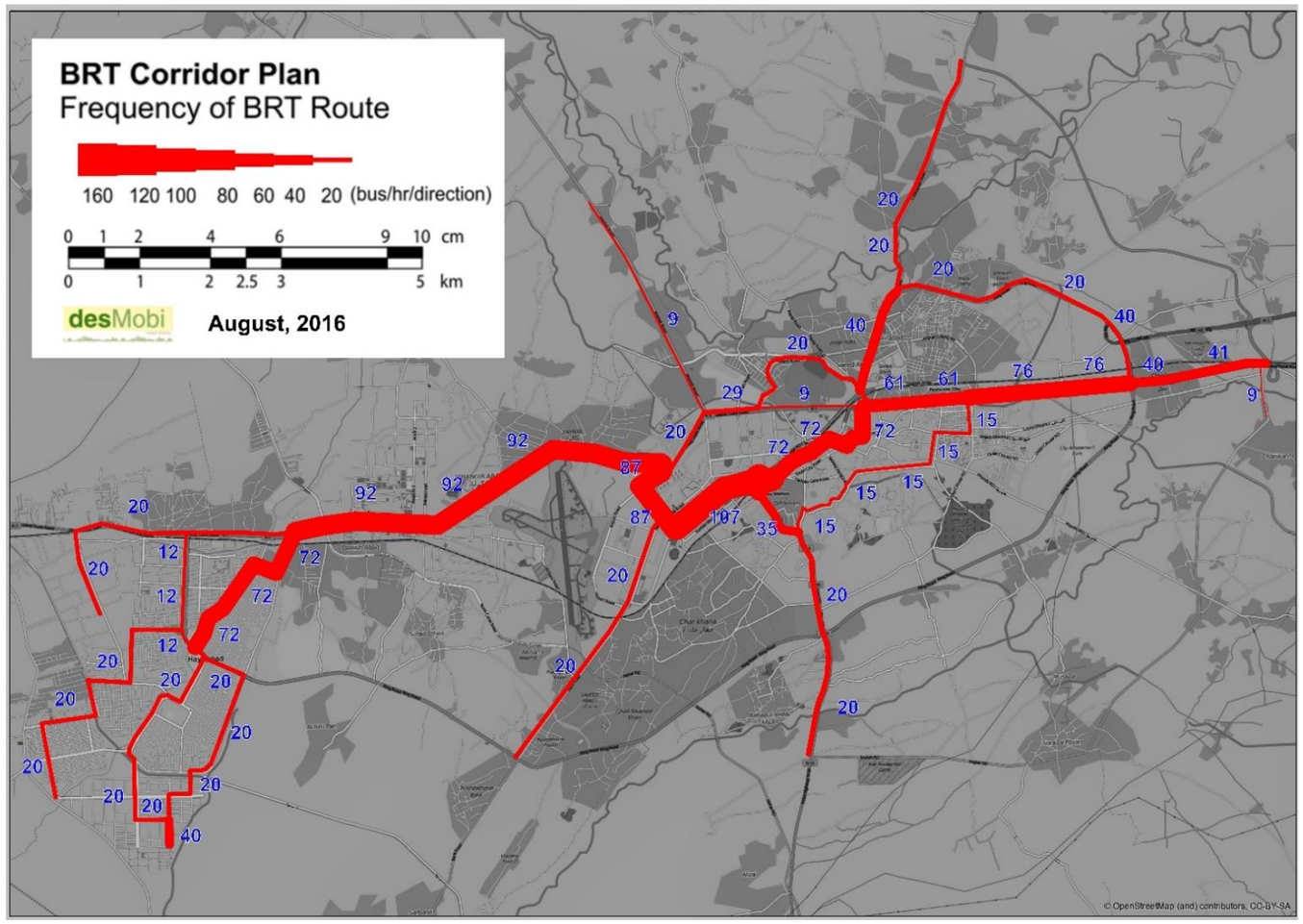


Table 7.4 BRT Frequency and Fleet Requirement

BRT Route	Frequency (bus/h)	BRT fleet
EASTBOUND		
1A	12	16
1B	15	14
1C	20	32
1D	20	37
1E	20	32
1F	20	27
1G	9	9
1H	20	24
WESTBOUND		
1A	12	16
1B	15	14
1C	20	32
1D	20	37
1E	20	32
1F	20	27
1G	9	9
1H	20	24

With direct service system, it appears the frequency shown in

Figure 7. 5 represents actual demand, i.e. the city center and university part – which have the highest demand, are served with higher frequency from multiple services – up to 107 bus/hour/direction. And the less demand area is served with less frequency service.

At the beginning, with mixed of 9-meter and 12-meter fleet, the carrying capacity of the system will be between 5,800 passengers per hour per direction (pphpd) up to 8,500 pphpd. However, if later on 18-meter buses are introduced, it could even carry up to 15,000 pphpd, or even bigger, since express services are also possible to run with the current infrastructure design.

Distance travelled

Given the fleet and route specifications (length, frequency), it is possible to determine the distance travelled by each bus, and by multiplication, the entire fleet, per day and per year. Knowing the distance travelled per period is crucial to determine maintenance costs, which are important in a project this scale. Distance travelled also helps setting performance indicators, payments to the operators, etc., elements analyzed later in this or following reports.

In order to calculate the travelled distance, some assumptions are made:

- Total operational days per year is 303 days (halved activity on holidays).
- Peak hour is assumed for 3-hour each period (morning and evening, total 6 hours).
- Frequency on the remaining 9-hour off-peak period is reduced to 50% or kept at maximum headway of 7 minutes per route.
- Average speeds outside corridor = 15 km/h, inside corridor = 25 km/h.
- Dead kilometer is assumed at 10 km total, which is needed to travel from the depot to the starting point and return.

Table 7.5 BRT Bus Distance traveled

BRT Route	km travelled daily: av. per bus
1A	353
1B	222
1C	230
1D	225
1E	249
1F	217
1G	298
1H	198

The distance travelled is an average per bus, knowing that during off peak-hours, the fleet is not expected to be fully into operations. Some buses will only travel during peak hours, given that the headway is increased during off-peak period.

Box 7.2: BRT Fleet Requirement

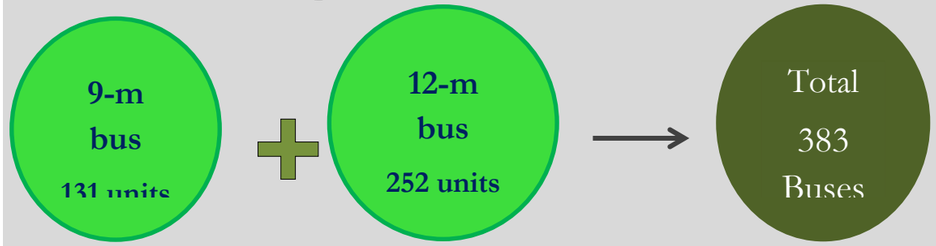


Table 7.6 Operational Plan Summary

	1A	1B	1C	1D	1E	1F	1G	1H
BRT Routes	Silver Line	Purple Line	Orange Line	Green Line	Yellow Line	Red Line	Blue Line	Brown Line
Origin - Destination	**Hayatabad** to **Chamkani**	**Saddar** to **Chughar**	**Hayatabad Phase 6** to **Chughar** *via Grand Trunk Rd*	**Hayatabad Phase 6** to **Chamkani** *via Charsadda*	**Hayatabad Phase 7** to **Kambo**	**Karkhano** to **Kohat**	**Warsak** to **Chamkani**	**Charsadda** to **Bara**
Route length	**23 km**	**13 km**	**26 km**	**29 km**	**28 km**	**21 km**	**15 km**	**16 km**
km in corridor	20.1	6.2	14.98	15.88	20.67	12.6	7.3	4.5
(percentage)	(88%)	(48%)	(58%)	(54%)	(73%)	(61%)	(49%)	(28%)
Daily boarding (pax/day)	**52,585**	**38,119**	**72,380**	**104,879**	**76,459**	**40,845**	**24,707**	**62,937**
Fleet type	12m	9m	12m	12m	12m	9m	9m	9m
Number of buses	30	26	94	108	64	76	30	68
Headway (mn) • **Peak**	**5 '**	**4 '**	**3 '**	**3 '**	**3 '**	**3 '**	**7 '**	**3 '**
• Off Peak	7 '	8 '	6 '	6 '	6 '	6 '	7 '	6 '
km travelled per bus • **Daily**	**304**	**228**	**222**	**216**	**237**	**223**	**227**	**193**
• Yearly	92,089	69,119	67,238	65,477	71,867	67,529	68,790	58,403

7.3 Integration with Suzuki as Feeder

7.3.1 Suzuki Routes

Although the proposed BRT routes with Direct Service system will be able to serve all major area in Peshawar, there are areas outside the BRT routes catchment – such as in Southern Ring Road, which will not be served by BRT services. Currently, passengers in this area travel using Suzuki.

Suzuki routes are not fixed, but based popular destination demand, they can also change their routes should a group of passengers ask them to. Having said that, we have identified the main Suzuki routes in Peshawar, where most of the routes are travelling on. The routes are as follows:

- GT Rd - Kohat Road
- GT Rd - Bara Road
- GT Rd – Hayatabad
- GT Rd – Karkhano
- Kohat Road – Hayatabad
- Kohat Road – Karkhano
- Bara Road – Hayatabad
- Bara Road – Karkhano

Figure 7. 6 Suzuki Travel on Grand Trunk Road

7.3.2 Feeder Routes

To allow good connectivity with BRT, some of the Suzuki routes running on Southern ring road can be utilized as feeder. The two routes identified for this are as follows:

- Feeder Line 1: Bara Road to Chamkani (Connected to BRT station BS-01 and BS-02)
- Feeder Line 2: Bara Road to Hayatabad (Connected to BRT station BS-29, BS-30 and BS-31)

Figure 7. 7 Feeder Line 1 Route

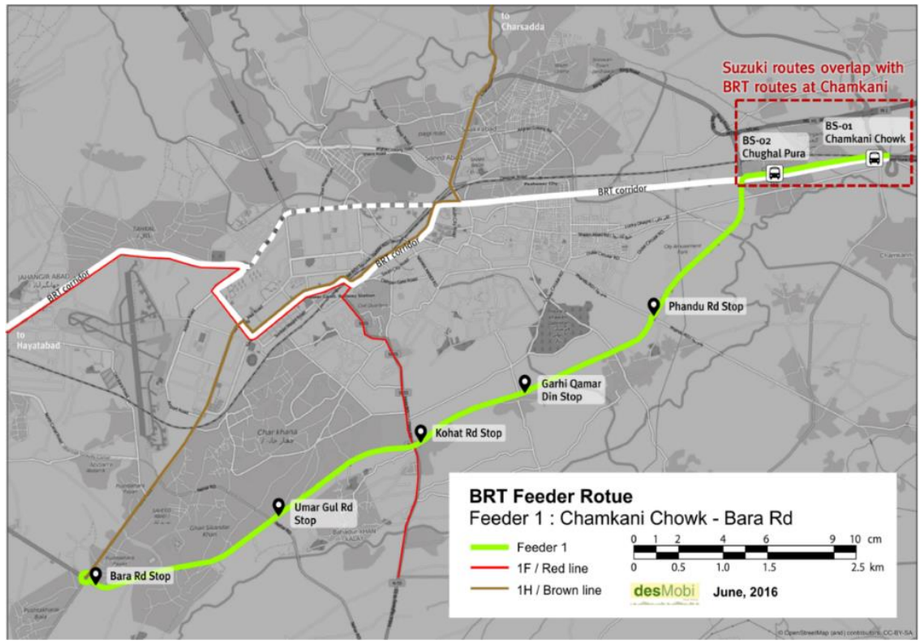
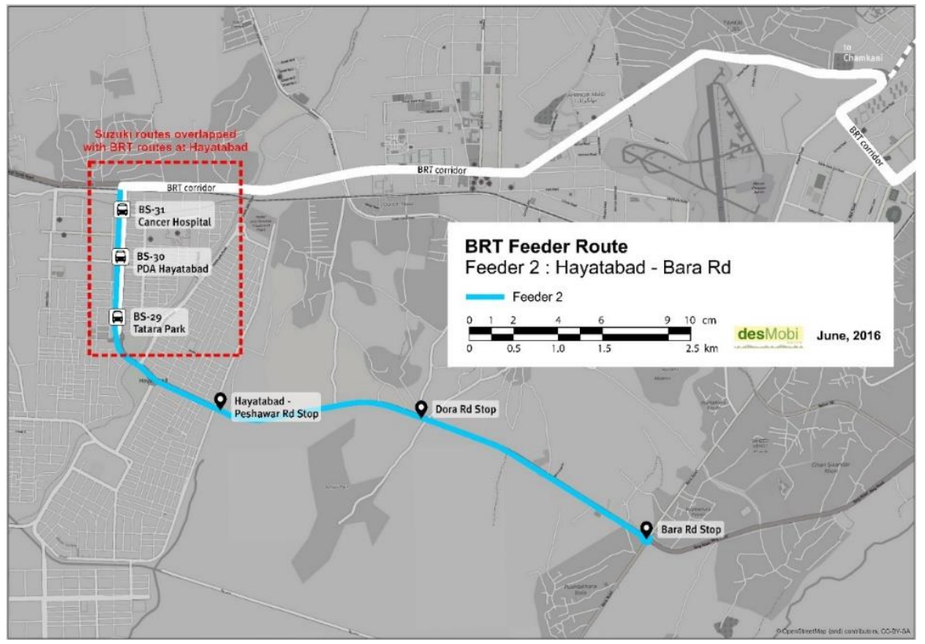


Figure 7. 8 Feeder Line 2 Route

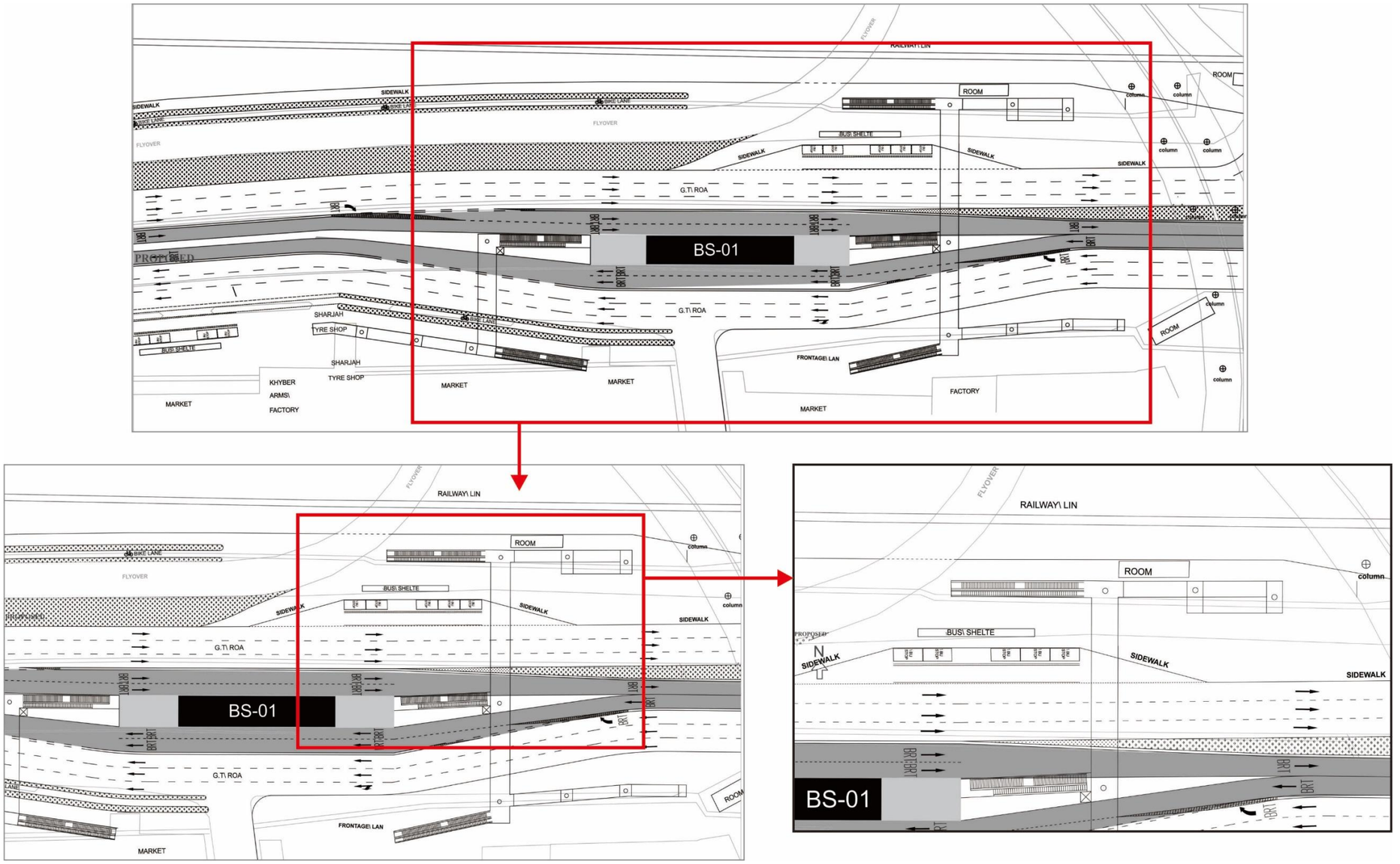


7.3.3 Feeder Connectivity

To connect these feeder routes with BRT station, a physical station to integrate those two services needs to be built. Since the Suzuki fleet will not be allowed to enter the BRT lane, they can make the stop on the curbside bus stop near the BRT station. The 5 BRT stations that will be connected with this service are built with pedestrian bridge connection from the BRT station to the bus stops located on the curb-side.

This effort is worth doing at the initial stage of the BRT, to ensure good integration and connectivity with existing service that are not part of the BRT. After few years, more comprehensive effort to include these feeder services as part of the BRT might be needed. For example, they can be part of the free feeder system, like provided in Bogota, where TransMilenio pays operator to run the free feeder service.

Figure 7. 9 Feeder Connectivity at Chamkani



8 Traffic Management

Several traffic management measures are proposed as an effort to mitigate potential traffic problems associated with the proposed BRT routes. These measures include treatments on U-Turn, critical intersections, as well as city center traffic management.

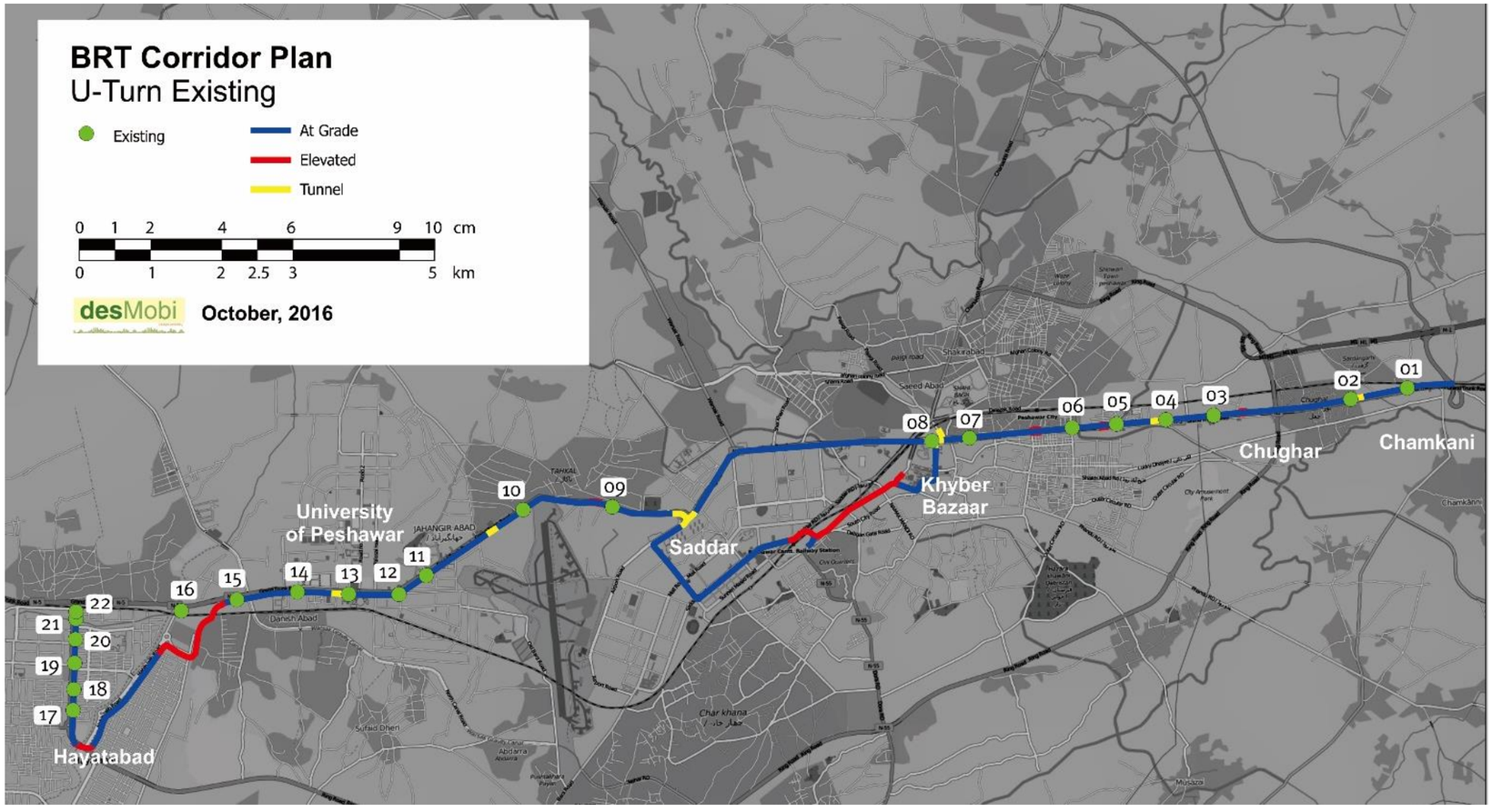
8.1 U-Turn Treatment

8.1.1 Current U-Turn Setup

Currently, U-Turns are completed from the fast-lane traffic into fast-lane traffic on the other direction by crossing over the median with no grade separation. Even without the median-aligned bus lanes, this could affect the speed along the road and safety especially since the movement concerns two fast lanes traffic. With the bus lanes, the U-turning vehicles will have to cross longer distance and will undermine the speed of both buses and general traffic. This could be a huge issue as we identified 22 existing U-turn locations on and near the proposed BRT corridor.

In order to solve this problem, the plan is to upgrade U-Turn infrastructure to allow slow-lane to slow-lane U-Turn using elevated facility. Figure 8.2 shows the conceptual design and an example of such facility.

Figure 8. 1 Current U-Turn location



While this design can solve capacity and safety issues concerning U-Turn, there are some problems to address. The boxes beside show the pros and contras of implementing slow-lane to slow-lane elevated U-Turn facility.

Pros

- Increase U-Turn capacity
- Minimize conflicts with buses and general traffic
- Increase speed for U-Turning vehicles
- Increase speed for buses and general traffic

Cons

- Costly to implement
- Requiring a large space
- Column placement could be a problem
- Impose visual intrusion in the city
- Against drivers' instinct to conduct U-turn from the curbside lane

8.1.2 Proposed U-Turn Setup

Alternatively, we proposed the use of a combination between elevated and at-grade U-Turns along and near the proposed BRT alignment. In order to address the issues concerning vehicle conflicts, we propose to use BRT tunnel to separate the grade between U-turning general traffic with buses. Figure 8.3 shows the design and example of this type of U-turn.

Figure 8. 2 Conceptual elevated U-Turn design (top) and example in Bangkok, Thailand (bottom)

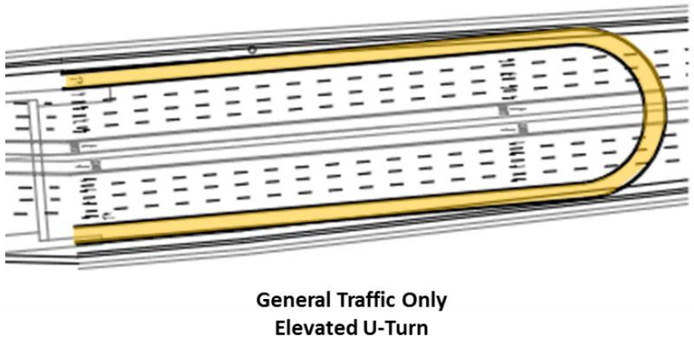
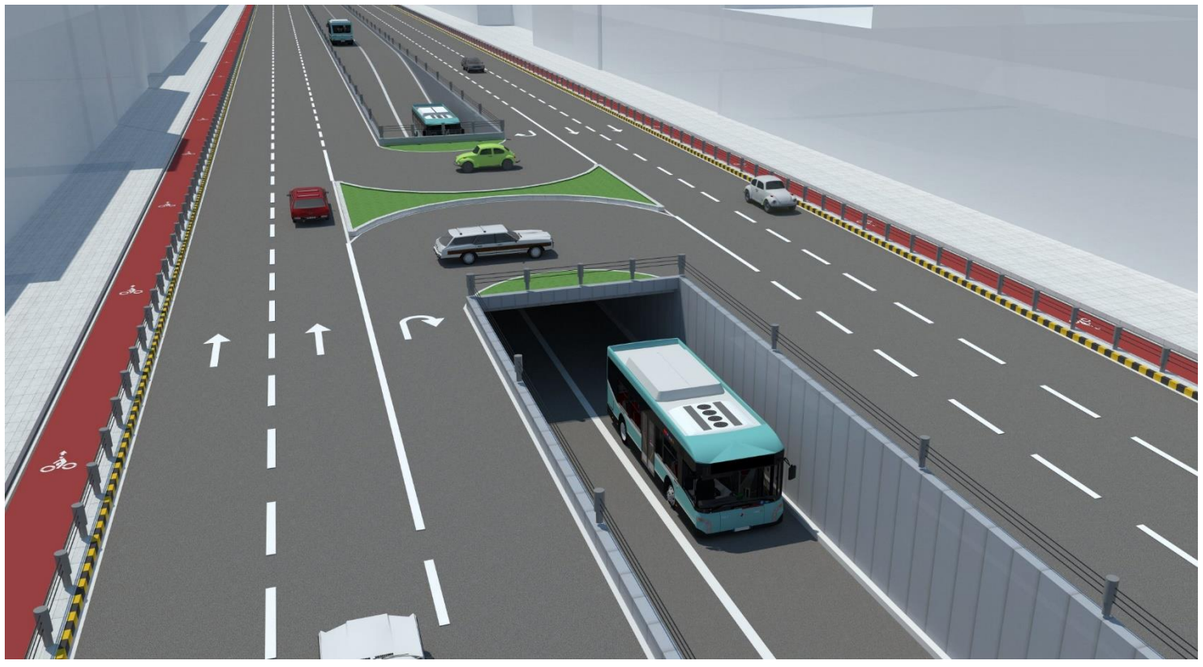


Figure 8. 3 BRT-only Tunnel to avoid U-Turn Movement for general traffic.



BRT-only Tunnel at Quito BRT, Ecuador

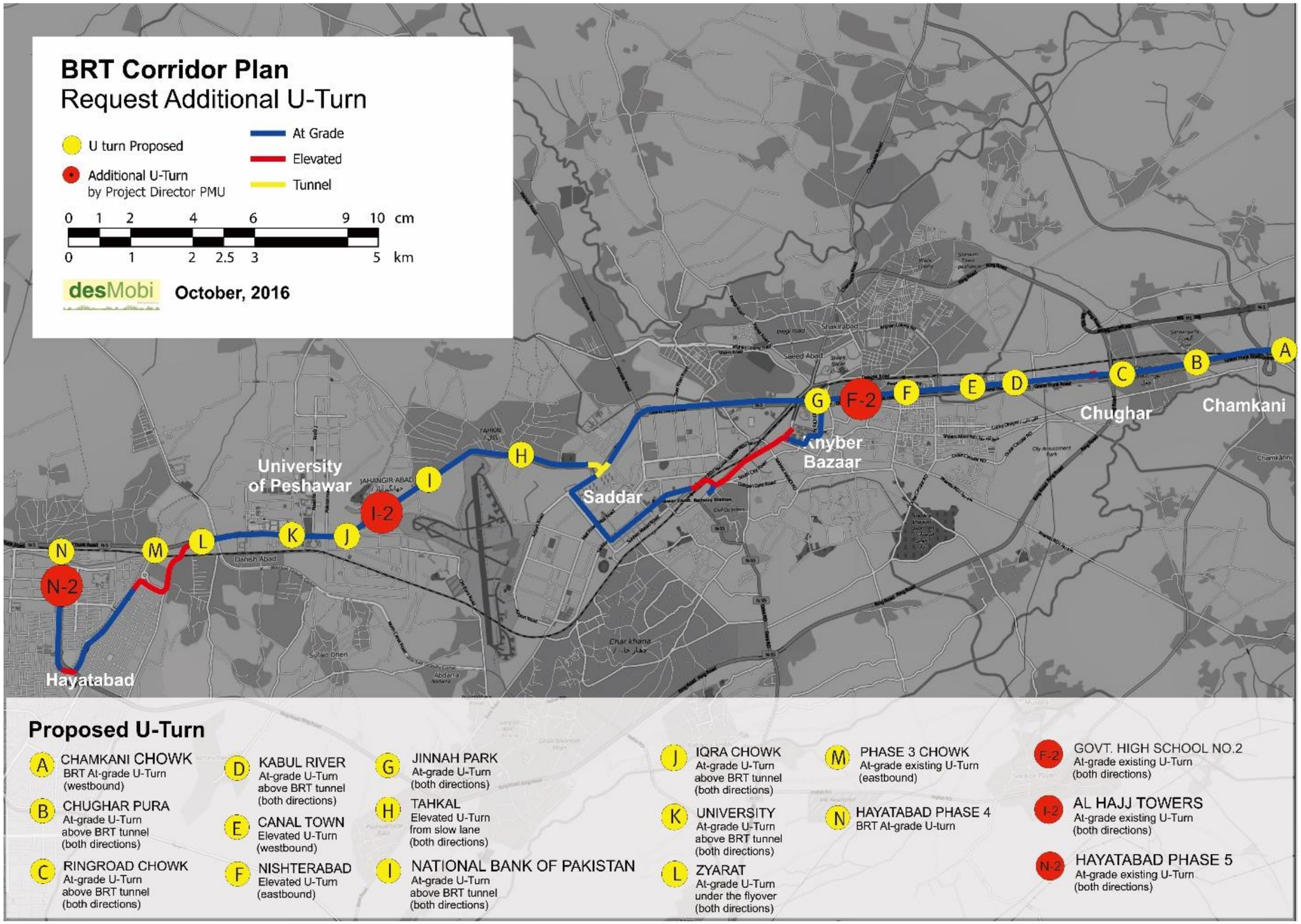
In order to optimize U-Turn movement, we propose to close several existing U-Turn location and open 13 improved U-Turn facilities.

To ensure conflict-free BRT movement along GT Road, the 14 locations on the map are designed with one of the two types of grade separation treatment mentioned:

1. Elevated U-Turn for general traffic (Location E, F, and H)
2. At Grade U-Turn for general traffic with BRT-only Tunnel (Location B, C, D, G, I, J, K, L, M, F-2, I-2, and N-2)
3. At Grade U-Turn for BRT only (Location A and N)

Location A and N are located on either end of the BRT corridor. These locations have at-grade U-turn facilities for buses and nearby general traffic U-turn facilities. Location G is an at-grade U-Turn facility on top of a tunneled junction for BRT. U-Turn Facilities L and M are located under a proposed BRT flyover or a current general traffic flyover.

Figure 8. 4 U-Turn Locations.



It is understood that the proposed set up will result in reduced U-Turn capacity along GT Road. However, there will still be adequate U-Turn capacity. The Table 8.1 shows the diversions of U-turn from the current locations to the proposed ones. On average, each U-turn will be diverted 0,311 km. Eastbound U-turns are diverted on average 0,327 km while westbound U-turns 0,295. U-turn traffic going towards city center (Location 1-8 westbound and 9-21 eastbound) are diverted on average 0,318 km while U-turn away from city center are diverted on average 0,306 km). These diversions are still within reasons and the proposed U-turn locations will have enhanced capacity to ensure smooth movement.

The use of a combination between elevated and at-grade U-turn with BRT tunnel will lower the cost of construction. BRT tunnels for at-grade U-turn are also less visually intrusive than elevated U-turn. Also, column placement for elevated U-turn can be challenging. Table 8.2 shows the comparison of costs associated with U-turn set up options.

The first option is to keep the number of current U-turn and transform them into elevated two-way U-turns. The second option is to reduce the number of U-turn to the proposed 14 locations and transform them into elevated two-way U-turn. The third option, which is our preferred option is by mixing between one-way and two-way elevated U-turn with two-way at-grade U-turn with BRT tunnel to avoid conflicts. From the table it can be seen that the proposed setup will cost only one-fifth to the fully elevated U-turn option.

Table 8.1 U-Turn Diversion

Current U-Turn	U-Turn Diversion			
	Eastbound Direction	Distance (km)	Westbound Direction	Distance (km)
1	Diverted to U-Turn B	0.650	Diverted to U-Turn B	0.650
2	Diverted to U-Turn B	0.150	Diverted to U-Turn B	0.150
3	Diverted to U-Turn C	0.900	Diverted to U-Turn C	0.900
4	Diverted to U-Turn D	0.150	Diverted to U-Turn D	0.150
5	Diverted to U-Turn D	0.550	Diverted to U-Turn E	0.120
6	Diverted to U-Turn F	0.530	Diverted to U-Turn E	0.500
7	Diverted to U-Turn F2	0.200	Diverted to U-Turn F2	0.200
8	Diverted to U-Turn G	0.000	Diverted to U-Turn G	0.000
9	Diverted to U-Turn H	0.250	Diverted to U-Turn H	0.250
10	Diverted to U-Turn I	0.500	Diverted to U-Turn I	0.500
11	Diverted to U-Turn I-2	0.230	Diverted to U-Turn I-2	0.230
12	Diverted to U-Turn J	0.000	Diverted to U-Turn J	0.000
13	Diverted to U-Turn K	0.150	Diverted to U-Turn K	0.150
14	Diverted to U-Turn K	0.550	Diverted to U-Turn K	0.555
15	Diverted to U-Turn L	0.000	Diverted to U-Turn L	0.000
16	Diverted to U-Turn M	0.000	not allowed	
17	Diverted to U-Turn N-2	0.950	Diverted to U-Turn N2	0.950
18	Diverted to U-Turn N-2	0.650	not allowed	
19	Diverted to U-Turn N-2	0.300	Diverted to U-Turn N-2	0.300
20	Diverted to U-Turn N-2	0.000	Diverted to U-Turn N-2	0.000
21	not allowed		Diverted to U-Turn N2	0.300
21	Diverted to U-Turn N-2	0.480	not allowed	
	Average Eastbound Diversion (km)	0.327	Average Westbound Diversion (km)	0.295
	Average Diversion Away from City Center (km)	0.318	Average Diversion Towards City Center (km)	0.306

Table 8.2 Cost Comparison of U-Turn setup

Scenario	Description	Cost (USD)	Proportion to Maximum Cost
1	22 two-way elevated U-turns	202.752.000	100%
2	14 two-way elevated U-turns	129.024.000	64%
3	1 two-way elevated U-turn, 2 one-way elevated U-turns, 11 two-way at-grade U-turn with BRT tunnel	38.232.000	19%

Cost Description	Cost (USD)	
Elevated U-Turn one way	4.608.000	per unit
BRT tunnel*	7.200.000	per km

notes: *At-grade U-turn with BRT tunnel requires 250m of BRT tunnel

8.2 Grade Separation Treatment

Grade separation is a measure to avoid conflict using either flyover or tunnel to separate bus and/or general traffic flows with conflicting flows. In addition to the U-turn treatment, grade separation treatment will be provided along the BRT corridor on junctions and intersections in seven different locations along the BRT corridor. The grade separation treatment will be applied on these locations:

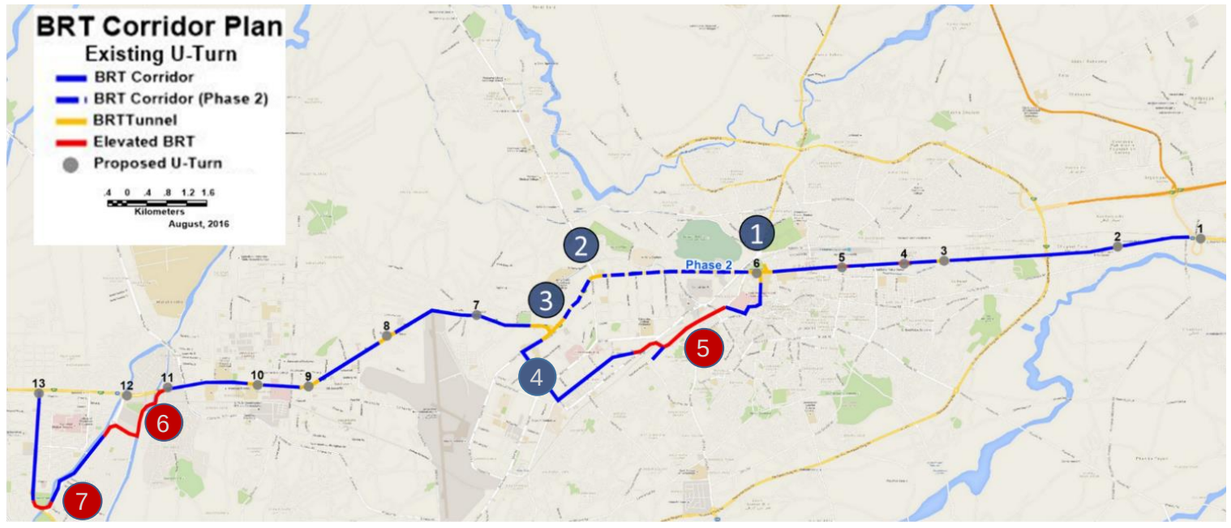
BRT Tunnel:

1. Qila Bala hissar
2. Khyber – Warsak Intersection
3. Amman Chowk
4. Garrison Club Chowk

BRT Flyover:

5. Railway Road
6. Hayatabad North
7. Hayatabad South

Figure 8. 5 Location of Grade Separation Treatment along BRT Corridor



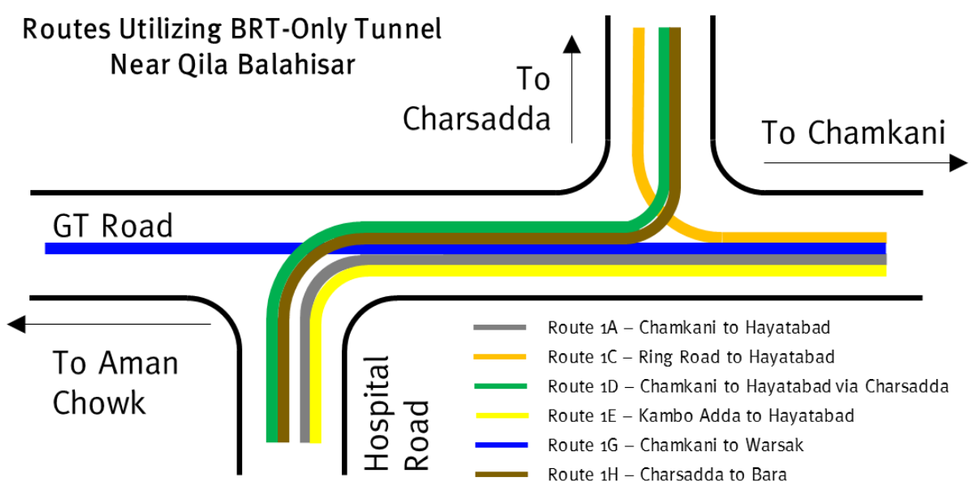
8.2.1 BRT Tunnel

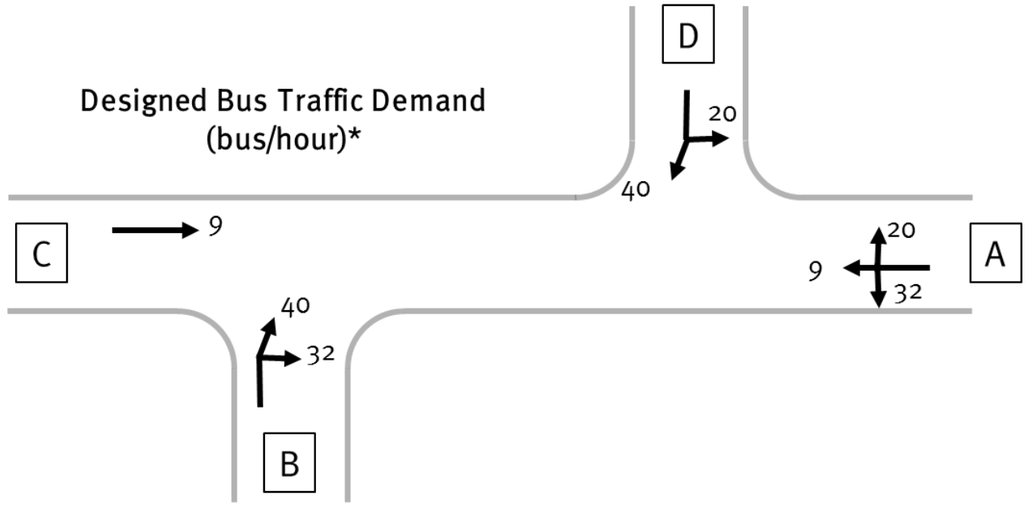
In addition to the grade-separation due to U-turns, BRT underpass would be built in 4 locations to avoid conflicts between buses and general traffic. These locations are chosen due to the complex flows and potential congestion as well as safety issues.

Qila Bala Hisssar

The tunnel in Qila Bala Hissar will allow buses to pass the staggered junction between GT Road, Hospital Road, and Charsadda. Six out of the eight routes will go through this junction; these are Route 1A, 1C, 1D, 1E, 1G, and 1H. Figure 8.6 shows the designed bus traffic demand for the junction according to the planned bus frequency.

Figure 8. 6 Bus traffic demand for the Qila Balahisar tunnel.





The staggered junction will be signalized to manage conflicting bus flows. Both priority junction and underground roundabout were also considered. While the tunnel's capacity would still be enough to accommodate priority junction, we are concerned about visibility. As the junction will be underground, bus drivers may have difficulties to notice other buses early enough to slow down safely. For a priority junction to work, the tunnel will need to be flared on the approach of the junction.

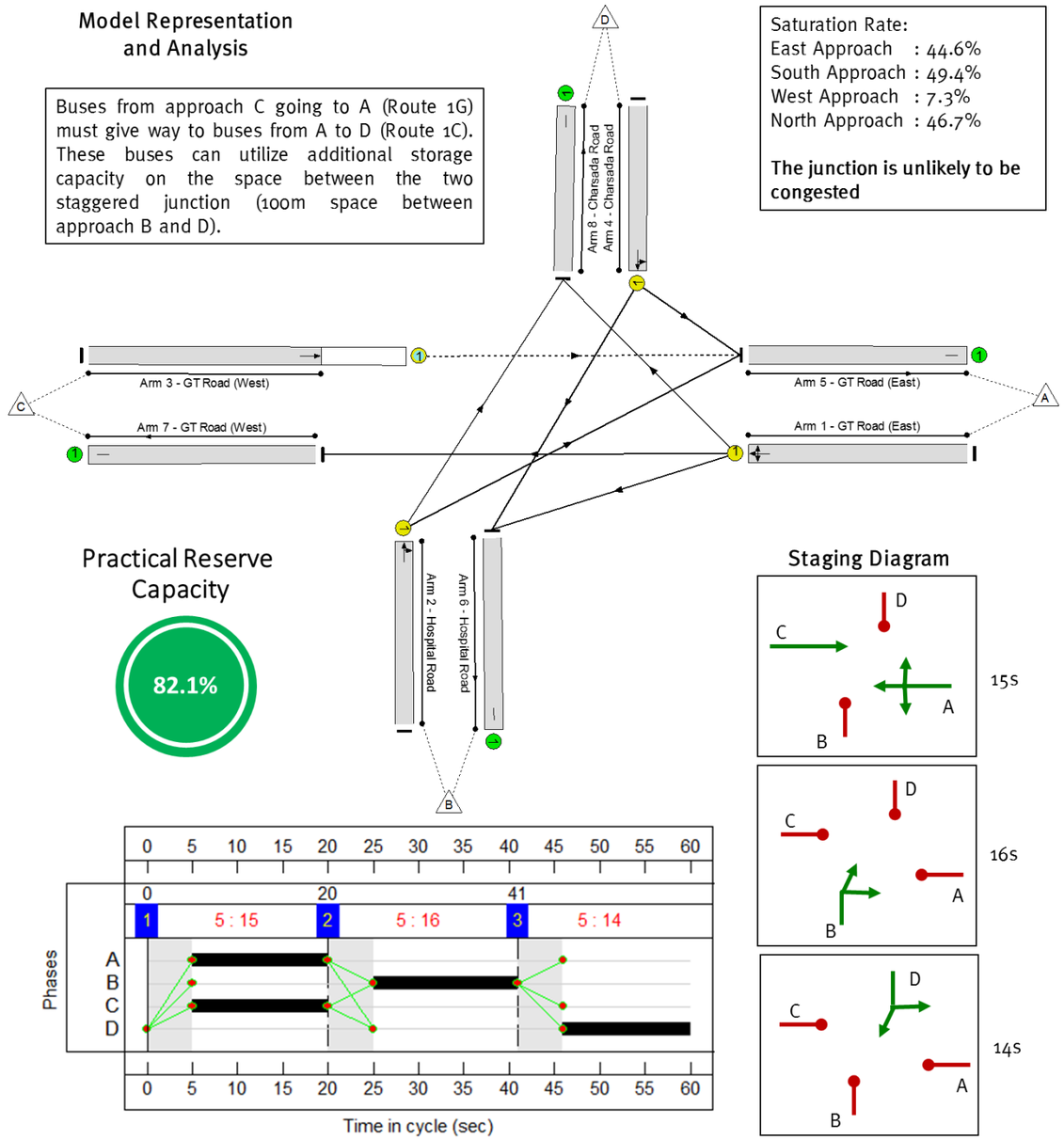
The space uptake, cost of construction, and structural characteristics for flared approaches may be similar to an underground roundabout. An underground roundabout would result in smoother movements of buses, however there are concerns about the costs of construction as well as underground space availability. Therefore, we believe the best setup for the junction inside the tunnel will be traffic signal, to promote safety.

Table 8.3 below shows the planned bus frequency which translate into traffic demand for the tunnel.

Table 8.3 Planned bus frequency and estimated ambulance demand flow

Planned Bus Frequency (bus/hour)

BRT Route	Frequency (bus/h)
WESTBOUND and EASTBOUND	
1A	12 (between A and B)
1C	20 (between A and D)
1D	20 (between B and D)
1E	20 (between A and B)
1G	9 (between A and C)
1H	20 (between A and B)



Aman Chowk

Allowing the BRT to go at grade at Aman Chowk will be potentially problematic. Buses will suffer long delays caused by the congestion in approach to the roundabout. Likewise, the movement of the buses on the roundabout may disrupt the other traffic. Figure 8.7 shows the potential conflict between BRT and general traffic movements.

Currently, the roundabout is prone to congestion, especially in the northeast approach from the GT Road East. At-Grade BRT facility can help alleviate the congestion on this approach but may harm the other approaches as seen in Figure 8.8.

The capacity of a roundabout approach will affect the other approaches. While improving the critical northeast approach, the BRT lane will put other approaches at risk of being congested. Moreover, there is a plan to extend BRT corridor along GT Road north of the Cantonment Area. The reduction of lane in this approach will potentially bring roundabout capacity to a saturated condition. Therefore, it is recommended to use a BRT-only tunnel at Aman Chowk.

Figure 8.9 shows the design for Aman Chowk tunnel. Inside the tunnel, the bus movements will be managed by priority junction rule, where the movements between Khyber Road and GT Road (West) are prioritized, and the other two approaches have to give way.

Figure 8. 7 Potential BRT Movement conflicts in Aman Chowk.

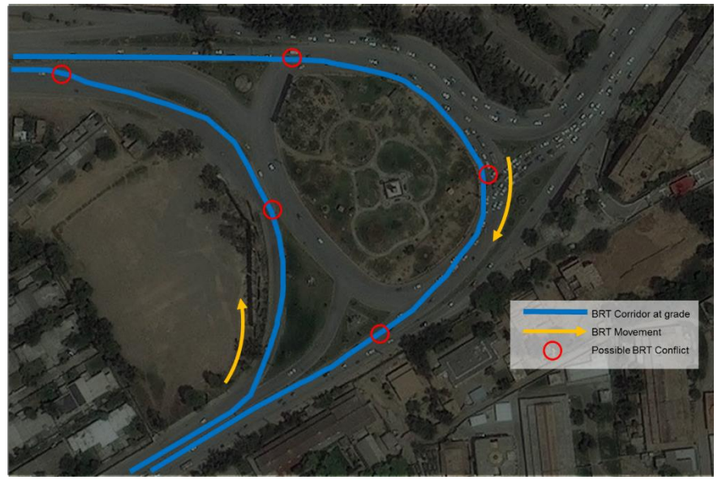


Figure 8. 8 Aman Chowk Tunnel Design.

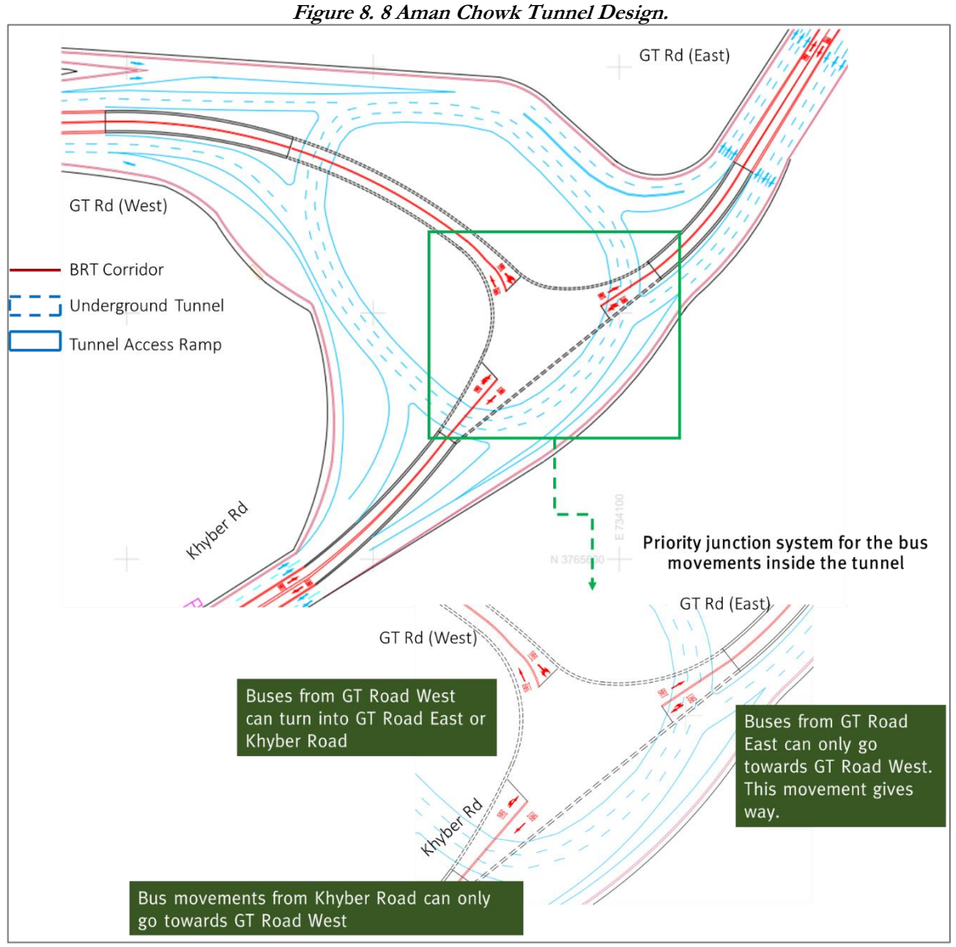
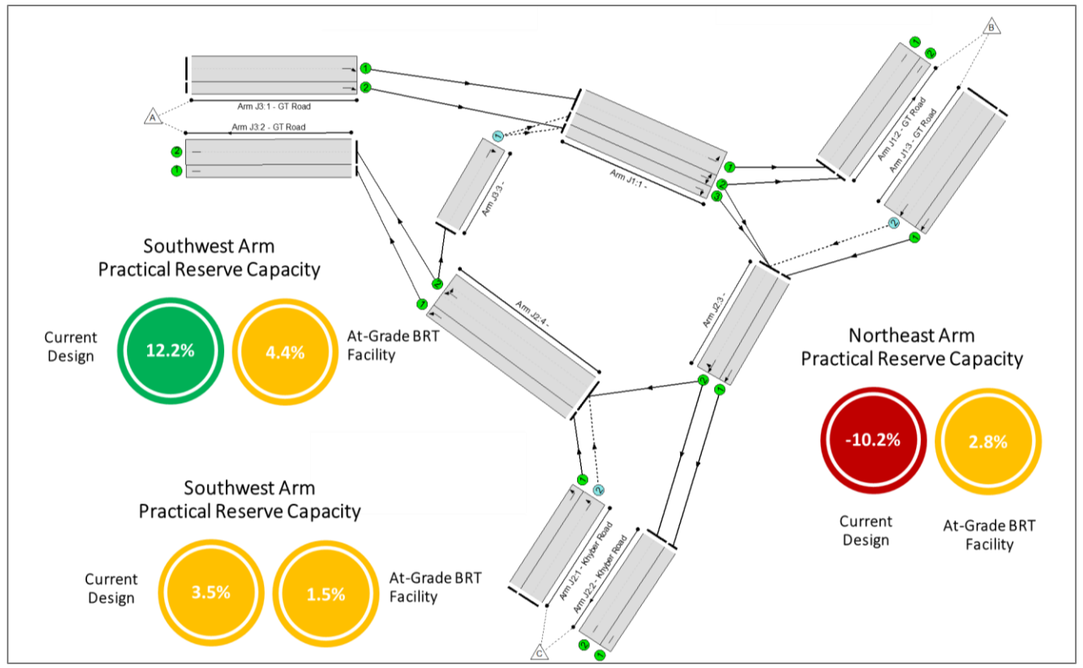


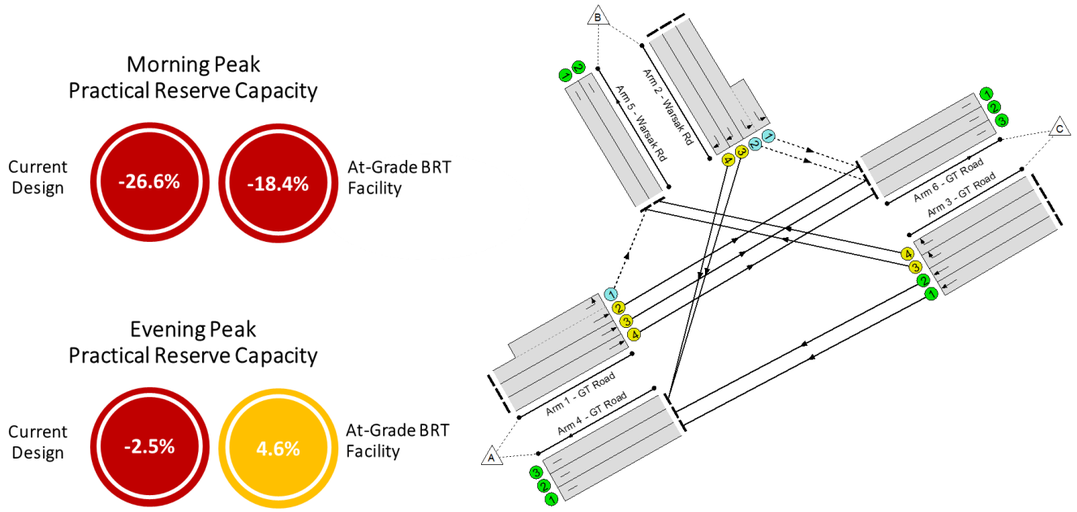
Figure 8. 9 Aman Chowk Capacity Analysis.



Khyber – Warsak Intersection

According to traffic survey data, the Khyber – Warsak Intersection is likely to be congested, especially in the AM Peak Period. The Khyber – Warsak intersection is a 4-arm junction with the fourth arm in the south going to a restricted army area. Due to security reasons, traffic to and from this approach could not be recorded. Nevertheless, since the access to the army area is limited, traffic to and from this arm can be neglected in the model. Figure 8.10 shows a model representation and capacity analysis of the junction.

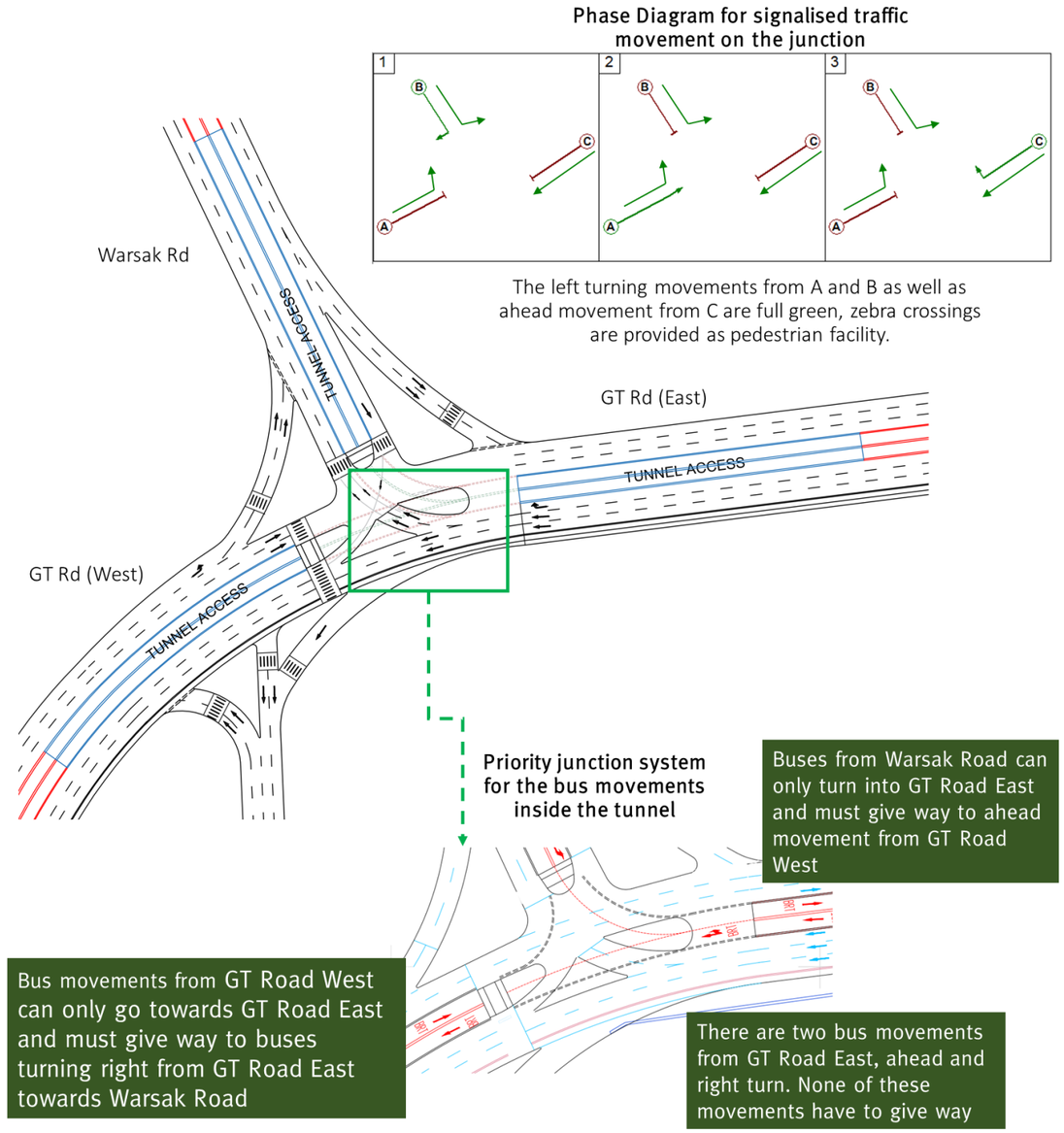
Figure 8. 10 Khyber – Warsak Intersection Capacity Analysis.



As with Aman Chowk, at-grade BRT at this junction will be problematic as buses will pose delay by the queueing traffic. Even though BRT corridor can alleviate the congestion in this junction, it might not be enough to transform it into an unsaturated junction. Therefore, we propose to use BRT-tunnel at this junction.

Movement of general traffic above the tunnel would be controlled by signal timing while the movement of buses inside the tunnel follow give-way priority rule, as can be seen in Figure 8.11.

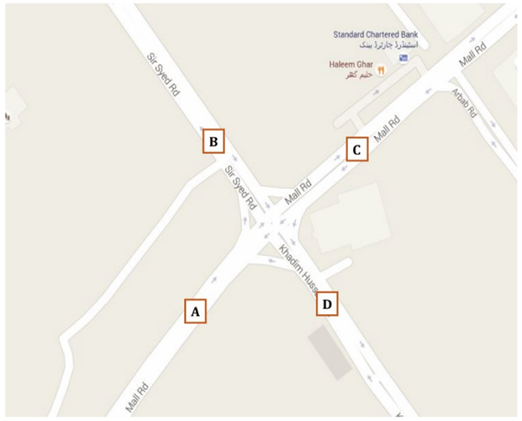
Figure 8. 11 Khyber- Warsak Intersection Tunnel Design and Signal Control.



Garrison Club Chowk

At the junction near Garrison Club, BRT-only underpass will be built to avoid conflict between BRT and regular traffic at intersection. One BRT lane on both direction will be provided at the underpass, and buses joining from Bara Road will have to join the BRT after the underpass or just before the BRT station in front of Garrison Club. Traffic demands for the PM Peak are higher than the AM Peak. Figure 8.12 shows the layout and demand profile for Garrison Club Chowk

Figure 8. 12 Junction Layout and Demand for Saddar - Khyber Intersection



PM Peak Hourly All Traffic Counts

		Destination				
		A	**B**	**C**	**D**	**Tot.**
Origin	**A**	0	114	334	153	601
	B	138	0	954	1243	2335
	C	393	860	0	140	1393
	D	76	1351	132	0	1559
	Tot.	607	2325	1420	1536	5888

PM Peak Hourly Non PT Traffic Counts

		Destination				
		A	**B**	**C**	**D**	**Tot.**
Origin	**A**	0	114	334	152	600
	B	138	0	954	948	2040
	C	393	858	0	140	1391
	D	76	1067	132	0	1275
	Tot.	607	2039	1420	1240	5306

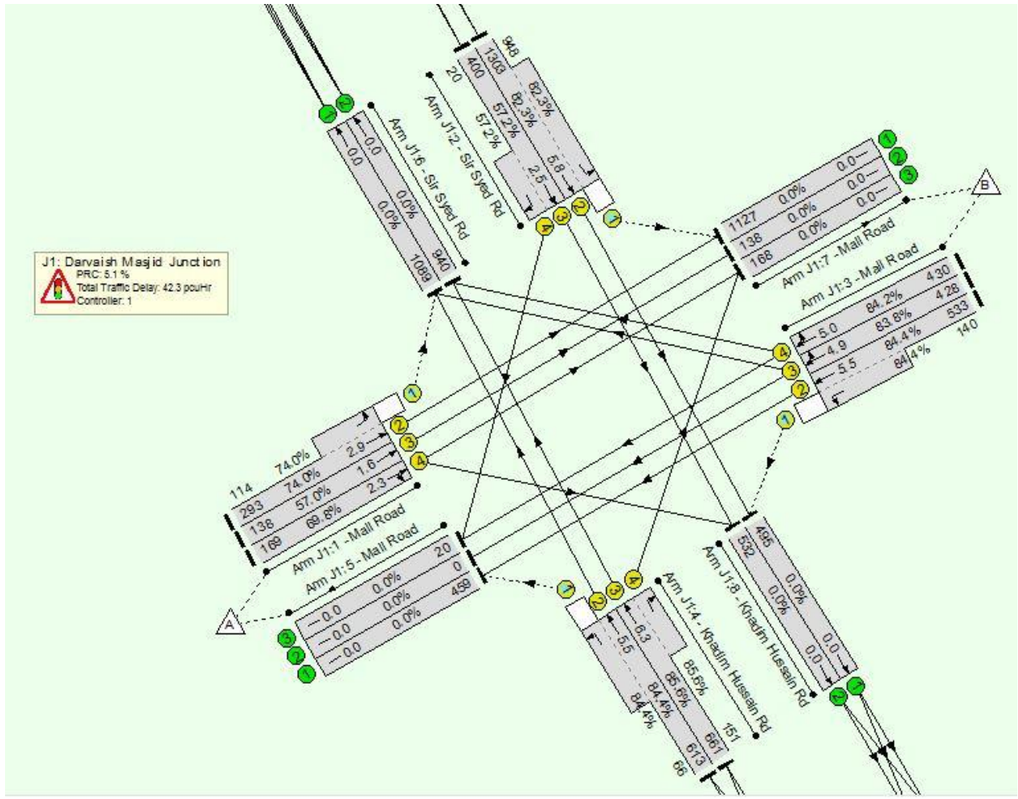
Garrison Club Chowk is modified on the Northwest and Southeast approaches. Although in order to minimise delay, the common practice is to minimise the number of stages, the Garrison Club Chowk requires four stages minimum to allow all traffic movements to commence without conflict. Using less than four stages may result in safety issues.

In addition, the BRT corridor that runs from southeast (Khadim Hussain Rd) to northwest (Sir Syed Rd) and otherwise will use underpass to get through the junction, then the BRT will not get any traffic conflict at this junction.

This junction is operating at capacity. Table 8.4 shows the detailed junction performance analysis results.

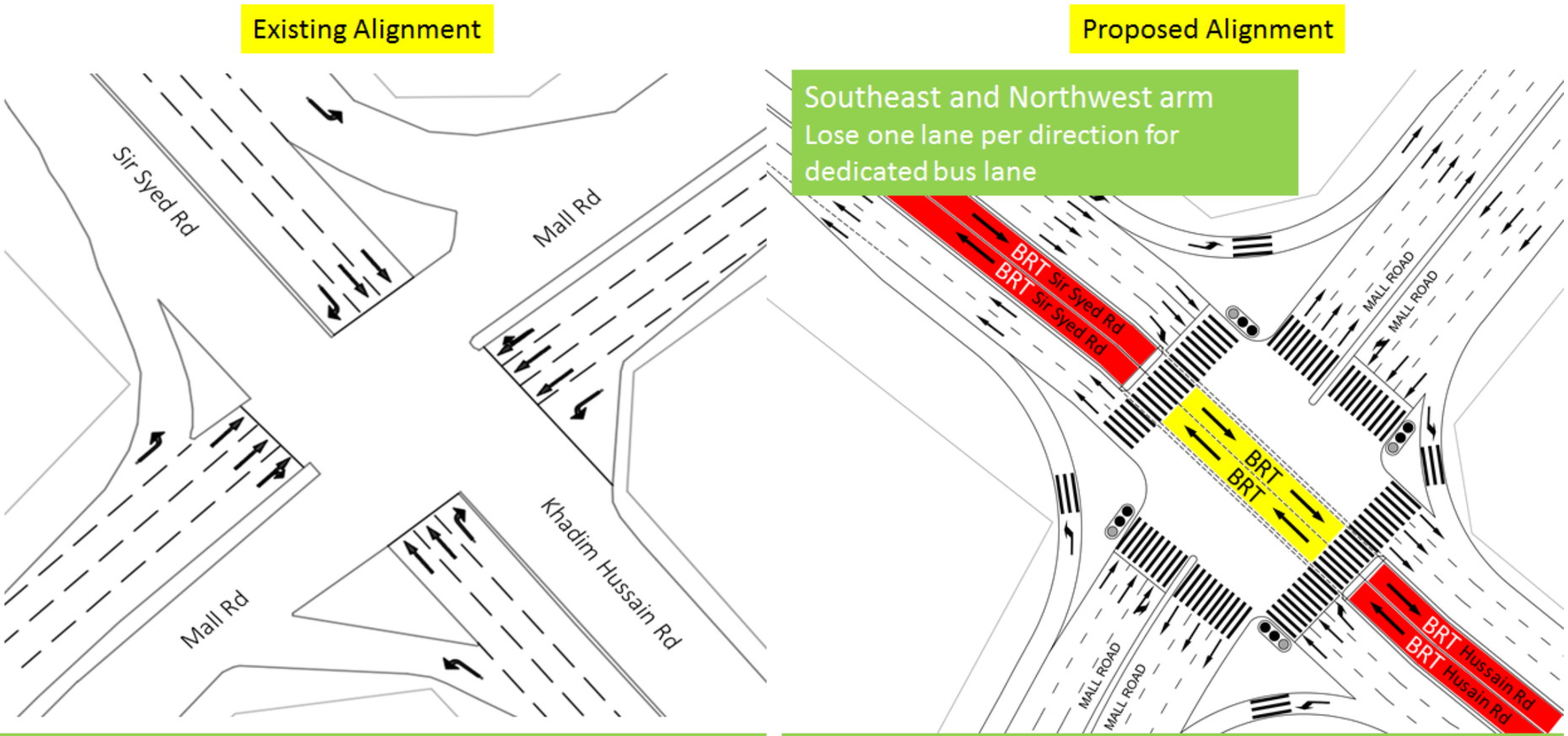
Table 8.4 Garrison Club Chowk Performance Analysis

Lane	Lane Description	Lane width at approach (m)	Demand Flow (pcu)	Capacity (pcu)	Deg Sat (%)		Av. Delay Per PCU (s/pcu)	
					Prop.	Curr.	Prop.	Curr.
1/2+1/1	Mall Road Left Ahead	3.5	293	242+154	74.0;74.0%	75.6;75.6%	36.1	36.1
1/3	Mall Road Ahead	3	138	242	57,00%	60.7%	41.5	43.2
1/4	Mall Road Ahead Right	3	169	242	69.8%	64.9%	48.8	45.4
2/2+2/1	Sir Syed Rd Left Ahead	3;3	1303	431+1151	82.3;82.3%	92.7;92.7%	16.1	22.2
2/3+2/4	Sir Syed Rd Right Ahead	3;3	400	664+35	57.2;57.2%	82.8;86.5%	22.2	41.1
3/2+3/1	Mall Road Ahead Left	3;3	533	465+166	84.4;84.4%	88.8;88.8%	37.0	41.1
3/3	Mall Road Ahead Right	3	428	511	83.8%	89.8%	41.3	53.7
3/4	Mall Road Ahead Right	3	430	511	84.2%	89.8%	41.8	53.7
4/2+4/1	Khadim Hussain Rd Left Ahead	3;3	613	648+78	84.4;84.4%	95.6;95.6%	32.1	52.7
4/3+4/4	Khadim Hussain Rd Ahead Right	3;3	661	596+176	85.6;85.6%	95.0;87.3%	34.5	61.0
Garrison Club Chwok		**PM Peak Condition**			**85.6%**	**95.6%**		



The proposed changes for this junction are shown below.

Figure 8. 13 Proposed Changes in Garrison Club Chowk.



Current condition

The left turning movements both from Sir Syed Rd (Northwest) have the highest degree of **saturation of 95.6%**

Followed by left turning movement from Khadim Hussain Rd (Southwest) **at 92.7%**

Proposed Design

The highest degree of saturation is observed on the ahead and right turning movements from Khadim Hussain Rd **at 85.6% saturation**

Nearly all lanes are operating **at above 80% saturation** except for the lanes from Mall Road

Underpass for BRT is proposed due to high saturation of this junction

Summary

With a small value of PRC by 5.1% (proposed), The Garrison Club Chowk is a **critical junction operating at capacity**

8.2.2 BRT Flyover

To avoid conflict between BRT and regular traffic movement on key junctions, three BRT flyover will be built, which are located at railway road, and in the north and south part of Hayatabad.

Railway Road Flyover

BRT corridor will be elevated along Railway Road. The bus lane will be elevated from the northwest end of Khyber Bazaar road until it joins Saddar Road (figure 8.14).

In addition to bypassing several junctions in Railway Road, the flyover also connects bus corridor to BS-13 which integrates BRT with the rail system. The BRT station, called BS-13 Railway Station will be built on the current railway dry port location to allow BRT passengers to connect to railway station using extended existing pedestrian overpass. Route 1B and 1F will stop at this station.

To access the station from the south buses will have to go through Ajab Khan Afridi Road. Buses will therefore have to cross the junction between Ajab Khan Afridi Road and Railway Road.

Currently, the junction between Ajab Khan Afridi Road and Railway Road is not congested and bus movements are not likely to disrupt traffic and movements can be managed using signal control. Figure 8.16 shows the potential conflict area between the traffic on railway road and the buses crossing to the station from Ajab Khan Afridi Road while Figure 8.17 shows the phase diagram to manage BRT and general traffic movement in the junction.

In the future there is an option to construct underground access for traffic if the junction becomes congested. But at the initial stage, this can be avoided.

Figure 8. 14 BRT Flyover along Railway Road

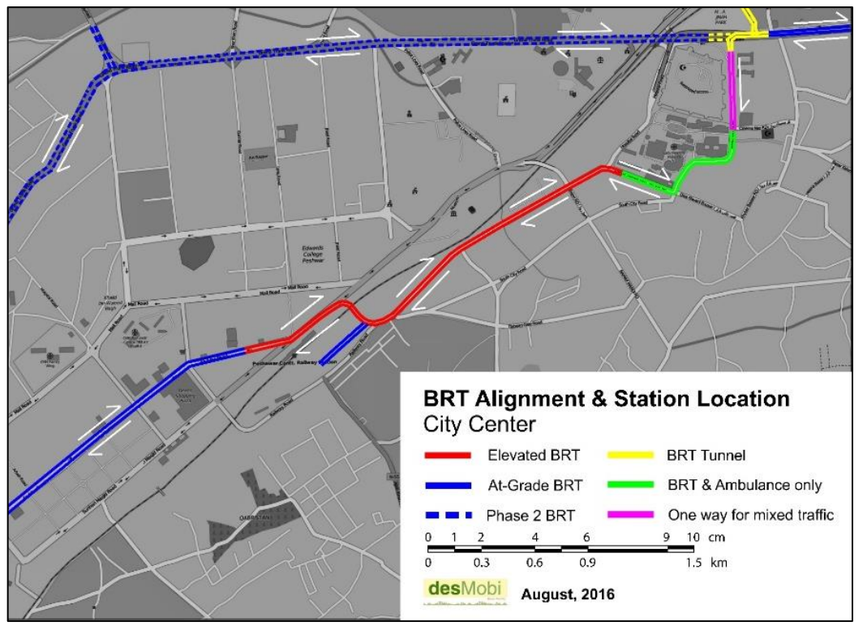


Figure 8. 15 BRT Only Ramp near Railway Station.

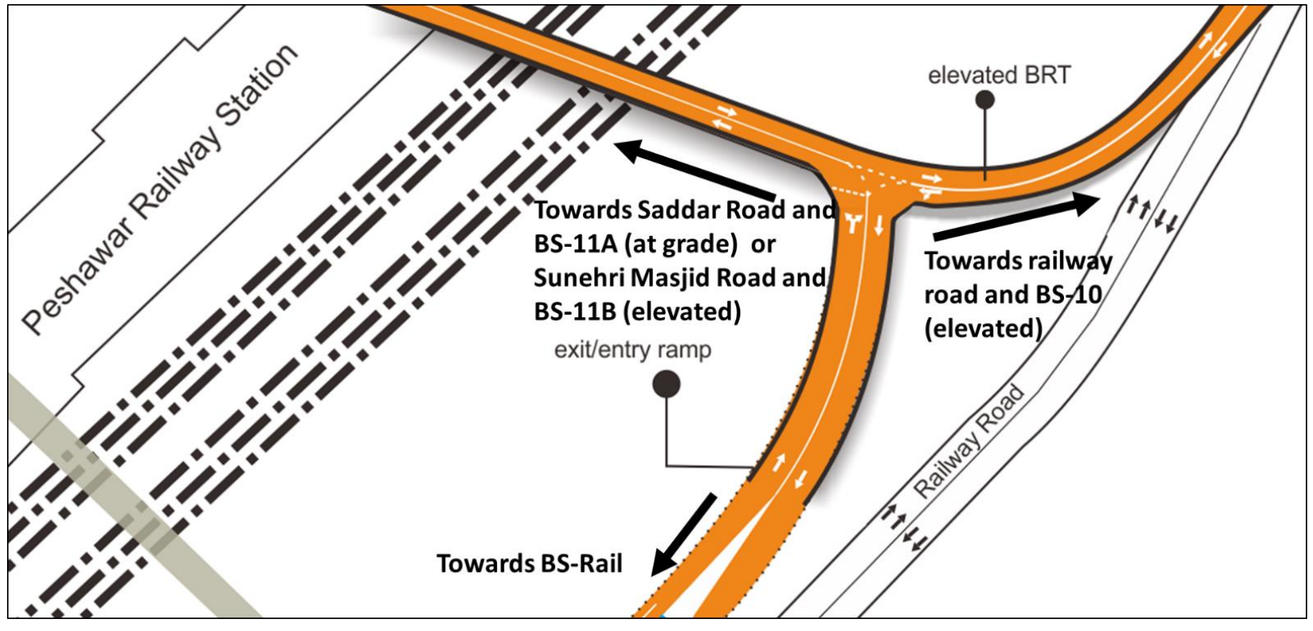


Figure 8. 16 Potential Conflict Area in at-grade railway station

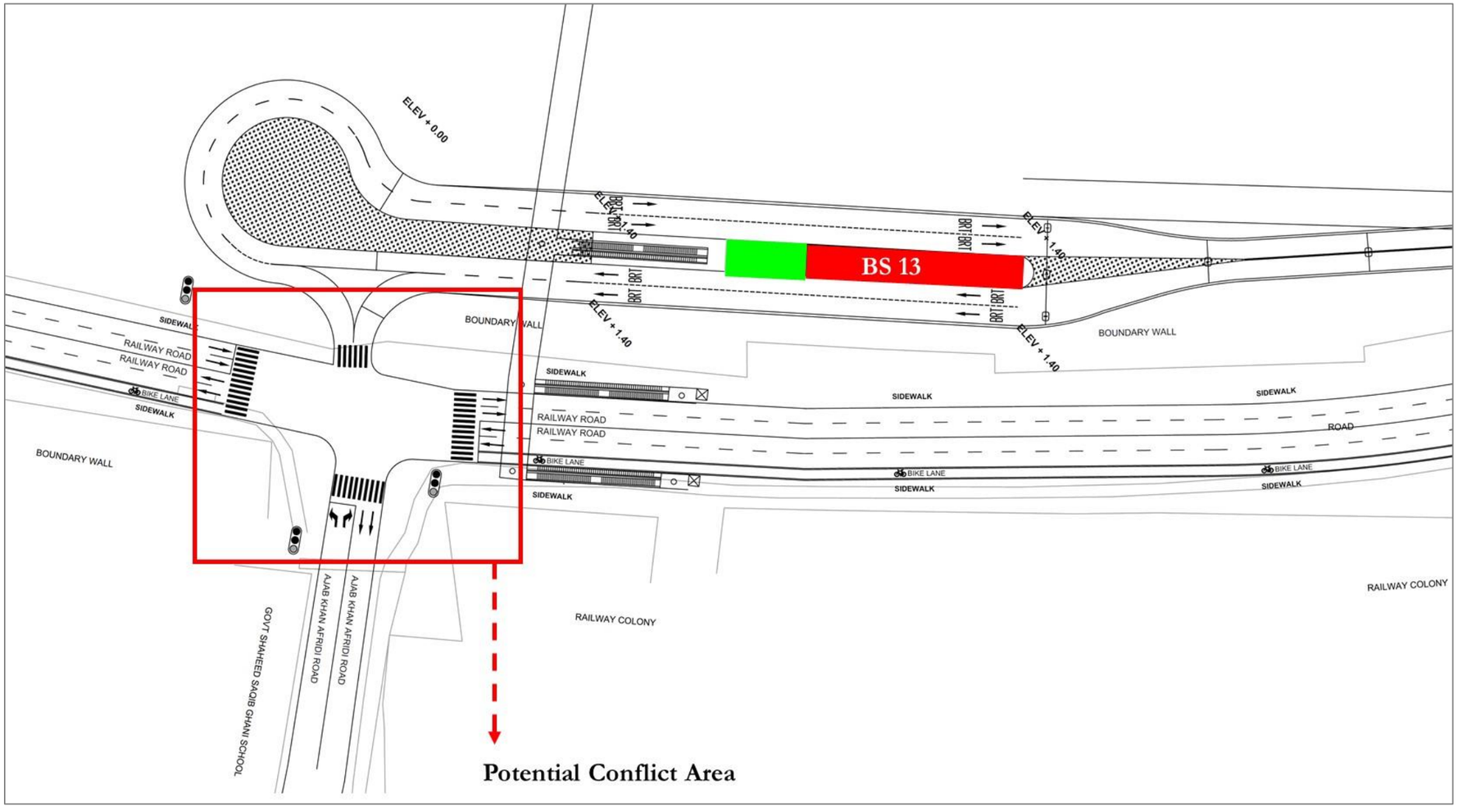
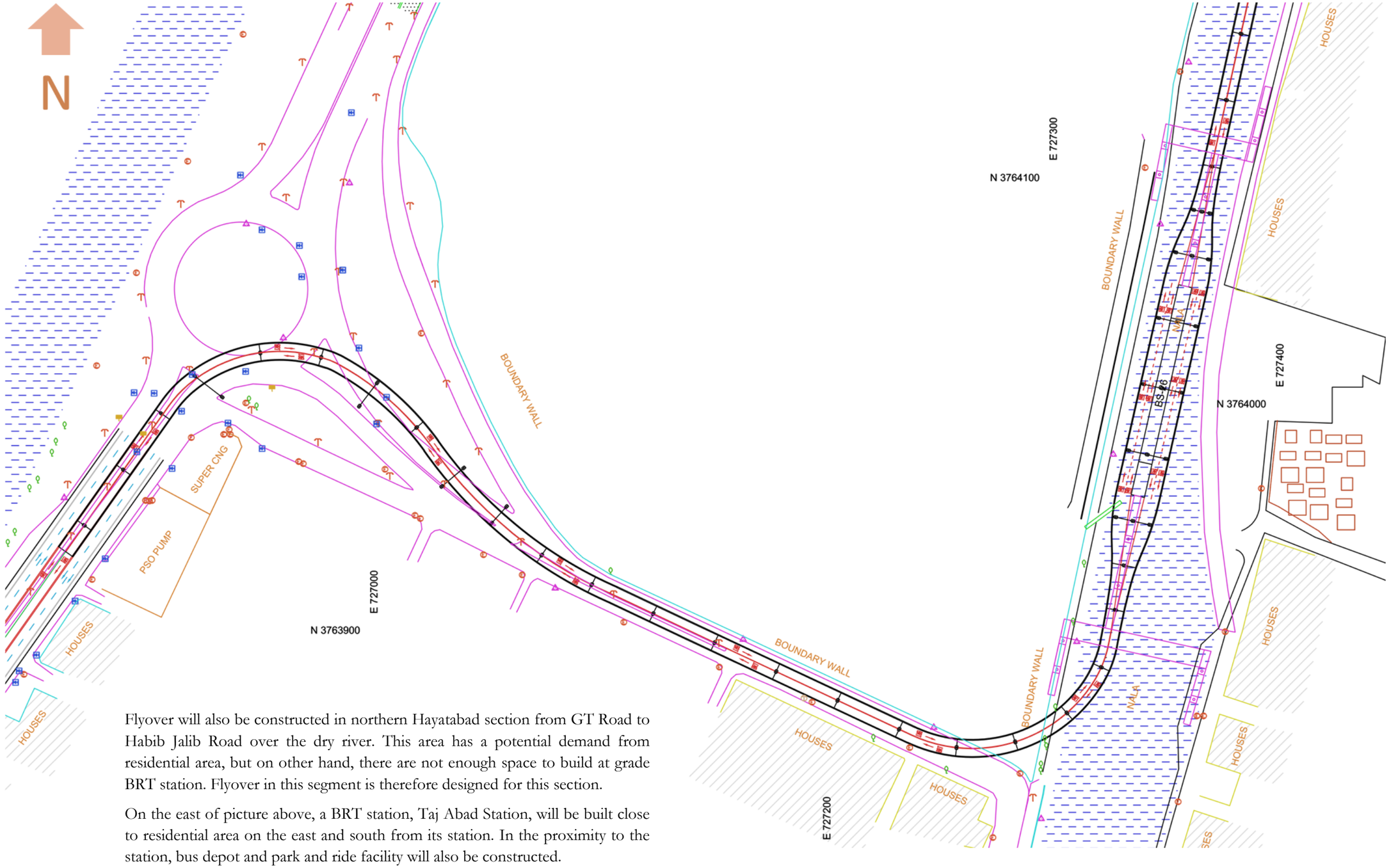


Figure 8. 17 Phasing Diagram in BS-Rail Access Junction.

Hayatabad Flyover – North

Figure 8. 18 Hayatabad Flyover (North)

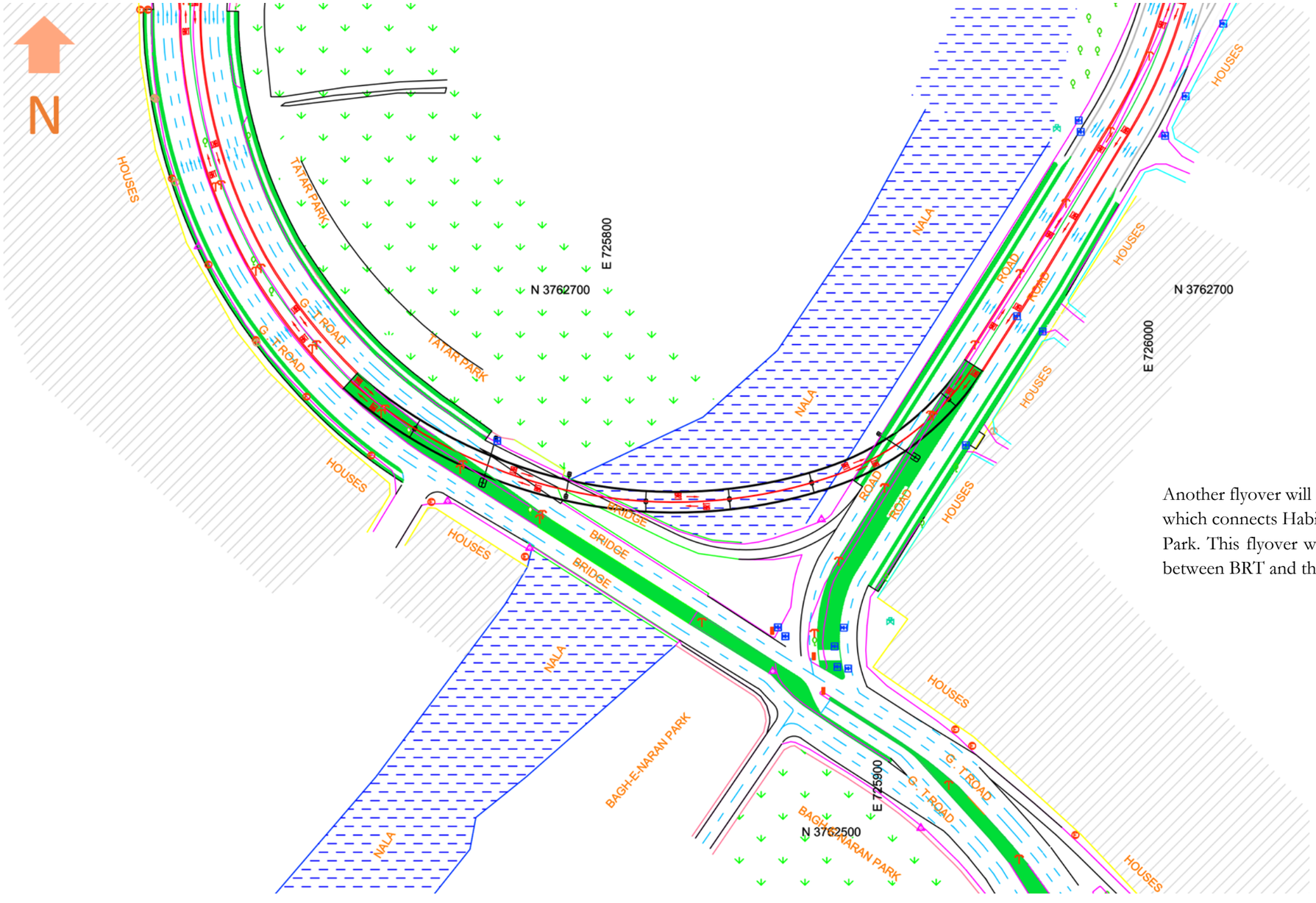


Flyover will also be constructed in northern Hayatabad section from GT Road to Habib Jalib Road over the dry river. This area has a potential demand from residential area, but on other hand, there are not enough space to build at grade BRT station. Flyover in this segment is therefore designed for this section.

On the east of picture above, a BRT station, Taj Abad Station, will be built close to residential area on the east and south from its station. In the proximity to the station, bus depot and park and ride facility will also be constructed.

Hayatabad Flyover – South

Figure 8. 19 Hayatabad Flyover (South)



Another flyover will be constructed on the southern Hayatabad, which connects Habib Jalib Road and the Ring road near Tatara Park. This flyover will minimize distruption and avoid conflict between BRT and the mixed traffic going on Habib Jalib Road.

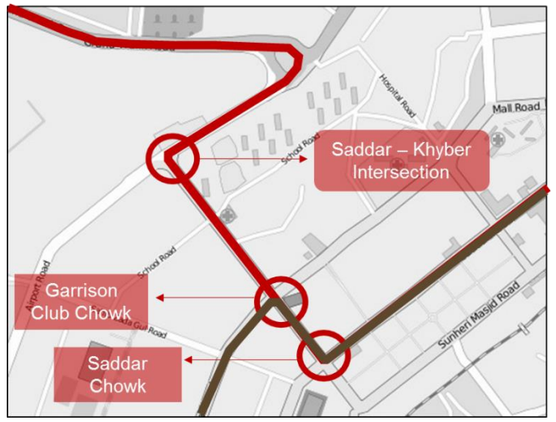
8.2.3 Grade-Separation Treatment for General Traffic

The proposed BRT corridor alignment requires a lane previously open for general traffic to be dedicated to buses. Therefore increase in traffic saturation level is expected in some junctions which may result in delays. Junction analysis is carried out to optimize capacity in order to reduce delays on junctions for both BRT and general traffic movement. The three critical junction in the Cantonment Area is shown in Figure 8.20.

Junction analysis will also produce optimum signal timing set up and junction layout. The analysis has been conducted for the two peak periods. The period when the junction has the worst performance indicator will be presented in this report.

Analysis have compared the 'before situation' where the public transport vehicles join the general traffic against the 'after situation' where one lane per direction becomes dedicated BRT Corridor. The 'before condition' analysis use total traffic volume from traffic count data as modelled demand. For the 'after condition' analysis public transport count is subtracted from the modelled demand because they are assumed to be replaced by buses traveling along the BRT lane.

Figure 8. 20 Critical Junctions in Cantonment Area.



Saddar – Khyber Intersection

For the case of the Saddar – Khyber intersection demands for the PM Peak period are higher than the AM Peak. Figure 8.21 shows the layout and PM Peak demand profile for the Saddar – Khyber Intersection.

Figure 8. 22 Junction Layout and Demand for Saddar - Khyber Intersection.

PM Peak Hourly All Traffic Counts

		Destination			
		A	B	C	Tot.
Origin	A	0	312	82	394
	B	308	0	1827	2135
	C	23	2433	0	2456
	Tot.	331	2745	1909	4985

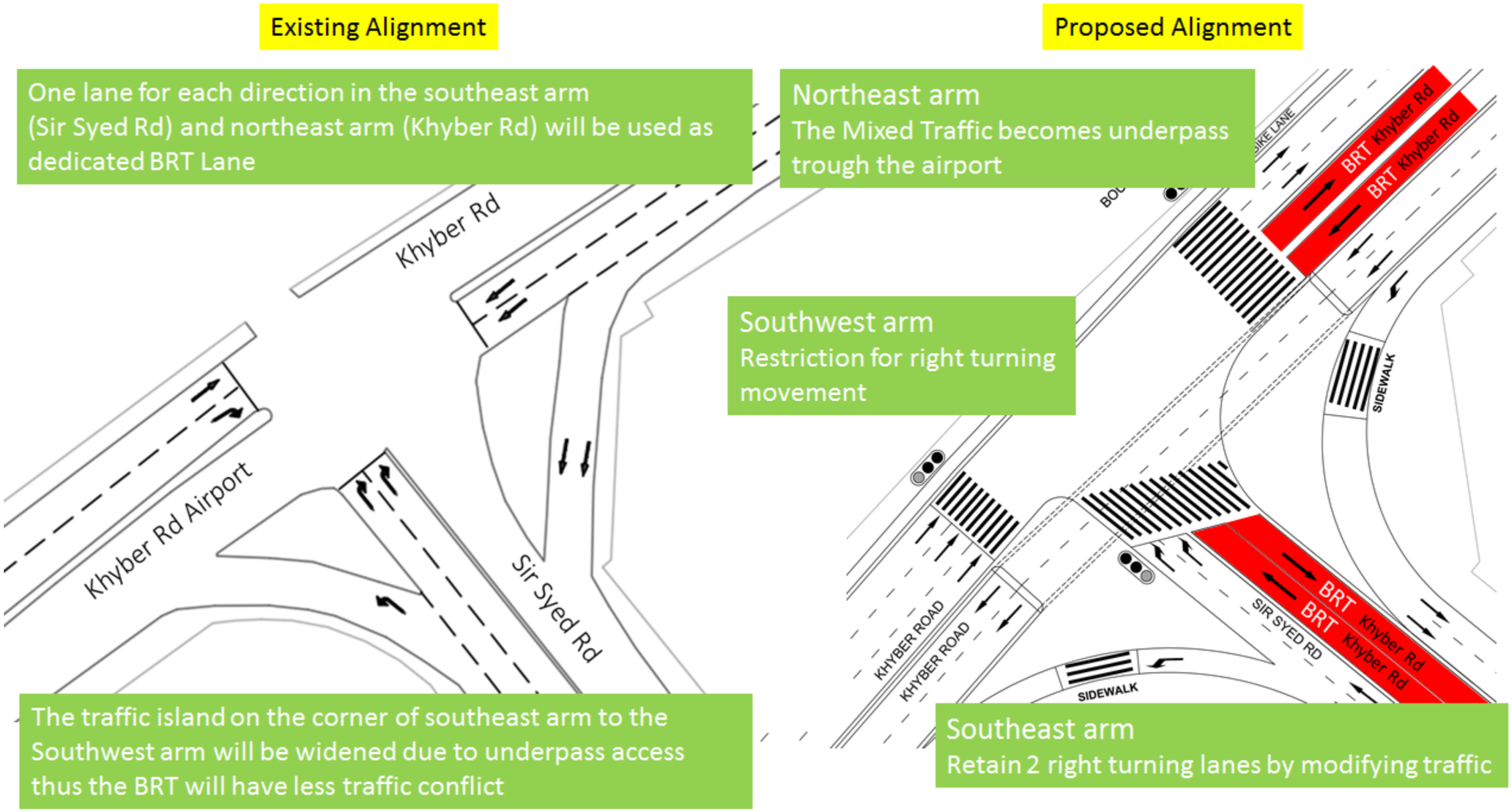
PM Peak Hourly Non PT Traffic Counts

		Destination			
		A	B	C	Tot.
Origin	A	0	388	0	388
	B	304	0	1512	1816
	C	23	2193	0	2216
	Tot.	327	2501	1592	4420

Figure 8. 21 Saddar – Khyber Intersection

Saddar – Khyber intersection is modified on the Northeast and Southwest approaches. The proposed changes can be observed below.

Figure 8. 23 Proposed Changes in Saddar – Khyber Intersection.



This junction is currently performing well, but can be optimized using signal timing optimization. Table 8.4 shows the detailed junction performance of Saddar – Khyber intersection.

In addition, need to be emphasize that the mixed traffic movement from northeast (Aman Chowk) to southwest (Airport) is using underpass to minimize BRT traffic conflict. Thus, the performance table analysis shows higher delay value on Khyber Rd, which does not affect the real condition.

Current condition

The two right turning lanes from Sir Syed Rd have the highest degree of **saturation of 87.7%**

Followed by the ahead movement in Khyber Rd from southwest to **northeast at 87.4%**

Proposed Design

The degree of saturation of the two right turning lanes from Sir Syed Rd **falls to of 64.9%**

The ahead movement in Khyber Rd from southwest to northeast becomes the lane with highest degree of **saturation at 64.9% and 64,2% (second highest)**

Summary

The Practical Reserve Capacity this junction is 38.7%, which indicates this junction is able to accept more traffic, and improved from current situation.

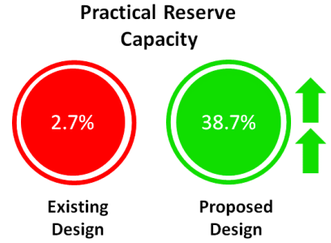
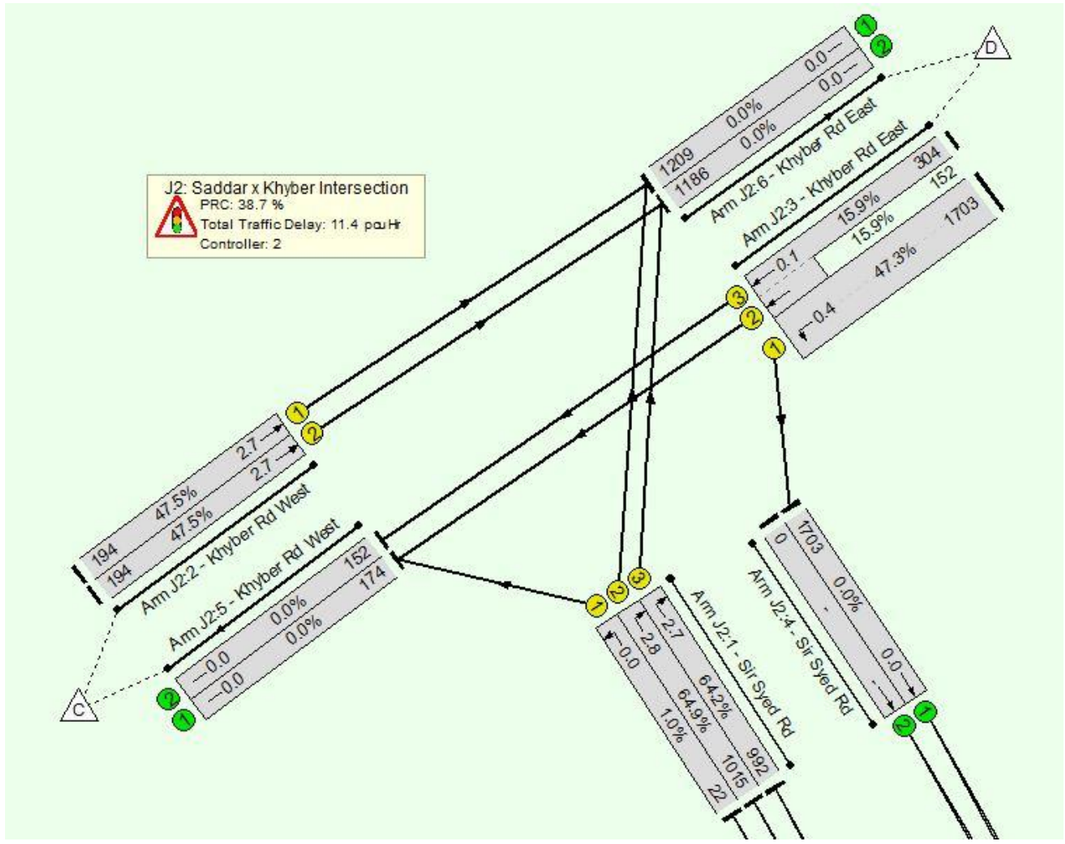


Table 8.5 Saddar - Khyber Intersection Performance Analysis.

Lane	Lane Description	Lane width at approach (m)	Demand Flow (pcu)	Capacity (pcu)	Deg Sat (%)		Av. Delay Per PCU (s/pcu)	
					Prop.	Curr.	Prop.	Curr.
1/1	Sir Syed Rd Left	5	22	2115	1.0%	1.1%	0.9	0.9
1/2	Sir Syed Rd Right	4.25	1015	1564	64.9%	87.7%	9.8	22.6
1/3	Sir Syed Rd Right	4	992	1545	64.2%	87.6%	9.7	22.5
2/1	Khyber Rd West Ahead	4.25	194	408	47.5%	87.4%	50.8	83.4
2/2	Khyber Rd West Ahead	4.25	194	408	47.5%	80.4%	50.8	133.1
3/1	Khyber Rd East Left	6.5	1703	3600	47.3%	59.6%	0.9	1.2
3/3+3/2	Khyber Rd East Ahead	4.25;3	304	956+956	15.9%;15.9%	48.2%	1.1	54.3
Saddar - Khyber Intersection		**PM Peak Condition**			**64.9%**	**87.7%**		



Saddar Chowk

An underpass for regular traffic movement on southbound direction at Khadim Hussain Rd will be built, and the remaining movements, including the BRT will remain at grade. This underpass will eliminate the conflict between mixed traffic and the BRT that moved from northeast to northwest.

For the case of Saddar Chowk demands for the PM Peak period are higher than the AM Peak. This junction is currently performing well in terms of capacity. However, proposed BRT alignment requires the median separator in Saddar Chowk to be removed to allow bus movement. Consequently, additional traffic movements will be allowed. As a result, the junction will need to be signalized to regulate these movements.

Current condition

The highest degree of saturation is on the northwest approach, each lane having **78.3% degree of saturation**

Proposed Design

The approach from Saddar Road has the largest **degree of saturation at 67%** Followed by the southeast approach (Khadim Hussain Rd) turning left **at 60.7%**

Summary

Saddar Chowk still has a large reserve capacity (34.4%) and is unlikely to be congested.

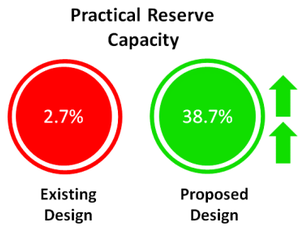


Table 8.6 shows the detailed performance analysis results for the junction and Figure 8.28 shows the proposed changes in Saddar Chowk

Table 8.6 Saddar Chowk Performance Analysis.

Lane	Lane Description	Lane width at approach (m)	Demand Flow (pcu)	Capacity (pcu)	Deg Sat (%)		Av. Delay Per PCU (s/pcu)	
					Prop.	Curr.	Prop.	Curr.
1/2+1/1	Barra Rd Left	3.5;3.5	556	527+527	52.8;52.8%	42.2%	24.2	1.3
1/3	Barra Rd Right	3.5	120	889	13.5%	N/A	21.1	N/A
2/2+2/1	Khadim Hussain Rd Left Ahead	3;3	463	808+1044	25.0;25.0%	78.3%	1.3	5.5
2/3	Khadim Hussain Rd Ahead	3.5	564	1965	28.7%	78.2%	1.3	5.4
3/2+3/1	Saddar Rd Right Left	3;3	574	110+764	67.0;67.0%	33.7%;N/A	30.8	1.6
4/2+4/1	Khadim Hussain Rd Left Ahead	3;3.5	1080	461+1317	60.7;60.7%	70.7;70.7%	7.0	4.1
4/3	Khadim Hussain Rd Ahead	3.5	364	999	36.4%	70.5%	20.6	4.1
Saddar Chowk Intersection		**PM Peak Condition**			**67.0%**	**78.3%**		

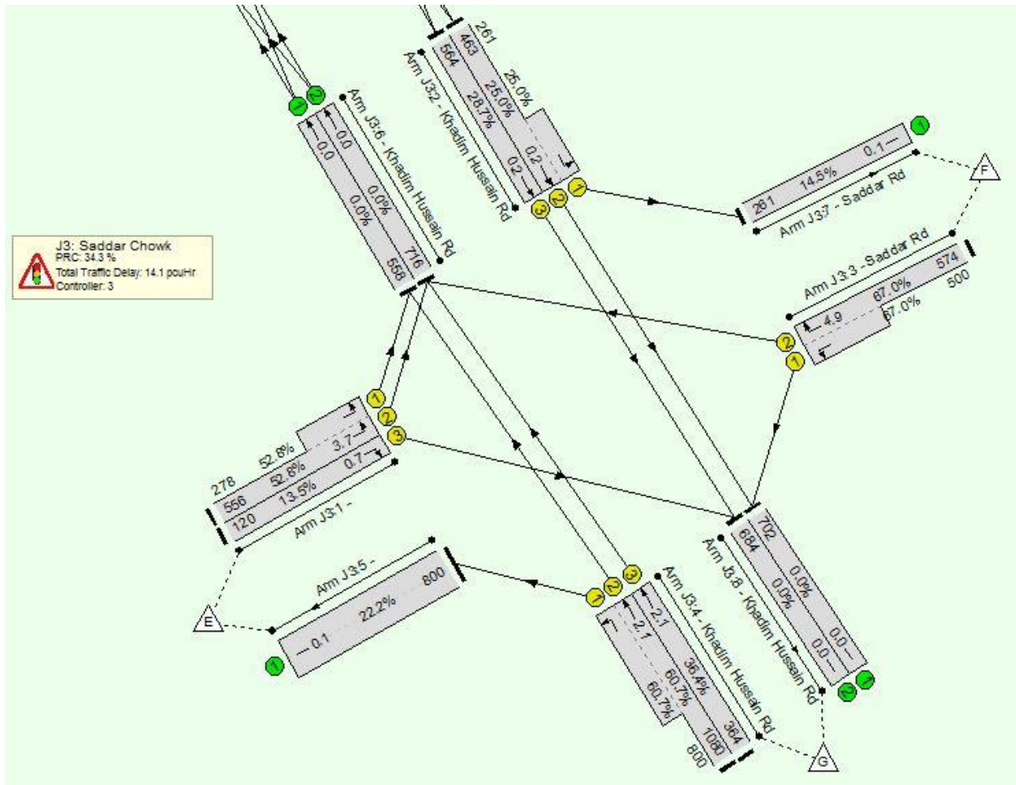
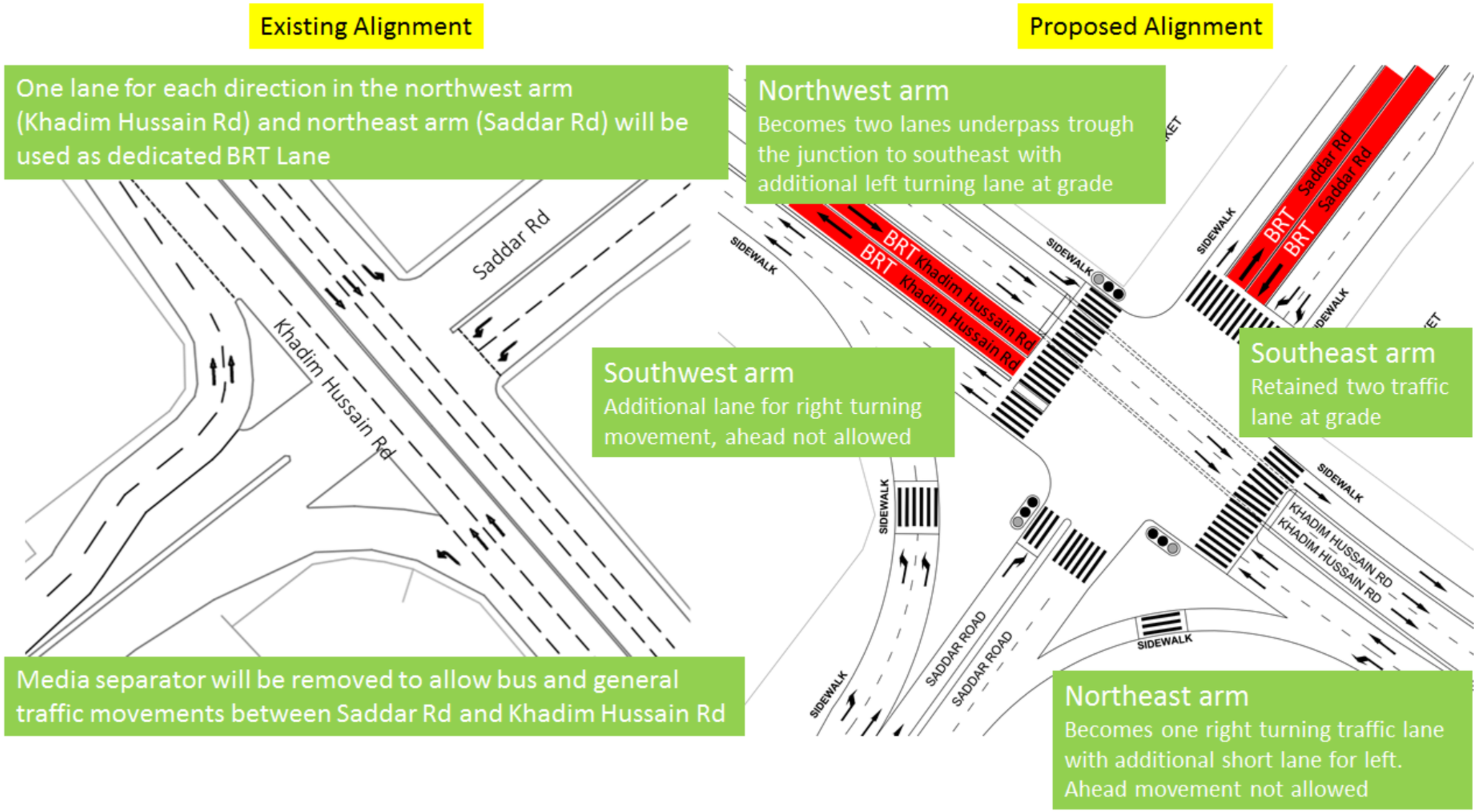


Figure 8. 24 Proposed Changes in Saddar Chowk.



8.2.4 Signal Timing

The signal timings for the three junctions analyzed in the previous subsection are optimized simultaneously to obtain maximum area capacity along the corridor. Need to point out that the underpass phase will be always green after the stage changed, which is shown on Figure 8.25 particularly for Saddar – Khyber and Saddar Chowk Intersection.

Figure 8.25 below shows the staging diagram for the three junctions. Furthermore, signal timings for these junctions for both AM and PM peak are shown in Figure 8.26.

Figure 8. 25 Staging Diagram for Cantonment Area Junctions.

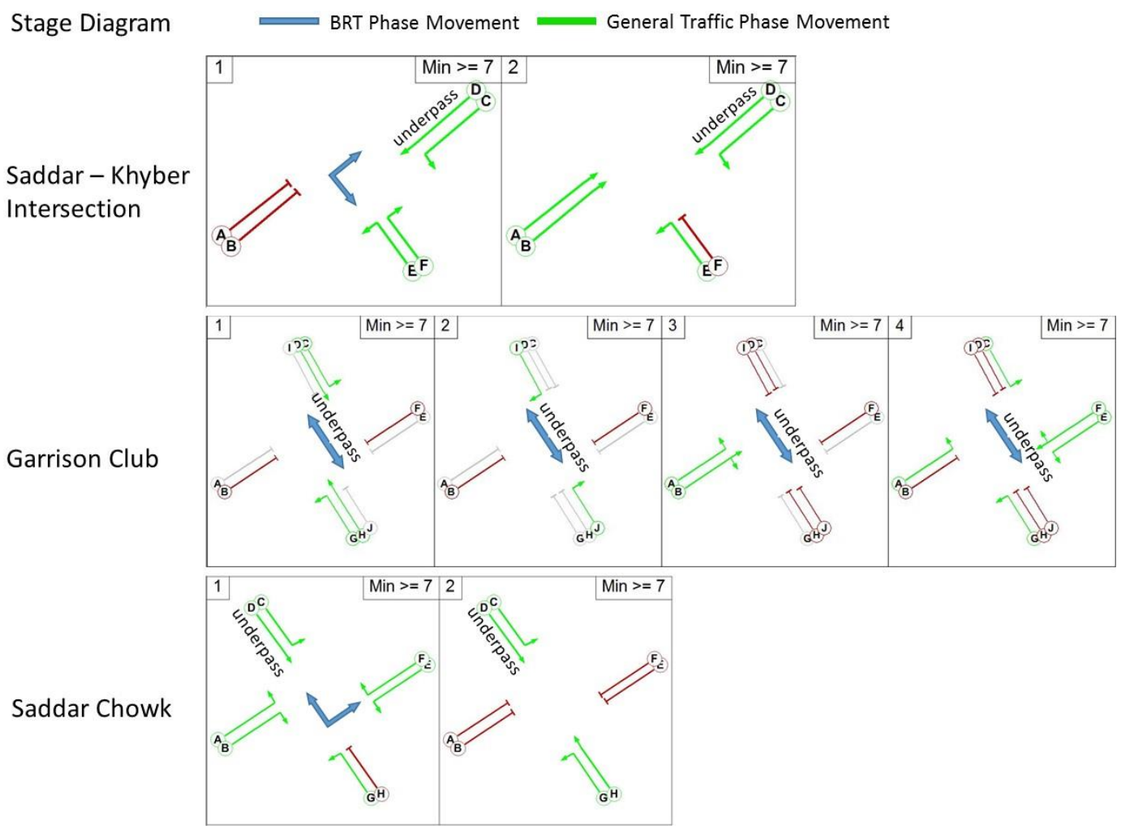


Figure 8. 26 Signal Control Timing.

AM Peak Signal Control View

PM Peak Signal Control View

Saddar – Khyber Intersection

Stage	1	2
Duration (s)	85	29
Change Point	108	76
Cycle Time	120 s	

Stage	1	2
Duration (s)	91	23
Change Point	72	46
Cycle Time	120 s	

Garrison Club Chowk

Stage	1	2	3	4
Duration (s)	20	7	7	15
Change Point	0	23	32	42
Cycle Time	60 s			

Stage	1	2	3	4
Duration (s)	17	7	10	15
Change Point	0	20	29	42
Cycle Time	60 s			

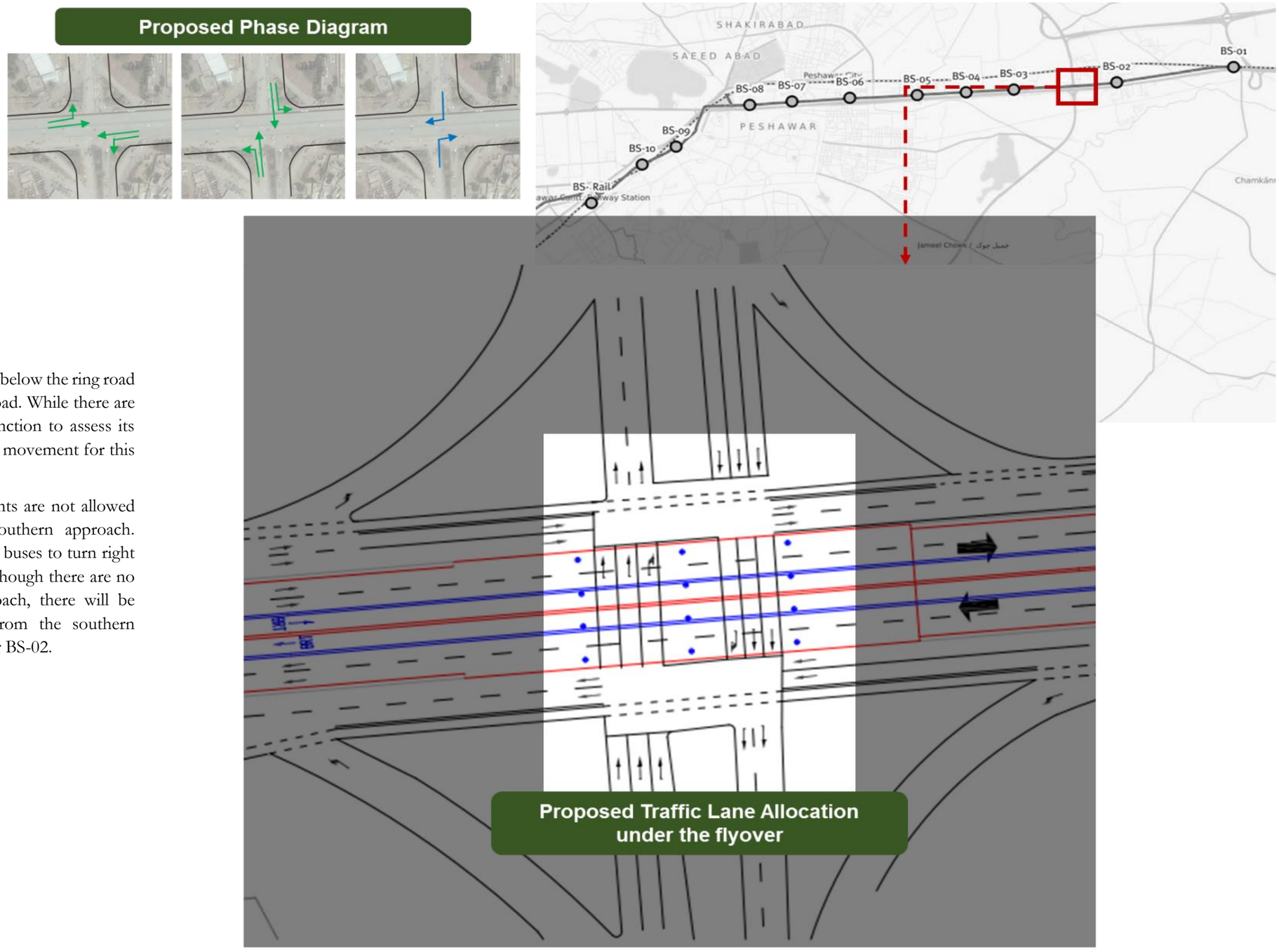
Saddar Chowk

Stage	1	2
Duration (s)	62	52
Change Point	108	53
Cycle Time	120 s	

Stage	1	2
Duration (s)	54	60
Change Point	9	72
Cycle Time	120 s	

8.2.5 Traffic Rearrangement below Ring Road Flyover

Figure 8. 27 Junction under the Ring Road Flyover.



Traffic rearrangement is required below the ring road flyover in the east part of GT-Road. While there are no traffic count data for this junction to assess its capacity, there is a need to adjust movement for this junction.

Currently right turning movements are not allowed from the northern nor the southern approach. Proposed BRT route will require buses to turn right from the northern approach. Although there are no buses from the southern approach, there will be feeder services turning right from the southern approach to access BS-01 and/or BS-02.

8.3 Turning Radius for BRT in City Centre

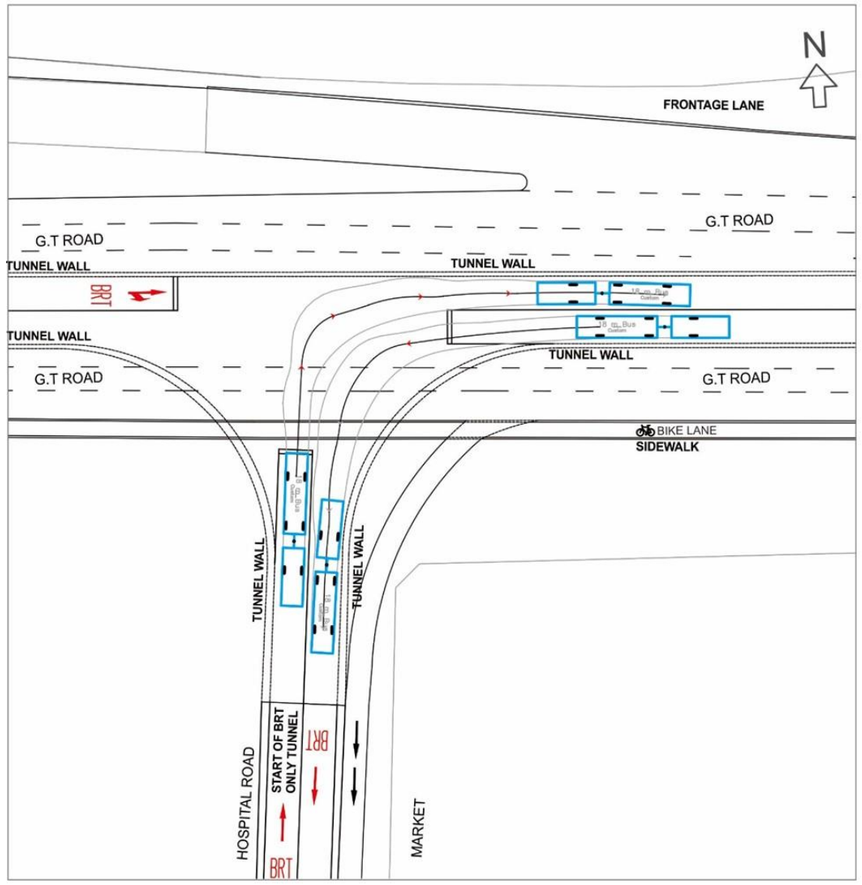
Vehicle turning radius is one of the important factor to measure feasibility turning bus. Every single turn along the BRT corridor is checked by vehicle swept path analysis with turn simulation software (AutoTurn). There are three locations which would potentially become critical spots for BRT turning, which are Qila Balahisar BRT tunnel, Lady Reading Hospital entrance, and at Khyber Bazaar Road intersection. The analysis provided below uses 18-meter bus, which is the longest BRT dimension (articulated bus), and tested for both directions.

In general, the minimum turning radius designed for city centre segment is between 12 and 15-meter radius. However, in these three places the existing design of alignment are too narrow, and should be modified or widened. For example, in Qila Balahisar, the turning radius for each turning is 25m in average. Bus on both directions could make a turn easily with speed around 10 km/hour. This condition also applies for the Lady Reading Hospital entrance, which is illustrated beside.

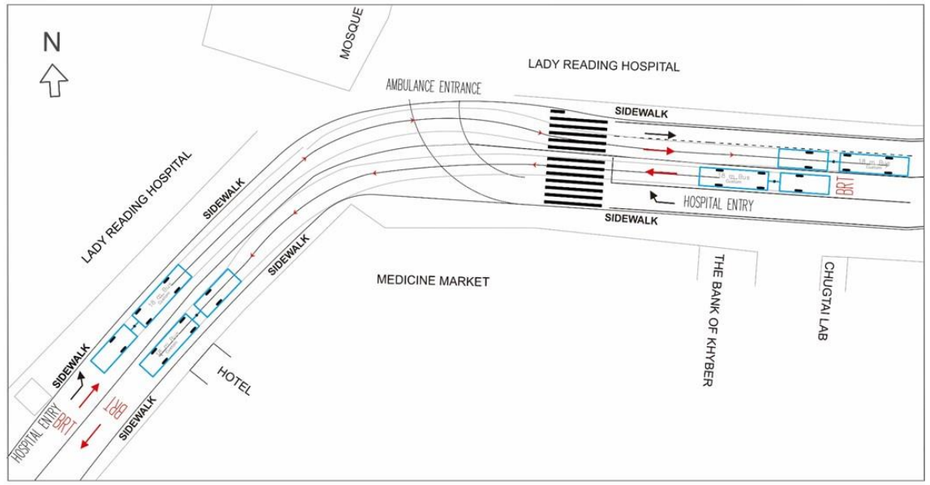
The third location is intersection near BS – 10 in Khyber Bazar road, which also connects Hospital Road. The recommended bus speed movement for this turning is also below 10 km/h. However, due to very tight turning movement radius for 18-meter bus, it is recommended that before the 18-meter buses are introduced, this junction needs to be altered and modified to allow more space for 18-meter bus to make the turn.

Figure 8. 28 Swept Path Analysis on Turning movement

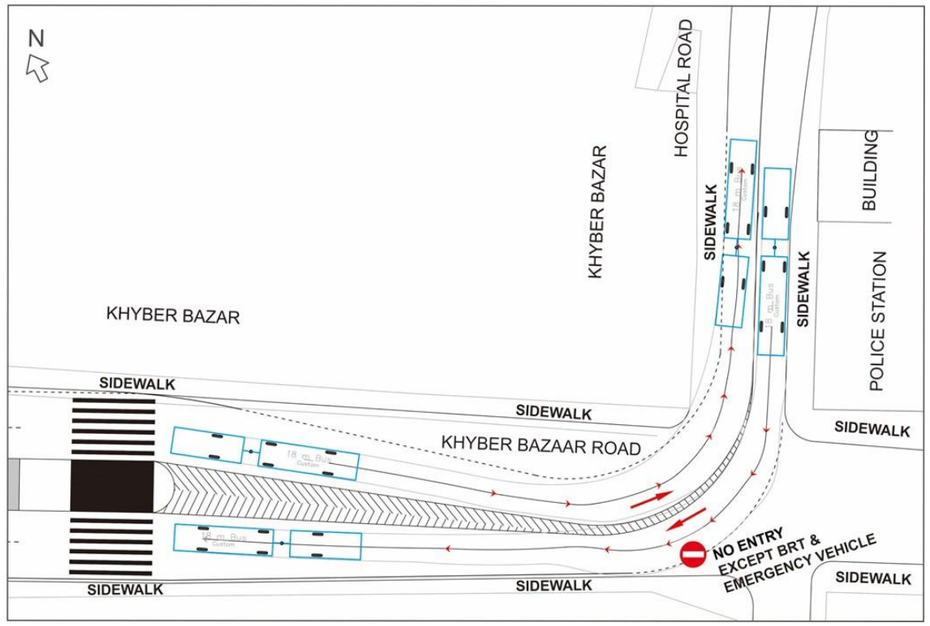
Swept Path Analysis on Turning movement at Qila Bala Hissar BRT Tunnel



Swept Path Analysis on Turning movement at Lady Reading Hospital entrance



Swept Path Analysis on Turning Radius at Khyber Bazaar Junction near BS 10



8.4 City Center Traffic Management

8.4.1 Traffic Lane Allocation

Outside the Cantonment Area, all portions of GT road have three main lanes per direction of traffic. In some parts of GT road there are additional service lanes as well. The number of lanes can be maintained as in the current condition due to the wide road and by transforming service lanes into main lane. The main traffic management along GT road is U-Turn rearrangement along the outer sides of GT road which have been discussed in U-Turn Treatment section.

Cantonment Area

Most of the roads in the Cantonment area currently have 2 lanes for general traffic with some exception along the wider Khadim Hussain Road and Khyber Road bordering the western edge of the area which have 3 lanes per direction. In the process of constructing BRT corridor, the number of lane is maintained as much as possible by adjusting lane widths and in some places road widening when possible.

In some cases, however, it is inevitable to reduce the number of lanes. In the preferred option of BRT alignment, lane reduction happens in Khyber Road (from 3 to 2 per direction) and Saddar Road (from 2 to 1 per direction). Meanwhile, in the second option, number of lanes in all roads can be maintained as the BRT lane will be grade separated from general traffic.

The effects of lane width and lane number reduction to junction capacity and the modification of traffic movement in the Cantonment Area are assessed in junction analysis and design.

Figure 8.31 shows the current number of lanes in the Cantonment Area, while Figure 8.32 show the proposed changes in the area when it is implemented.

Figure 8. 30 Possible Parking Plaza 1 Location

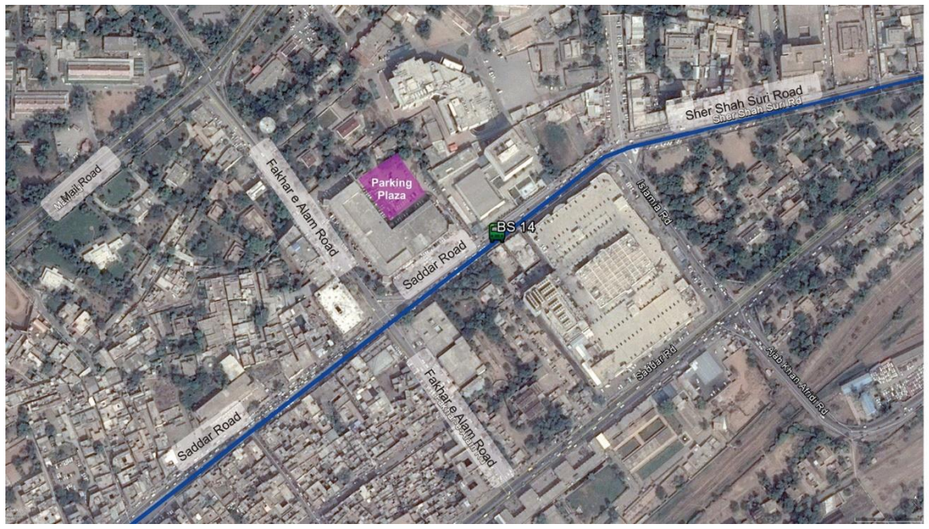
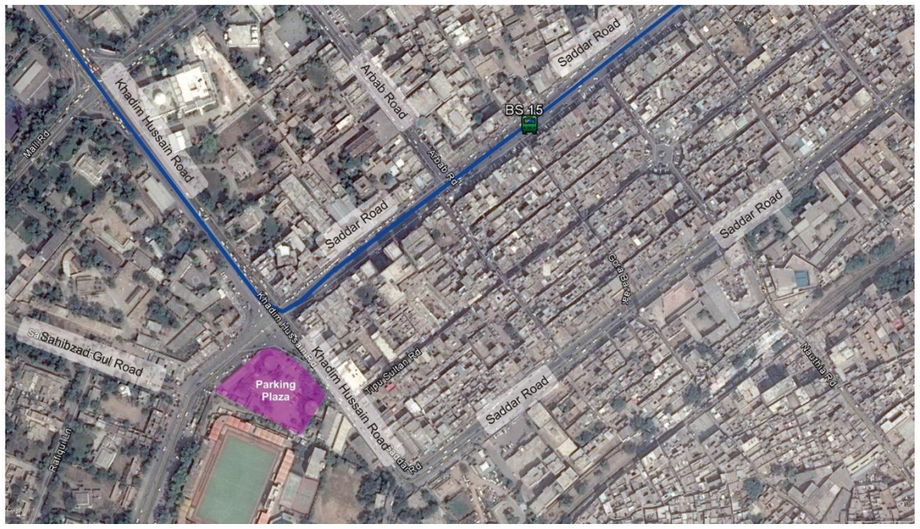


Figure 8. 29 Possible Parking Plaza 2 Location



Box 8.1 : Parking Relocation on cantonment

Since the BRT will take up most of the road space on Saddar Road, current on-street parking arrangement along Saddar road will have to be changed. Few on-street parking spaces will still be provided on Saddar Road after the BRT, and this is shown in more detail on the "Peshawar Non-Motorized Transport Improvement Conceptual Report", specifically on Chapter 3.

To cater the parking on Saddar Road, two off-street parking plaza will be built as part of the project, which are located on Fakhar e Alam road, near the State Bank of Pakistan, currently being used as parking lot; and on Khadim Hussein Road, where currently the site is used as parking lot and water towers. These are shown in Figures above. Design for the latter location is currently being developed by Cantonment Board of Peshawar (CBP).

Figure 8. 31 Cantonment Area Current Traffic Lanes and Directions.

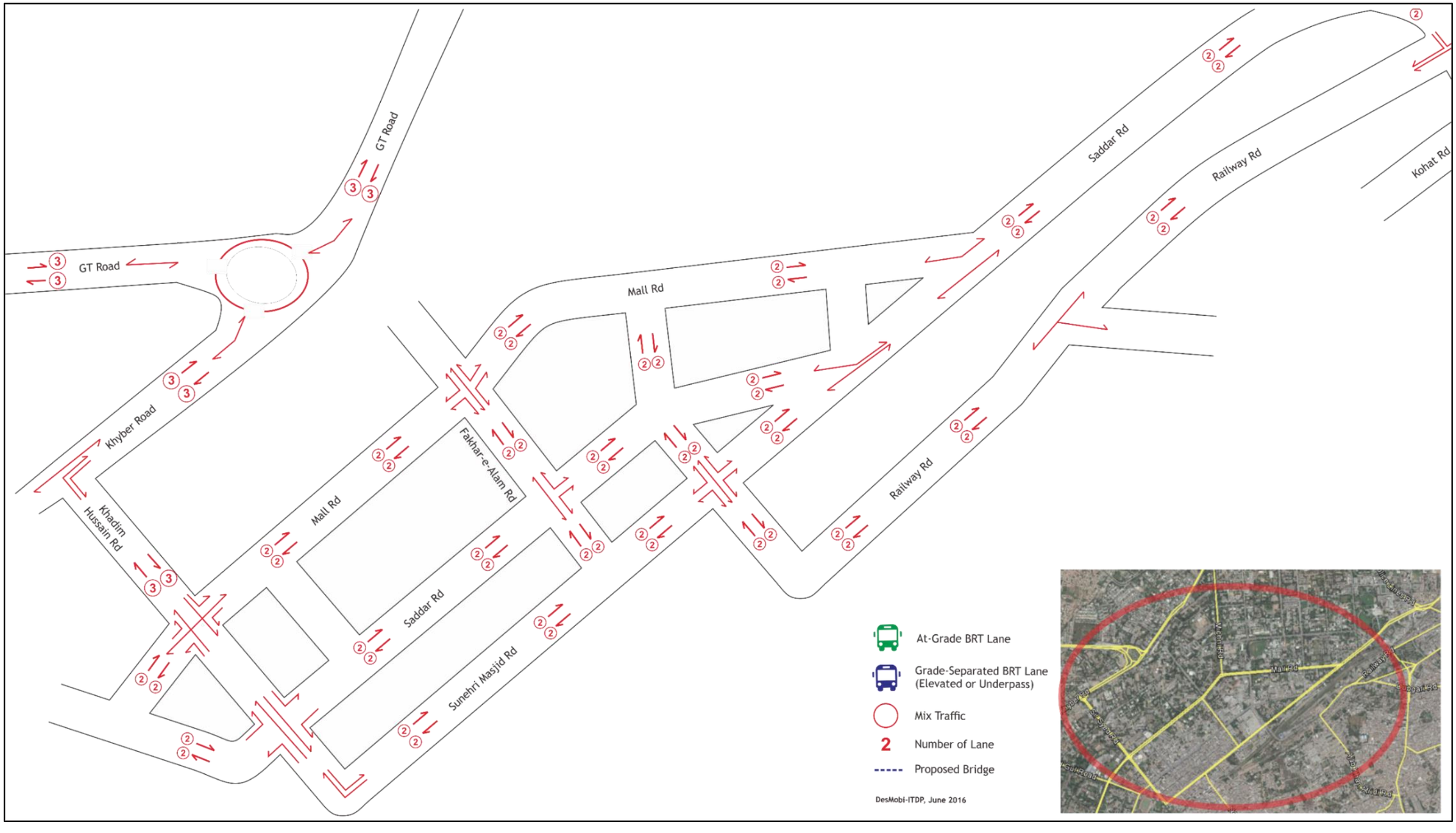
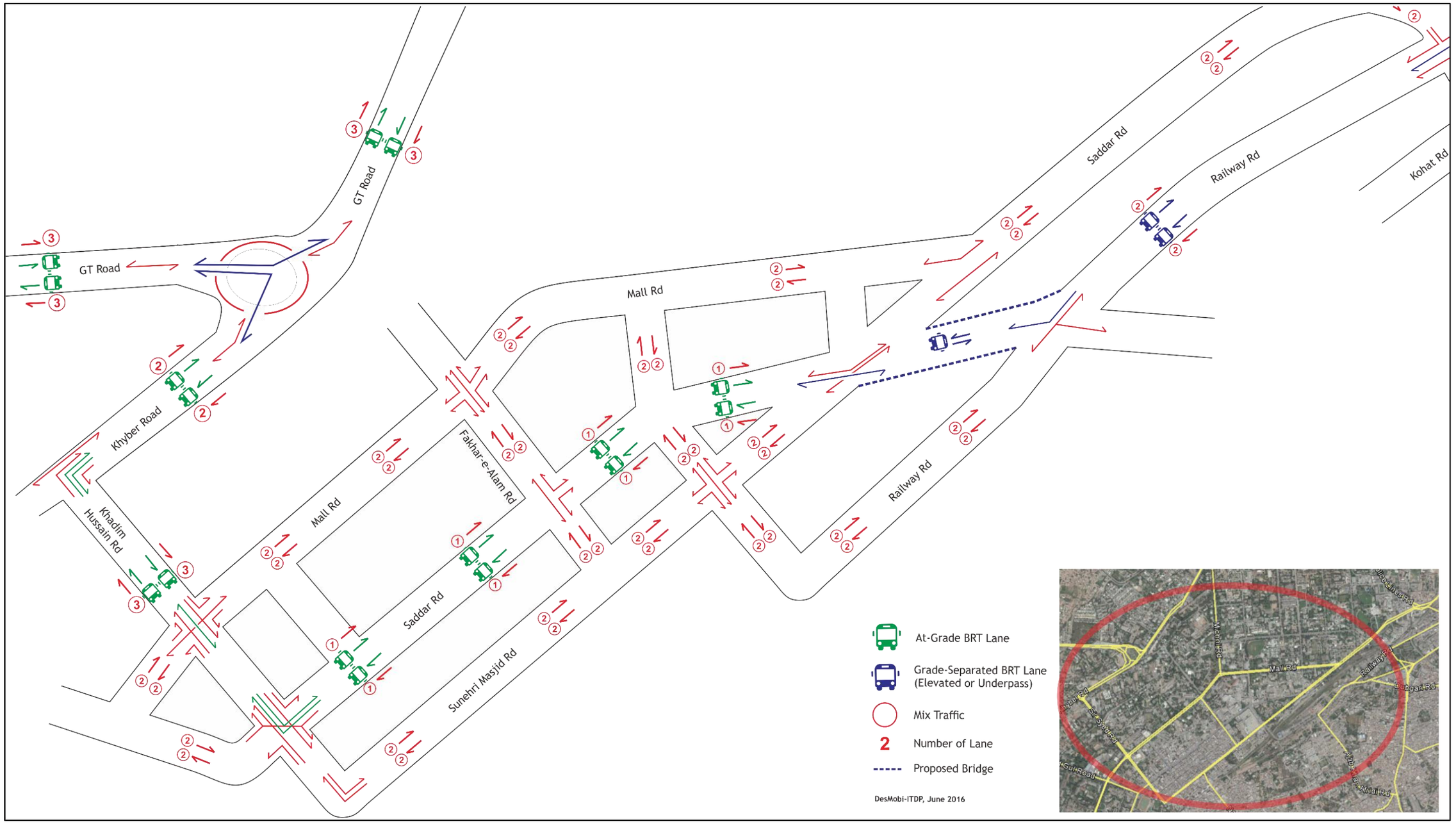


Figure 8. 32 Cantonment Area Traffic Redirection

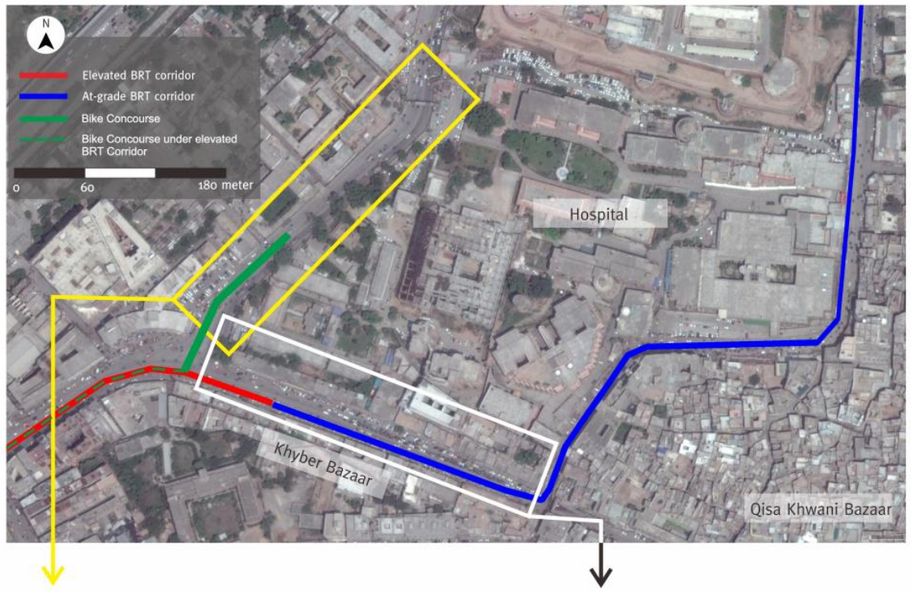


Khyber Bazaar Area

In the existing condition, Khyber Bazaar Road currently have two lanes per direction, but in the future, Khyber Bazaar Road can only be accessible for BRT and ambulance only. There will be a station and flyover ramp of at-grade BRT corridor (before elevated BRT corridor). The illustration of traffic lane allocation on Figure 8.34. And also in the existing condition, Khyber Bazaar Road is occupied fully by on-street parking. After the BRT, the on-street parking will be relocated to Soekarno Road as shown in Figure 8.33.

To access Khyber Bazaar area, private vehicles from Railway Rd can park their vehicle on Soekarno Rd and walk to Kyber Bazaar Road. On the other hand, private vehicles from GT Rd can access Khyber Bazaar area from Ashraf Rd, Qisa Khwani Bazaar, Kohat Rd, Bajori Rd , Railway Road, and park on Soekarno Rd or directly go to Soekarno Rd from GT Rd.

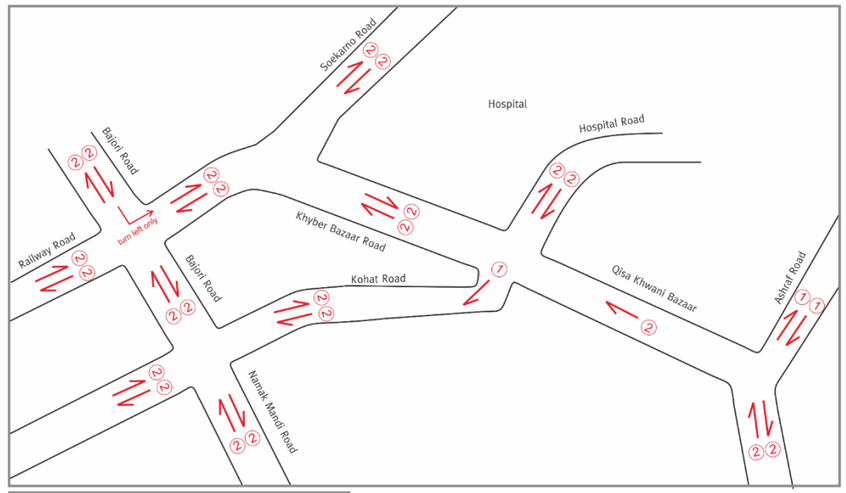
Figure 8. 33 Khyber Bazaar Road Parking Reallocation

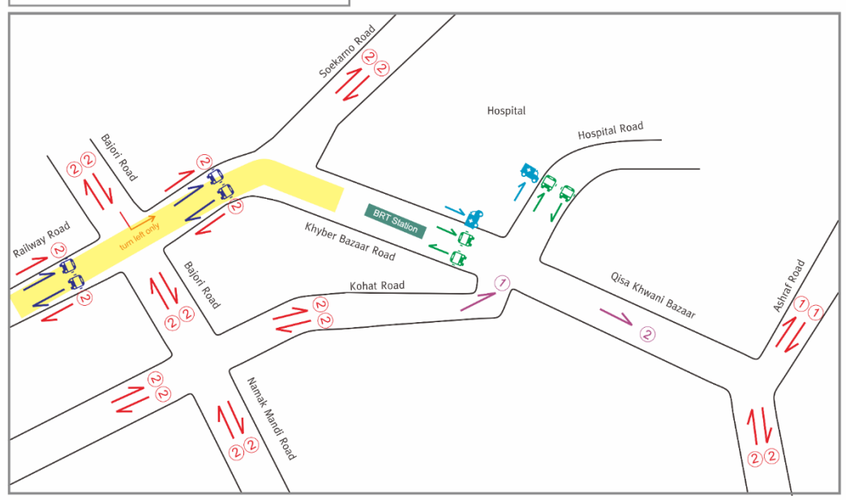


On-street parking relocation location, **SOEKARNO ROAD**

Existing on-street parking location, **KHYBER BAZAAR ROAD**

Figure 8. 34 Khyber Bazaar Area Current and Proposed Traffic Lanes and Directions



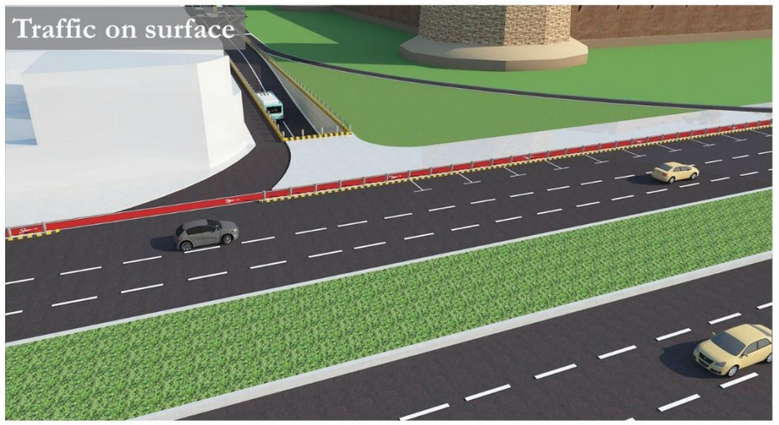


8.4.2 Hospital Road Traffic Management

On Hospital Road, the BRT corridor will join GT Road through a BRT-only tunnel that needs to be built. This tuneel will also connects with Malik Saad Shaheed Road to go to the north. On the hospital Road, along with BRT corridor, one lane for regular traffic will be provided on the southbound direction until Naz Cinema Road, and one lane on the northbound for ambulance lane. The BRT will be fully segregated on this segment.

After Naz Cinema Road, only BRT and ambulance that will be allowed to pass the Hospital Road. and the ambulance will run mixed with BRT until the Emergency entrance at the hospital. Pass this entrance, on southbound direction, no ambulance will be allowed to pass, and every ambulance exiting from the hospital has to turn left to Qila Bala Hissar Chowk. On the northbound direction, ambulances are allowed to enter from Khyber Bazaar Road until Hospital Road. But apart from BRT and ambulance, no vehicles are allowed to go on Khyber Bazaar Road.

Figure 8. 36 Traffic in Hospital Road



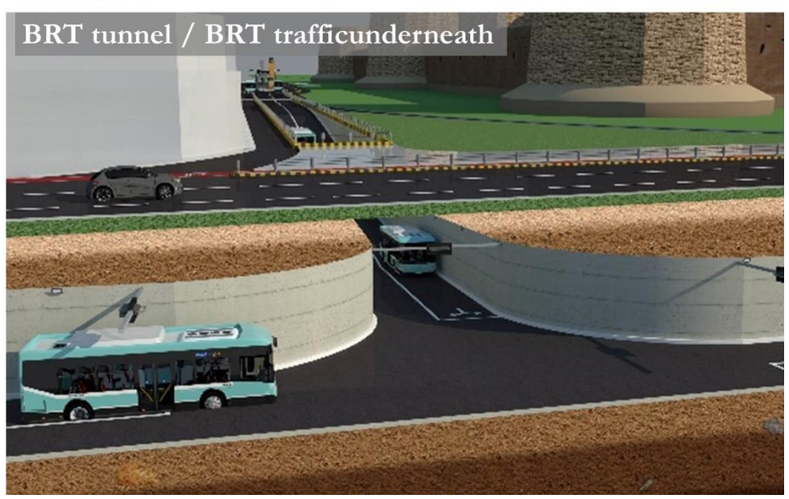


Figure 8. 35 Junction in east part of GT Road to Hospital Road

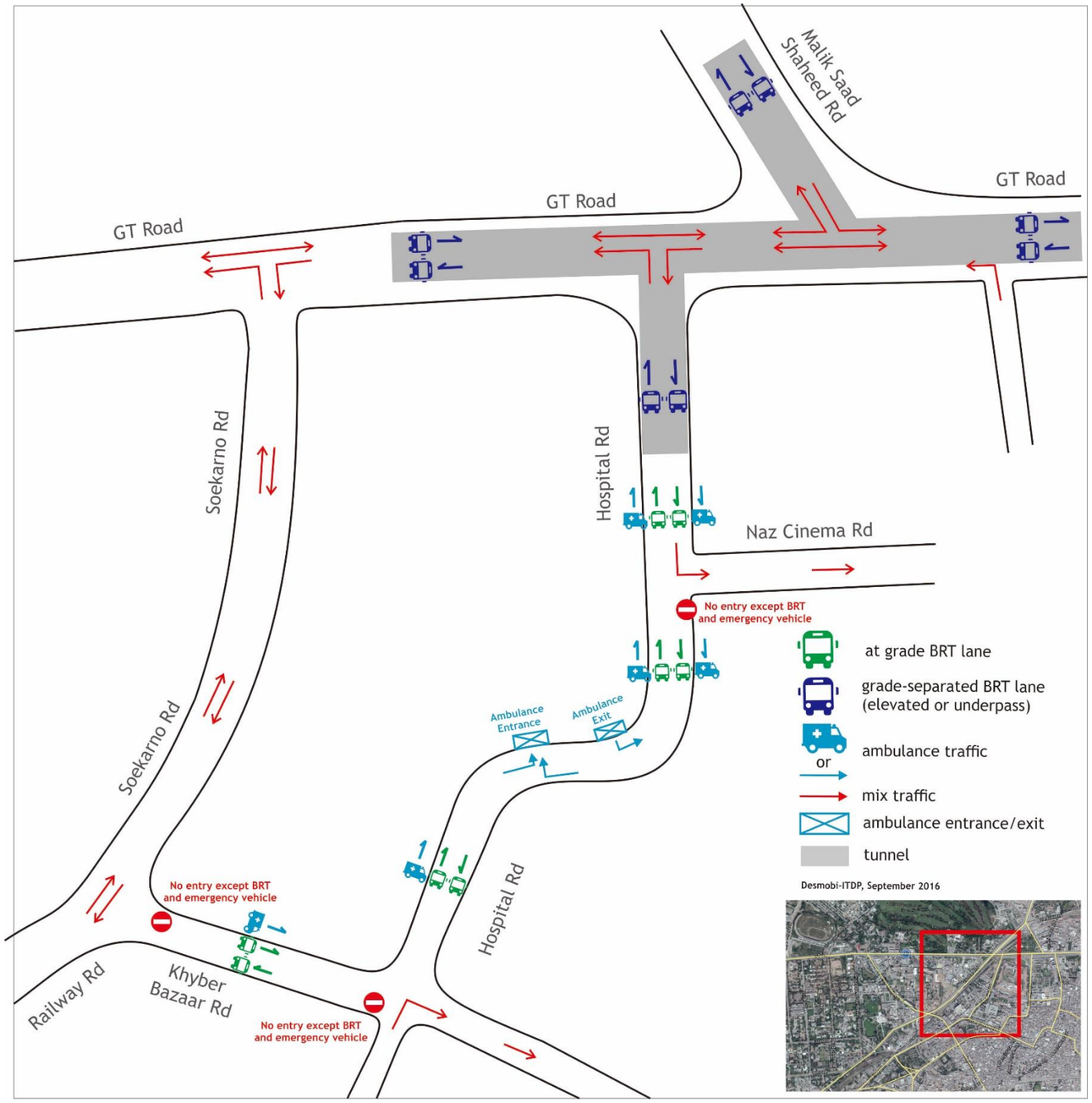
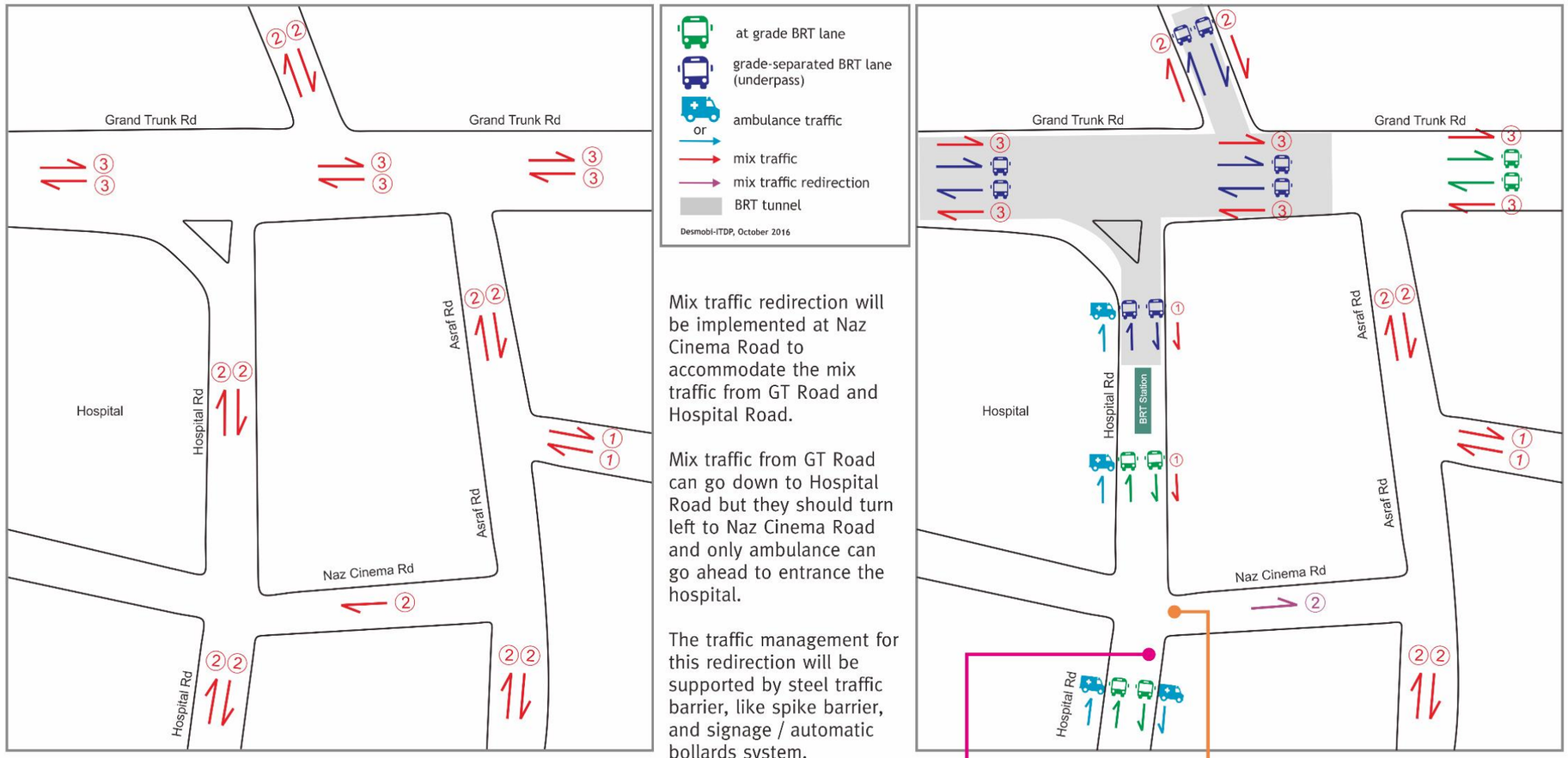


Figure 8. 37 Hospital Road Area Current and Proposed Traffic Lanes and Directions



Option 1 - Signage
Pro: Flexibility
Contra: (sometimes) traffic violations

Option 2 - Automatic Bollards
The automatic bollards can go down automatically if the sensor identify an ambulance in front of them.

Pro: The road segment will be cleared from private vehicle.
Contra: Time duration for waiting the automatic bollard go up/down (not efficient)

9 Fare and Payment Collection

9.1 Existing Fare

Currently, distance-based fare regime is applied in Peshawar public transport routes, with average fare per segment (i.e. around 7 kilometers per segment) is Rs 10. From our investigation and analysis on different routes, it was found that the average fare for minibuses is Rs 1.4/ kilometer, with maximum fare around Rs 30 with approximately 20 kilometer distance per trip. The fare summary table is shown on Table 9.1.

The existing fare information is important to determine the BRT fare to not significantly differ from the existing. However, since the BRT service will offer better service, air-conditioned bus and free transfer, additional 10-15 Rs increase from the existing would still be deemed acceptable. From O-D survey, the average distance travelled is 9.3 kilometer per passenger, or in average each passenger spends around Rs 13 per trip.

9.2 Proposed Fare

For BRT, it is proposed to apply distance-based regime, and a smartcard system for the payment method, to automatically calculate the distance travelled by each passenger. However, since distance-based might penalized the people who live further away from the town to pay more, the maximum fare needs to be capped.

Maximum fare cap is proposed to be Rs 50 for distance travelled more 40 kilometers, and applicable daily. Therefore, any passengers travelling on a BRT system in one day will only need to pay a maximum of Rs 50 per day, even though they travel more than 3 times. Proposed fare structure and fare scenarios are shown in table below, as well as its comparison to the existing fares.

Table 9.1 Existing Fare Summary

Description	Rocket/Minibus				Summary
From General Bus Stand GT Rd to:	Landi Kotal	Bara	Jamrood	Kohat Bus Stand - Karkhano	**Average**
Distance (km)	50	15	20	17	**21.8**
Fare (Rs):					
Stop to Stop (Segment)	10	15	10	10	**10**
End to End	60-70	30	35	25	**30**

Table 9.2 Proposed BRT Fare Table

Travel (Km)	Cost per trip (Rs)
1 – 10 km	25
10 – 15 km	30
15 – 20 km	35
20 – 25 km	40
25 – 30 km	45
30 – 35 km	50
> 35 km	50
Daily Maximum	50

In general, after the BRT, the maximum fare travelled in BRT routes will be slightly more expensive for passengers, which is between Rs 4 and Rs 12.9 per route. This is still acceptable for passengers and with this fare, the subsidy required will be very minimum.

Table 9.3 Comparison between Existing Fare and Proposed for BRT

Route	Route Name	Maximum Distance (km)	Maximum fare Existing (Rs)	Max fare Proposed (Rs)	Difference in Fare (Rs)
Route 1A	Silver line	21.9	Rs 30.7	Rs 40	Rs 9.3
Route 1B	Purple line	12.2	Rs 17.1	Rs 30	Rs 12.9
Route 1C	Orange line	25.8	Rs 36.1	Rs 45	Rs 8.9
Route 1D	Green line	29.3	Rs 41.0	Rs 45	Rs 4
Route 1E	Yellow line	28.4	Rs 39.8	Rs 45	Rs 5.2
Route 1F	Red line	20.8	Rs 29.1	Rs 40	Rs 10.9
Route 1G	Blue line	14.8	Rs 20.7	Rs 30	Rs 9.3
Route 1H	Brown line	15.8	Rs 22.1	Rs 30	Rs 7.9

9.3 Proposed Fare Medium

In an era where technology is growing so fast, there is no reason for Peshawar not to catch up with the latest technology in payment systems. Currently, there are three types of technology for public transport that are widely used across the globe, which are Paper RFID; NFC Token and; Smartcard.

Paper RFID is relatively new and requires high volume of production, since their recent technology only allow them to use the paper ticket 5 times before being disposed. NFC token is now widely used for single trip payments, including in Islamabad and Lahore Metrobus. However, for Peshawar, it is recommended to use smartcard instead of NFC token. This is due to the nature of the fare, which will be distance-based and gives incentive for frequent users who will make the trip more than 3 times per day. Thus, smartcard will be easier to keep, and does not require disposal like paper RFID.

To produce smartcard is not cheap, and at the beginning, TransPeshawar should invest in producing these cards and sell it for free, say for the initial 6 months as promotional tool. After 6 months, the cost of owning the smartcard can be added into the fare. So for passengers who want to buy the smartcard at the first time, they need to pay additional Rs 100 in addition to the card's store value, i.e. if a passenger wants to buy Rs 200 worth of credit, he needs to pay Rs 300, which includes the smartcard cost at the beginning.

With smartcard, Transpeshawar will also have all the journey database made by its passengers. Since the system will require a tap-in & tap-out system to enter and exit the system, origin and destination of each trips will be acquired by Transpeshawar, which later can be used to improve its operational plan.

Figure 9.1 Comparison between Fare Medium.

Paper RFID

New Technology. Can be used for 3-5 times. Production cost is cheaper, but need to have massive production. Ideal if single trip users are not too many

NFC Token

Mostly used for single trip, can also be used for multi-trip but difficult to keep. Production cost is cheaper than smartcard

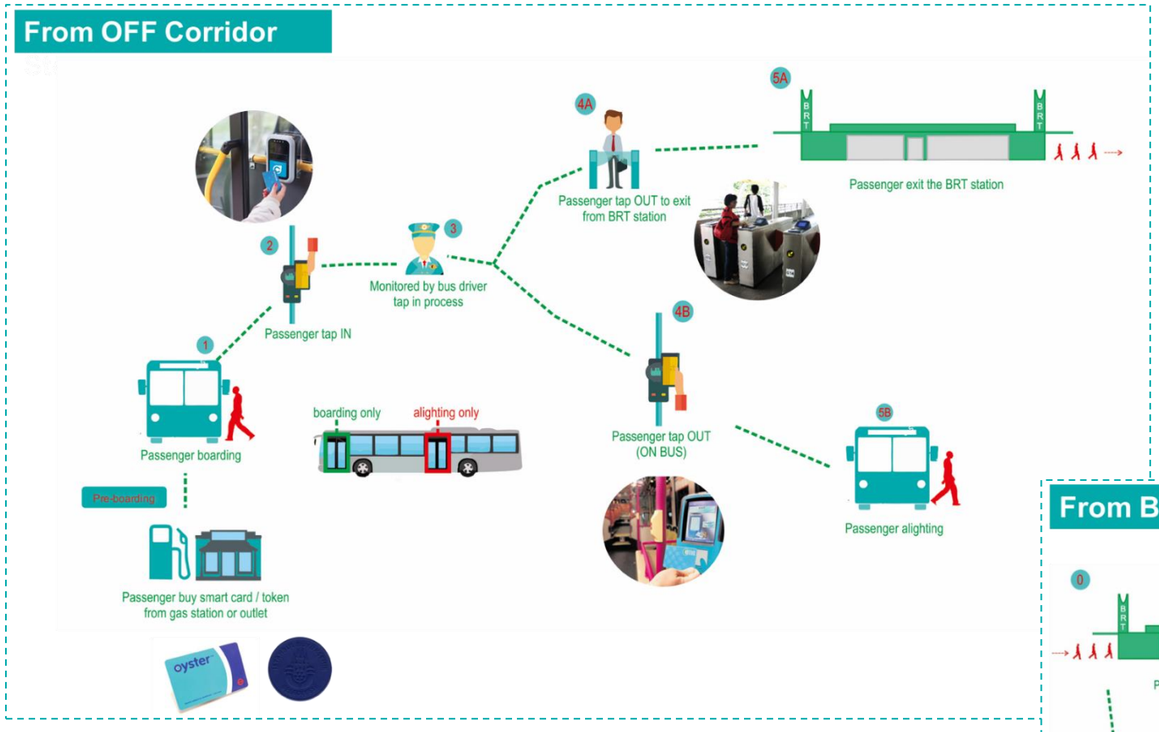
Smartcard

Recommended for Peshawar. Can allow all types of fare. Cost US$ 1.00 to 1.50 to produce the card

9.4 Payment Mechanism

Payment mechanism for the BRT is divided into 2 parts: payment for journey started from off-corridor segment, and payment for journey made from BRT station.

Figure 9.2 Payment Mechanism for Peshawar BRT.



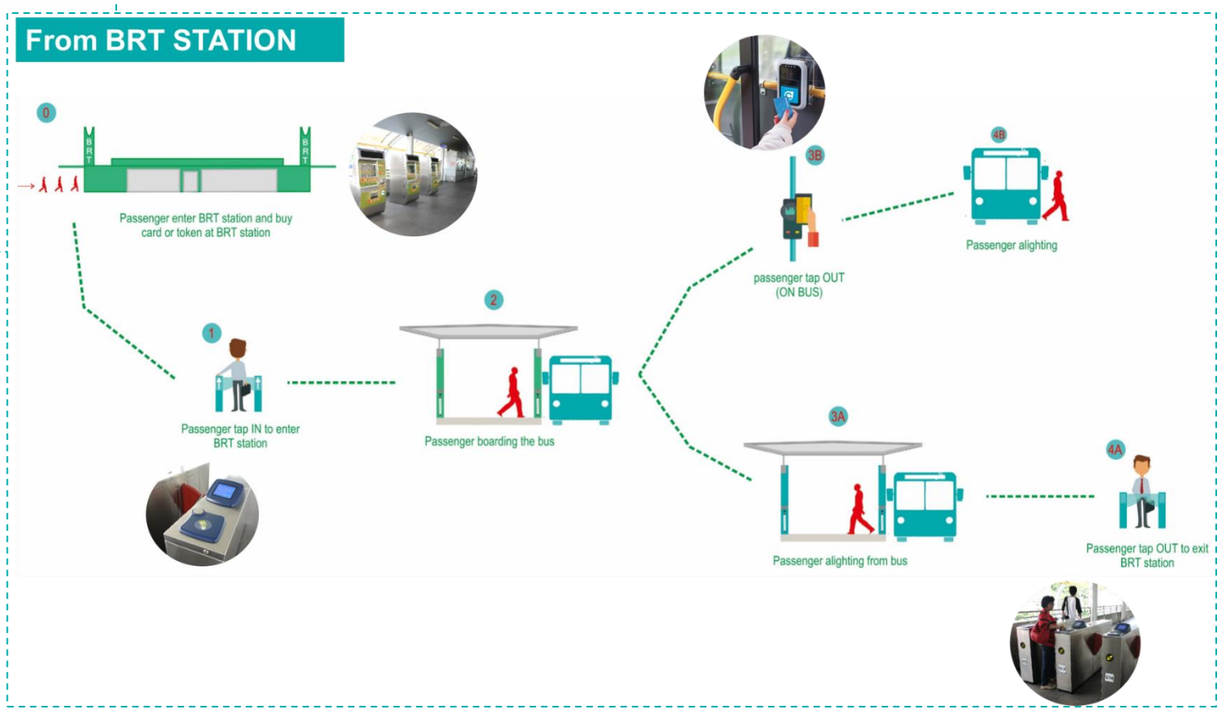


Table 9.4 Payment Mechanism for BRT.

Fare Structure	Pre-Boarding	Boarding	Alighting
Distance Based Fare	At BRT Station Passengers buy Smart card (can be used for multi-trip or single trip) at ticket office or vending machine at station	At BRT Station Passengers tap the card at the station gate	At BRT Station Passengers tap card at the exit gate
	Off Corridor Passengers buy smart card at gas station near bus stop. Other option is to provide vending machine on the bus to sell card (might be too complicated)	Off Corridor Passengers tap the card at the reader inside the bus	Off Corridor Passengers tap card before exiting

10 Initial Business Model

The business structure and contracts are described here based on present plans. It may be necessary to change elements of these during the processes of tender and negotiations for the various services. TransPeshawar with the mandate and resources (human and financial), is expected to proceed with actions as outlined in this Initial Business Model and to work with the FS to implement the "Declared" BRT project.

10.1 Business Structure

10.1.1 Overview

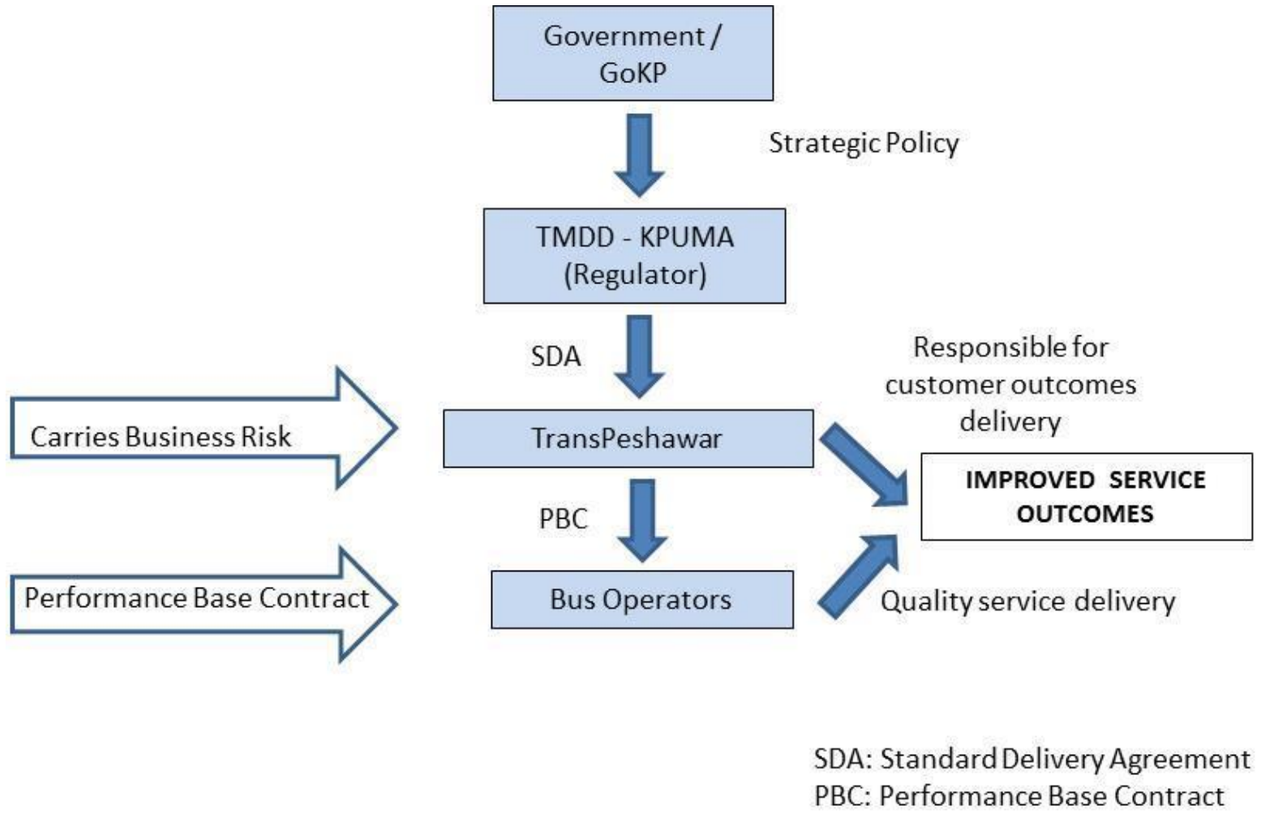
The objective of the institutional development is to separate the area of policymaking, management and operation into 3 clear hierarchal levels as follows:

- Strategic Policy and Regulation – KPUMA
- Management and Customer Service Delivery – TransPeshawar
- Service Operation – Private Operators

KPUMA determines where the system is to be rolled out, builds and maintains the BRT infrastructure, and sets the terms under which the system operates. This includes setting the framework for establishing fare levels and establishing through negotiations with TransPeshawar the level of additional finance contributed by GoKP to run the transport operations.

The funding of Public Service Obligation (PSO) services will be governed by Public Transport Contracts between the Authority / KPUMA and TransPeshawar (Service Delivery Agreement / SDA). The contents of the contracts and the basis for maintaining them may be reviewed at any time (as appropriate) by the Authority in consultation with TransPeshawar, however, a full review of the contract must occur at the end of contract. In carrying out the review at the end of the period, the Authority must engage in a public consultation process and report on the operation of the services to which the contract relates stating the reasons for amending the contract or entering into a subsequent direct award contract. The contracts meet the current criteria set down in the laws of the Islamic Republic of Pakistan, setting strict standards of operational performance and customer service and contain penalties for non-performance.

Figure 10.1 BRT Proposed Business Structure.



The BRT system requires the development of institutional framework comprising:

- TransPeshawar is governed by a service delivery agreement (SDA) with KPUMA.
- TransPeshawar manages the design and implementation of the BRT project as per the conditions attached to the assigned project by KPUMA. Typically, these will include contract procurement and management for the delivery of services as per the requirement of the KPUMA conditions.
- TransPeshawar to manage the BRT system (the structure of TransPeshawar is commercial and business-like arrangements) and which manages the bus operator contracts.
- A performance-based contract (PBC) under which bus operators will supply services to the system (under a kilometer based fee). The business risk of the system will be borne by TransPeshawar

TransPeshawar as a service delivery management function consist:

- Establishment of a Bus Operations Center (management system center) to plan and manage the route network and manage bus operator contracts.
- Manage the Control Centre for BRT system to provide in-service monitoring and control.

- Manage the fare collection and ticketing function through a contracted fare system collection company (FSC).
- Manage ancillary revenue and upholding the BRT system's quality goal of good customer service.

The nature of the business should be explained, as follows:

- TransPeshawar should operate as a commercial and business-like entity that:
    - capable of developing the bus business to its potential and deliver a high quality of customer service. The incentive to perform is that it is dependent on passenger growth and revenue, without operational subsidy from Government;
    - carries the business risk of the system, and requires high caliber business management skills. This management structure separates the various function and holds each entity clearly accountable for outcomes.
- TransPeshawar is at "arm's length" from both the Government and as a public service body is fully accountable and transparent and subject to annual audit and review.
- TransPeshawar
- Operates under KPUMA policy set and develops its own tactical policy to develop its services (to operate efficiently and develop revenue).
- Traditionally the purchase of the vehicle is carried out by the bus operators (BO) company as this is a major ongoing cost component they will bear. The main task of bus operators to stay viable is to manage costs and therefore should have the ability to choose the type of bus they operate. However, given financial constraints or the high cost of finance, the government may need to assist the industry in bus purchase.

For the purchase of vehicle, the options for raising vehicle finance include:

- The bus operator raising commercial finance against the security of a fully funded contract
- Supplier finance where the bus supplier makes favorable finance conditions available
- Finance made available through a government sponsored scheme under a local industry stimulation package if the buses are built in Pakistan. This option could be coupled to the option above.

TransPeshawar will need to establish and operational well prior to the commissioning of the BRT phase 1. It should be developed in conjunction with the TA for Institutional and Organization Development for the BRT system.

Table 10.1 TransPeshawar BRT Management Function.

Responsible	Function	Activity
Planning	Bus networking planning	• Scheduling and managing bus control center • Inspection and monitoring of services • Enforcement of routes and standards • Manage compliance of bus operator trunk line (BRT) contracts • Manage compliance of bus operators feeder service contracts • Oversee fare collection by Fare System Collection Company (FSC) • Supervise housekeeping & cleaning contracts • Safety and security

Infrastructure & Asset management	Management of BRT infrastructure and assets :
	• BRT corridor
	• BRT terminal stations
	• Depot
	• The Estate
		• Responsible for maintenance the facilities of BRT system like stations, depots as well as feeder bus stops (in future) etc.
		• Supervise BRT infrastructure and assets contracts:
		  ○ Supply & Service Contracts for Bus Station building equipment
		  ○ Maintenance Contract for BRT corridor, terminal stations (Civil works & mechanical contract)
		  ○ House Keeping & Cleaning of Bus corridor & terminal stations contract;
		  ○ Security contract

Operation	Bus operation: • Network and service planning • Timetable planning and optimization of services • Performance evaluation • Monitor user satisfaction	• responsible for overall BRT operations, safety & security and information technology and related work. • It will manage day to day management of bus operations. • It will manage the BRT Control Centre, (CC) perform quality control checks on vehicle and infrastructure, and oversee fare collection activities at terminals and in the system in general. • Its function is to provide on time, dependable, transportation services to the citizens of this city. • It will liaise directly with the bus operators, fare collection agency, infrastructure maintenance agencies and all other groups involved with operations. • It will be in-charged with delivery of service to the community. • Advises the Administration and Finance department regarding payments to be made to bus operators and all other external contractors.
Market	Market development: • demand management • plan medium to long term changes in operations. • Fare structure, fare incentives, economic and business model	• Its role will be to conduct passenger surveys, compile and analyze data pertaining to passenger demand, not just on the BRT system but in the whole city on other relevant modes. • It will assess possible extension to the system, when required, and take necessary approvals from relevant authorities. • It shall study and develop for the operations management group to implement.
Management	Finance & Accounting	• System finance management and monitoring • Revenue and marketing plan • Finance planning and projections • Oversight of revenue collection, banking and distributions to service providers • Internal finances and budgets
	Legal	• Review performance contracts • Review fare collection contract • Review service contracts • Brief management on contract queries • Update conditions of contract if necessary
	IT	• Manage IT and systems
	Administration & Human Resources	• General administration • Human resource management • Manage office physical resources
	Internal Audit	• Audit company monthly revenue and expenditure • Audit TransPeshawar annual accounts

10.2 Performance Based Contracts

10.2.1 Objectives of Performance Based Contract

The purpose of the Performance-based Contract (PBC) is to place bus operators under a sound financial business model while giving adequate control to TransPeshawar. Also, the PBC (paying operators by km of service) separates the operator income from per passenger fares allowing distance-based fares to be introduced and there is no need to divide revenue between operators. What this means is that all revenue goes to TransPeshawar, allowing passengers to transfer across service without cost penalty, and operators are paid for contracted services provided.

The PBC is a quality based contract that gives TransPeshawar a strong hand in control of quality service delivery. As the revenue risk of the business is under TransPeshawar, the operators have a clear contractual responsibility to deliver quality services under the contracted service specification. The contracted per km cost can be negotiated with TransPeshawar or under a tender system where the bidders bid on a cost per km. The tender system is recommended as it will encourage greater efficiency.

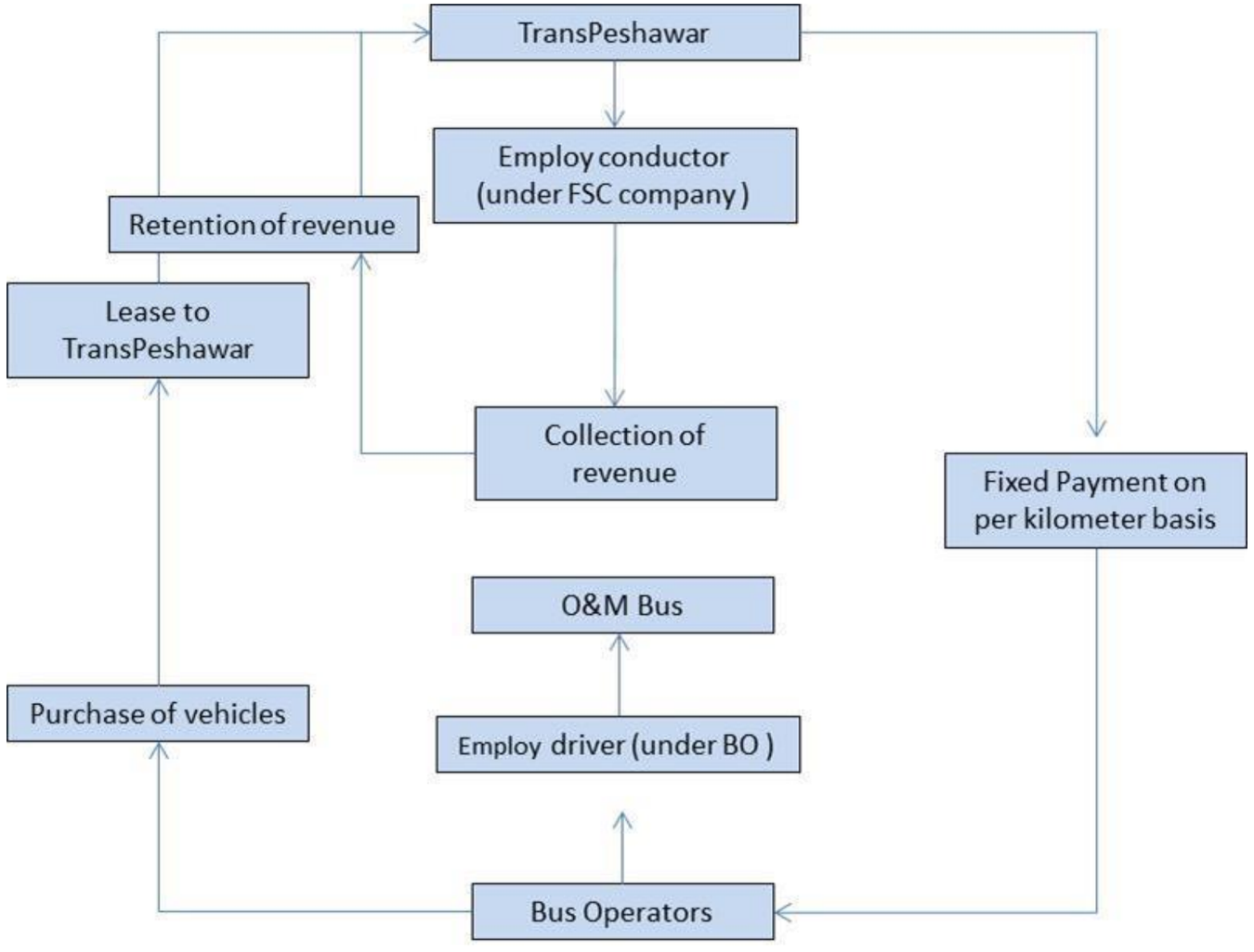
10.2.2 Service Delivery Contract Models

There are two types of contracts proposed for the city, to account for different type of operation; briefly described as:

a. A 'Gross-cost' contract which pays operators the full cost of operation. This contract is the type used for all main BRT and secondary bus routes operation. TransPeshawar has full control of bus routes and will assign contracts to these routes on a per km basis. TransPeshawar has the ability to reassign contracted operators to other routes to balance supply and demand as necessary to maintain maximum efficiency. The operators do not collect fares as all revenue goes to the system.

b. A 'Net-cost' contract where operators are assigned contract areas and can develop their own services under the guidelines set out in the contract but giving them some freedom in tailoring services efficiently and to meet customer needs. The operators collect a small fare that they keep, however some cross subsidy may be needed from the bus system to top up earnings and make the business viable.

Figure 10.2 Structure of Gross-Cost Contract.



Note that under TA, the form of contract proposed to be used for service delivery – at this stage (BRT phase 1 – trunk route) is a "gross cost" contract that is envisaged between TrasPeshawar and the bus service provider(s).

Under the gross cost contract, the bus operator (BO) company would procure the vehicless and lease them to TransPeshawar based on a fixed pre-determined per-km charge or charge per hour basis. The BO company is in charge of the operations and maintenance of the bus and of employing skilled staff for running the same. The BO company maintains a record of the kilometers travelled each day by the bus and is reimbursed in terms of a fixed per-kilometer charge or per hour charge.

The bus operator is able to recover its investment through the fixed per-kilometer or per-hour charge. This charge does not change during the contract period except for standard yearly escalations accorded by TransPeshawar. Revenues are collected by TransPeshawar and fares decided by KPUMA.

The bus operator bears all the costs associated with the procurement of the vehicles. The vehicles must conform to the physical specifications and performance standards stipulated by TransPeshawar in the contract. TransPeshawar appoints the bus operator and lays down the physical specifications of the buses, performance standards and penalties, and minimum running of the buses. The contract period is indicated in the agreements and varies between 5 and 7 years or depends on bus usage (typically 7.5 million kilometers).

Table 10.2 Roles and Responsibilities sharing of the private bus operator and TransPeshawar.

Activity	TransPeshawar	The private bus operator
Primary task	Fare setting, route planning, and management of transport infrastructure like bus stops and terminals Performance and quality monitoring and regulation Collection of all revenues such as tickets, seasonal tickets, advertising revenues	Procurement of buses and skilled staff to operate and maintain the buses Procurement of permits Procurement of diesel, spares, engine oil, and other consumables for the running of the buses Procurement of buses, ad revenues from buses
Fares and payments	Fare setting and collection	Receipt of a fixed amount based on per-kilometer or per-hour bus operation
Operating expense	Not applicable	Spares, minor and major repairs Fuel Any other operation and maintenance expense Bus registration
Capital expense	Not applicable	Capital expenditure for the procurement of buses
Asset ownership	Buses are run in the name of the bus transport authority or urban local body.	Takes over the assets at the end of the contract

The net cost contract is considered as suitable for the community feeder services that feed into the main bus system which are contracts that the minibus operators could be assigned. The advantage of such a contract is that all minibus do not require electronic ticketing equipment and the operator has the incentive to develop local services as the operator is closer to community needs (to develop appropriate service levels). This reduces the cost and supervision requirements of the IC-ticketing system.

10.3 Fare Collection and Management, Control Center Contracts

10.3.1 Fare collection

Automated Fare System Collection (AFSC) refers to all fees and tolls collected in relation to transport. AFSC refers specifically to fares collected for public transport (PT) and the associated information and systems utilized for the management and analysis of the collected information. AFSC will manage the entire fare collection and ticketing function of the BRT system for TransPeshawar. On-board units and all station ticketing equipment including ticketing turnstiles will be managed and maintained by the Fare System Collection (FSC) Company and they will train and employ all staff at BRT ticket offices.

Issuance of smartcards and cash payment collection and banking is also a responsibility of the FSC to deposit all revenues to the bank who will manage the clearing house (disbursing funds to payees under instruction from the TransPeshawar)

FSC operates under contract to TransPeshawar. As such it is likely to be a ticketing equipment supplier operating a service contract to manage the system. Therefore, it would be a major task for TransPeshawar to setup an internal division (fare collection unit) to manage this task as it would need a high level of technical skill. Contracting management to an equipment supply company is recommended as it creates incentive for the supplier to ensure the robustness in services as they will deal with the consequences of any deficiency in equipment quality.

10.3.2 Control Center

The transit management center is the hub or nerve center of a transportation management system. It is where information about the transportation network (freeway system, traffic signal system, or transit vehicle network) is collected and processed, and fused with other operational and control data to produce information. The information is then used by system operators to monitor the operations of the transportation system and to initiate control strategies to effect changes in operation. It is also where agencies can coordinate their responses to transportation situations and conditions. Furthermore, the management center is the focal point for communicating transportation related information to the media and the motoring public. Main function of management center for BRT system can be described as follow:

1) Bus fleet management
   - BRT management center as known for Control Center (CC) is typically tasked with tracking and supporting fleets of transit buses.
   - Bus vehicle location and tracking technologies range from simple tracking through radio communication with the vehicle operator, to systems with onboard global positioning systems (GPS) which transmit vehicle location second-by-second to the center. Bus fleet management systems may also capture vehicle condition information and vehicle performance compared to schedule. Newer systems also allow transmission of mayday signals from the vehicle, allowing the center to contact appropriate emergency services and public safety officials.
   - CC also maintains voice communication with the vehicle drivers. For bus networks, transit management centers may be able to alert drivers to problems along their routes, allowing alternate routing where permissible. Similarly, CC may capture traffic information from their drivers, which can be passed along to management personnel.
2) Center-to-Center Coordination
   - Cross-center coordination begins not when the center is operational, but during initial planning, design, and implementation. Involving all agencies active in the situations addressed by the management center ensures that the center is optimally configured, equipped, and staffed to achieve full benefit from the taxpayer investment. Ideally, the concept of operations will reflect the actions and methods of each partner in transportation management, and will reflect the resources and capabilities necessary to achieve the chosen operational method.
   - The focus of cross-center coordination is the sharing of information. Non-infrastructure intensive traveler information includes provision of information via broadcast media, press, Internet, telephone systems, or via fax. Information sharing may occur at any time, i.e., as part of event planning, during an event, or following the event as a "post mortem" evaluation.
   - While every component of a BRT is critical to success, the management and control of the system is the defining feature that sets BRT apart from a general bus service. Management and Control of a BRT system includes:
     (i) Direct monitoring and control of buses 'in-service' in real time through the GPS tracking on buses allows the system to:
        a. Develop a high level of service control (demand sensitive and improved reliability)
        b. Immediate attention to any service disruption or emergency response
        c. Added passenger safety through CCTV monitoring at stations
        d. Passenger advice and service information

     (ii) The BRT Management Centre managing the Performance-based Contracts of operators under an established monitoring system where failures in performance are penalized.

10.3.3 Summary

The BO will be appointed through a negotiation process to be run by TransPeshawar. The BO to purchases, operate and maintain buses of given specifications on specified routes under TransPeshawar supervision. The BO will be contracted to provide trunk services and the contract will be paid mainly by way of a fee per kilometre of service provided. The BO will be paid an amount per kilometre sufficient to cover total operational costs, plus a reasonable rate of return on their investment. This is the key element to be negotiated between TransPeshawar and BO, and eventually of the companies' bids. Vehicle purchase and ownership are dealt with differently in the initial phase of BRT. The GoKP considered a range of options, which are described and discussed later.

TransPeshawar and the Control Centre (CC) for and on behalf of TransPeshawar will collect data is for contract compliance purposes. The information affect to the performance of the operator relevant to the imposition of penalties. On the other hand, the KPUMA will guarantee that TransPeshawar segregated lanes and corridors will not have illegal competitors, subject at all times to the provision of the KPUMA.

11 Stakeholder Analysis and Bus Industry Transition

11.1 Introduction

This chapter provides a preliminary negotiating strategy with existing transporters currently operating on proposed BRT routes. It is based on a series of meetings and discussions held with transporters who are currently operating vehicles on proposed BRT routes, drivers and conductors of such vehicles, time keepers based at bus stands, and Regional Transport Authority (RTA) officials, amongst other stakeholders. The two-fold objective of these discussions, as stipulated in the Terms of Reference (ToR) for the Chief Negotiator, and laid out in the remainder of this section was to:

1. Engage with existing bus operators to:
   (i) Collect data,
   (ii) Share information about the future BRT project
   (iii) Probe issues of greatest importance to transporters in order to gain understanding of problems and challenges of current operating environment; and

2. Undertake initial discussions with all existing operators and develop an overall negotiation strategy.

This chapter begins with a brief overview of the regulatory landscape for public transport in Peshawar; section 11.3 provides a description of the different transit types and their ownership; while section 11.4 details issues and challenges faced by transporters/route operators. Section 11.5 provides operational data on the main routes, including vehicle details, routes information and revenue & expenses for main the categories of public transport in Peshawar; sections 11.6 describes the transporters' impression and section 11.7 provides strategy for incorporating them into the proposed project.

11.2 Regulatory Framework for Urban Transport in Peshawar

The key legislation that governs transport sector in KPK is the Motor Vehicles Ordinance (MVO), 1965, which has a limited focus on mass transit operations. The key agency that deals with transport regulations and related route permits and vehicle standards is the Transport and Mass-Transit Department (TMTD) of KPK. The route permit is issued, however, by the regional transport authorities (RTA), under the 1965 act.

Function in the province is fragmented with overlapping responsibilities between provincial and local level (district level) organizations and departments. There are a number of departments and agencies playing a role in the management of roads, public space and transport services. Some agencies represent the Provincial Government while others maintain direct links to the District and Tehsil Governments. Each agency has its own priorities and objectives and this impairs their effectiveness in delivering the various services related to urban transport, chiefly because there is no coordination mechanism in place. Local institutions also experience frequent changes that undermine their capacity to discharge their duties as envisioned (KP Local Government Act 2012 and KP Local government Bill 2013).

As a result, these factors have cast a negative impact on the urban transport system, resulting in inefficiencies, inhibiting development of local institutions and coordination issue in related departments.

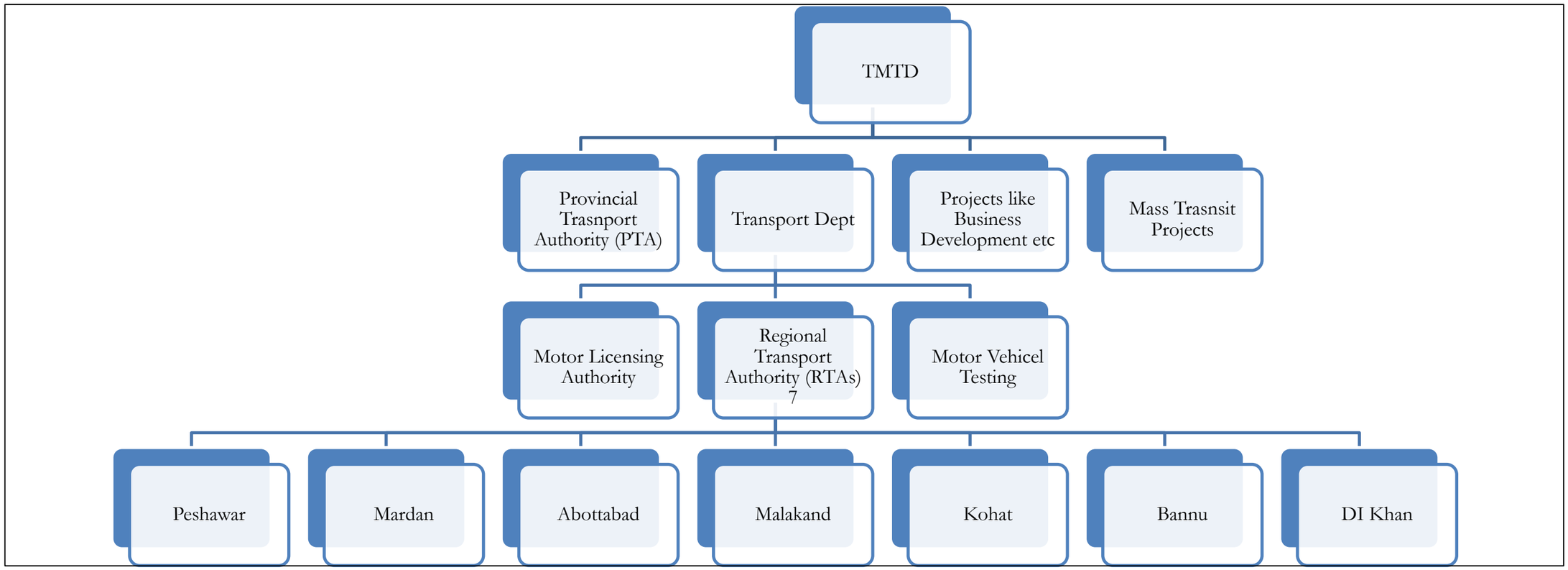
Box 11.1: Role and Function of TMTD

The Transport Department under full-fledged secretary in KPK was created in Dec 2008. Earlier, the transport functions, were controlled by the environment or labour departments' in some combination. Recognizing the importance of mass transit, the government changed the nomenclature of the transport department to Transport and Mass Transit Dept. (TMTD) in 2013. This department is now responsible for rules of business and the custodian of Motor Vehicle Ordinance (MVO), 1965. Most of the activities pertaining to transport have since been streamlined and transferred to TMTD (See TMTD Organogram below).

The TMTD, headed by a Secretary and aided by technical and administrative staff, sets overall policy and direction with the objective of fostering socio-economic development. Its specific objectives are:

- Introduce transport infrastructure policy for connecting central industrial regions with less developed areas.
- Employ public private partnership for new investment in road infrastructure.
- Mitigate deterioration of road & transport infrastructure; improve existing road and highway networks with special emphasis on transport infrastructure up gradation and maintenance.
- Promote multi-modal transport network.
- Improve road connectivity to railway stations for passengers and freight traffic.
- Construct trucking terminals at Peshawar and Dera Ismail Khan and Havelian to meet the needs of the trucking sector for the next 30 years.
- Introduce Mass Transit System in Peshawar and other big cities in KPK.

Figure 11.1 Organogram of TMTD.



The provincial and regional transport authorities (RTA) perform transport functions, and some traffic control functions with municipal authorities and the traffic police under the local government ordinance 2013.

These agencies lack both the capacity and structure to undertake their function effectively, especially when it comes to urban mass transit. Because of the weak capacity of the TMTD, the Urban Policy Unit (UPU, under the Planning and Development Department) has been playing the lead role in initiating reforms and new initiatives in the urban transport sector, as a de facto project/program management unit of GoKPK.

Box 11.3: Role and Function of RTA

The RTA is the lead government agency responsible for regulation of public and goods transport in Peshawar and beyond. The Agency is governed by the Motor Vehicle Ordinance (1965) and since 2011 has been placed under the Transport Department of TMTD. The Agency is governed by a Board, which is chaired by the Commissioner of Peshawar, while the Director Transport, at TMTD acts as Co-Chairman. The Director Transport reports to Secretary TMTD.

The Agency has a small staff comprising of: the Secretary (1), Superintendent (1), Assistant Superintendent (2), Senior Clerk (3), Junior Clerk (3), and support staff of 3-4 peons. The main functions of the RTA include to:

- Grant, issue and renew route permits in respect of stage carriages, contract carriages on intra city classified routes, private carriers, public carrier permits.
- Regulate and restrict the operation of transport service.
- Prepare fare table for transport vehicles.
- Grant/renew body building licenses.
- Enforce various conditions attached to the route permit such as provisions of bus stands, passengers' waiting rooms, workshops and other amenities for the traveling public.
- Grant/renew goods forwarding agencies licenses.
- Allot bays, stands, parking places to transport companies including local councils.
- Conduct checking on the roads.

11.3 Affected Public Transport Service

The Peshawar public transport sector consists mostly of individual owners of vehicles, i.e., one vehicle per owner, but there are a number of individuals who own several vehicles, while some vehicles have as many as three or four owners. To date, there has been no systematic survey of vehicle ownership, and so data on number of owners and types of vehicles are based on rough guesstimates and vary widely.

The current fleet, although required by law to be no more than 10 years old, comprises almost exclusively of models from the 1980s and 1990's. There is no effective Government oversight of fleet quality or supply against demand. There has not been any noticeable investment in the public transport sector for a number of decades, one evidence of which is to be found in the poor state of affairs at the bus stands in Peshawar, including the main General Bus Stand on G.T. Road, which lacks even the most basic facilities.

As most of the Peshawar public transport sector fleet is owned by individual owners who own no more than a few vehicles, most of the power in the industry rests with the heads of the associations who control the licenses. For the Mazdas, Rockets, and Wagons, there are five registered transport owners and worker's associations', most of which have existed in one form or name or the other for a number of years but were registered recently. Most of these associations represent and are organized along different vehicle types, i.e., 'Rocket', Mazda, etc. The main associations include:

1. Public Transport Owners Association, KPK (Khan Zaman Afridi, President)
2. Mutahida Transport Workers Federation (Haji Noor Muhammad Khan Mohmand, President)
3. Local and Urban Transport Association (Haji Yar Muhammad Khan Afridi, President)
4. Local Mazda (Mini Bus) Owners Association (Haji Almas Khaleel, Chairman/ President).

The Associations are more like informal groups rather than rule bound organisations that hold regular meetings and record minutes, elect office bearers, and carry out audit expenditures and accounts. Rather, they exist as advocacy and support groups (usually) led by one of the leading transporters or a person of influence in the transport sector. The Associations charge their members at the rate of Rs. 10 per day – payable at the different bus stands. In return, members are assisted in their problems with police, RTA, and other government authorities. Depending on the case, members might also get help with other issues like hospital or road accident related expenditures. In essence, the head of the association acts like the leader of a social group, whose interests he protects vis-à-vis government. He helps out the members with their work related problems. The members, in turn, place their trust in him to negotiate on their behalf – which is the basis for his influence and position.

The operators who carry the bulk of passenger on the proposed BRT route and associated feeder routes consist of the following three vehicle types:

- Non-AC Bedford buses a.k.a. "Rocket" (45 seater)
- Non-AC 'Mazda' minibuses (30 seater)
- Non-AC 'Ford Wagons' (14 seater)

In addition to the above-mentioned, there are Suzuki carrier vehicles (capacity 12 seats), which run on RTA issued route permits from points within Peshawar to destinations located in adjoining Districts. While these vehicles are not authorized to pick-and-drop passengers within Peshawar while on their designated route, the common practice is contrary to this. Except for three routes, used by Suzuki carriers, which overlap with some portion of proposed BRT routes, the remaining routes lie outside the BRT and anticipated feeder routes.

Another 'special' service operating, that is referred to as the "Buxa" has been operating under a special arrangement since 2014. The TMTD, under pressure from the government to improve the quality of public transport in Peshawar, invited Expressions of Interest in 2012-13 for running air-conditioned vans on 21 routes in Peshawar. The Department received no satisfactory response to its solicitation. Another EoI was put out in 2014 and this time, an individual who is politically influential and connected to the ruling party in the province was encouraged to apply. The individual applied and was granted route permits to operate 50 Air-conditioned Toyota Hi-Ace vans on the Chamkani to Karkhano (via Suneri Masjid Road) route in Peshawar. Apparently, he did not agree to run the vans on the other routes because these would not be profitable.

Currently 43 of these "Buxa" vans are running on two routes in Peshawar. The vans belong to different owners while the route permit for these has been granted to the individual in question. He has an arrangement with the van owners whereby he pays them Rs. 100,000 a month (based on 6 round trips a day, 30 days in a month). The fares for the air-conditioned vans, at Rs. 60 from end-to-end, is more than double the rate allowed to regular vehicles.

Figure 11.2 Type of Public Transport Vehicles Operated in Peshawar.

In recent years the RTA has issued large number of permits to private taxis for operating within Peshawar. Many, if not all, of these taxis operate like a public transport service by picking-and-dropping multiple passengers on different routes throughout the city. The transporters of "Rocket", "Mazda", "Ford Wagons", and 'Buxa' complained that they have lost out on business to Suzuki's and Taxi's. Additionally, they added, the law enforcing agencies closed down Khyber Road to their vehicles for security reasons, but still allow Suzuki vans and Taxi's to operate on the road. All of the different public transport vehicles described above run on CNG.

11.4 Problems and challenges related to the current operating environment

Discussions with affected transporters revealed a number of concerns about the existing regulatory environment that should be taken into consideration when developing a strategy for negotiating with them during BRT implementation.

11.4.1 Route permits

Currently, all of the operators on corridors affected by the proposed BRT, except the Toyota Hiace "Buxa" fleet, are operating without a valid route license.

The TMTD notifies routes while the RTA issues the route permits (See Appendix for list of official twenty-one urban routes in Peshawar). Prior to 2002, urban route permits for Peshawar were in Category C (see box 11.3). Thereafter, the government made the decision to shift all urban transport vehicles in Peshawar to Category A route permits, and placed a complete ban on renewal or transfer of existing permits and issuance of new ones.

Box 11.3: Category of urban route permits (by age of vehicles)

Category A – models ≤ 9 years

Category B – models ≤ 11 years

Overnight, the entire public transport fleet was made ineligible from operating as all the vehicles were older than 9 years. The government's rationale for taking this decision was based on earlier attempts to get transporters to bring newer buses on the road through dialogue and persuasion, which did not produce desired results. Hence, the government adopted this strategy as a way to compel transporters to replace the existing fleet with newer vehicles.

The transporters are of the view that given the small profit margins in their business, lack of adequate investment capital, and absence of loan guarantees, financing, or leasing options from the formal sector, it was difficult, if not impossible, for bus owners to replace their vehicles with newer models. As such, none of them complied with the requirement to procure new vehicle.

Recognizing that not replacing an operational system – however inefficient and problematic – with an alternative was not a viable strategy, the government was forced to reverse its decision and allow the existing fleet to operate till such time that a viable alternative became available. So, while a ban on renewal, transfer, and issuance of route permits remains in place, vehicles that had permits prior to the ban are authorized to continue running on allotted routes on a temporary basis. The transporters argued that this temporary arrangement has unnecessarily created uncertainty for their operation, and the government should revert to formally allowing buses to operate according to the given route permits. Transporters added that there are some unauthorized routes on which "Rocket" and "Mazda" buses ply, but such routes are few and the number of buses running on them small.

11.4.2 Arbitrary Enforcement of Traffic Laws by Traffic Police

Declining road conditions on key arterials is reaching a stage where the situation is becoming unmanageable both for traffic regulation enforcing police and drivers of public transport buses. During consultations, the traffic police commented that the real issue is increasing volume of traffic and the growing numbers of impatient drivers who flout rules.

The chief compliant of transporters (including "Buxa" van owners) and drivers was the unjustified levy of fines for alleged traffic violations. Frequently, the same vehicle is fine more than once in one day. The bus operators claimed that the excessive zeal with which traffic police was levying fines was eating into razor thin profit margins and thus imperiling their operations. They claimed that traffic police also routinely rough up bus drivers during arguments over the alleged traffic violations, which include "minor" infringements like bus decorations.

In recent times, the government had increased rates of traffic fines from a minimum of Rs. 200 up to Rs. 5,000. More importantly, the traffic police are now allowed to retain 40 percent of the amount of fines collected, while the remaining 60 percent is deposited in the provincial treasury. Monthly collection of fines is to the tune of Rs. 20 million. Transporters argued that both the increase in rates of fines for different categories of traffic violations, and allowing the traffic police to retain a portion of the total fines collected has created a perverse incentive for police to levy fines even when these are not warranted.

Moreover, since any dispute over the legitimacy of a fine comes down to the word of the policeman issuing the fine against the word of the bus driver, there is no effective recourse available to challenge the imposition of fines, said the transporters. They added, that while an appeal process did exist, it would most likely be biased in favour of the traffic police officer. Moreover, following such a recourse is difficult for the additional reason that it would be too time consuming for daily wage earners like bus drivers to pursue. The upside of the traffic police being allowed to retain a share of the traffic fines collected has been that they no longer demand bribes.

11.4.3 Regulated Fares Too Low

The transporters cited low fare levels (See Annex for official fare rates) as the single biggest reason they are unable to invest in newer (better quality) vehicles and improved service. They argued that at a cost of anywhere between Rs. 5-15 million for a newer model bus (depending on make/model/seating capacity), current rider volumes and fare levels would not generate enough surplus for owners to be able to pay back high interest loans taken from the informal sector (See section on Financing below).

The approved minimum fare used to be Rs. 12 (from stop to the next) but due to pressure of TMTD to reduce fares further to facilitate the public, transporters reduced the fare to Rs. 10 in 2012. Transporters added that school and college (male) students in particular, do not pay fare for riding on the buses and when asked to do so, frequently damage the vehicles in protest. The transporters claimed that nearly 70% of their riders were Afghan refugees, who travel across the Pakistan-Afghanistan border regularly. So, whenever the border closes down, it restricts the flow of Afghan refugees into Pakistan from 1000 a day down to 100-200, which in turn affects the available ridership numbers.

11.4.4 Road congestion

Both the traffic police and transporters complained of increasing traffic congestion and poor driving sense of competing road users. .Transporters complained that they have been forced off main G.T Road and are now required to drive on narrow and dilapidated service roads alongside the main road. As a result, it takes them much more time to complete one round trip, leading to reduced daily revenues. Driving on the 'potholed' lanes is also causing increased wear and tear of vehicles. Another source of delays affecting profitability of the business are the numerous security check posts and the frequent closure of roads due to security reasons. The Law enforcing agencies has closed off Khyber Road, which was a profitable route, to all kinds of public transport- except for taxis and Suzukis's. This too has adversely affected transporters revenue.

Figure 11.3 Bus Stands in Peshawar.

11.4.5 Poor Quality Bus Stands and Extortionate Access Fees

There are four official bus stands in Peshawar for intra city public transport. The largest of these is the General Bus Stand (GBS) situated on G.T. Road. In addition to official stands, there are a few smaller informal bus stands situated on private property for which rent is paid by whosoever manages the stand.

The four official stands are the property of the Local Government and are given out on yearly contract. The contractor(s) place people on site who collect a set amount from all bus and wagon drivers who use the bus stand. The rates vary from Rs. 50 per trip per day (at the GBS) to Rs. 100 (at Karkhano bus stand). This amount is considerably higher than the local government sanctioned rates. It was reported that part of extra money charged goes to the contractor(s), while those collecting it on their behalf also pocket part of it for themselves. There are no toilets or drinking water facilities, and neither is there a shaded area where drivers, conductors, or passengers can sit or rest. There is also no drainage on-site and so during rainy season, all the sites get flooded.

11.4.6 'Inconsistent policies'

Inconsistent government policies and arbitrary decisions, argued the transporters, is a major reason why the public transport sector in Peshawar (and KPK) is in such poor state. Citing a recent instance of the government reneging on a commitment, a leading transporter said that in 2015, the TMTD asked transporters to refurbish their vehicles in return for which they would consider providing part funding for the cost of refurbishment, and would also extend the duration of their road permit. The transporter claimed that to set an example for other bus (Mazda) owners, he undertook refurbishment of two vehicles using own money (approx. Rs. 800,000). In return, the government not only did not provide the 'subsidy' they had promised but also did not renew the road permit as they had promised to do. The 'Buxa' Van operator had a similar complaint against the government. He claimed that contrary expectations and his understanding with the government, his vans were being fined for stopping to pick up passengers from bus stops, because the traffic police claimed they were not authorized to do so. The regular imposition of fines, alongside the large number of permits given to Taxi's, which operate like public transport, were eating into his profits and ridership and making the business financially unviable. He said he had implored the TMTD to address these issues but nothing had come of it. He claimed the business was becoming a 'headache' for him and were it not for his political connections, he would have withdrawn the service.

11.4.7 Financing

Financing for purchase of vehicles is available from the informal market where interest rates tend to be much higher than official bank lending interest rates. The advantage of the informal sector is that it is simple, i.e., money is made available readily and there is very little paper work involved. Most the individual bus owners are said to have purchased their vehicles through informal sector loans.

11.5 Operational Data of Main Routes

Vehicle Details, Routes Information and Revenue & Expenses for Main Category of Public Transport in Peshawar

Figure 11.4 Operational Data for Different Transporters Route in Peshawar.

#	Description	Bus (Bedford 'Rocket')				Minibus (Mazda)					Station Wagon (Ford Wagon)
	Vehicle Details										
1	Year of Manufacture	1970, 1973, 1980				1980, 1986					1980's
2	Seating Capacity	45				30 + (20 Standing)					14
3	Cost of Vehicle (Rs.) - Cash[1]	600,000 – 1,000,000[2]				600,000 – 900,000					400,000 – 600,000
4	Cost of Vehicle (Rs.) – Instalments	700,000 – 1,200,000				800,000 – 1,000,000					500,000 – 700,000
	Operation Timings										
5	Operation timings	0500 – 2000 hrs.				0600 – 2000 hrs					0630 – 1800 hrs
6	Weekly Operation (Days)	06 (some operate 07)				06 (some operate 07)					06 (some operate 07)
	Revenue										
7	Official Routes[3] (From General Bus Stand GT Road to:	Landikotal	Bara	Jamrood	*Saddar-Qayyum Stadium*[4]	A-1 Kambo Ring Rd. - Hayatabad Phase 3, 6	2-B Kambo Ring Rd. – Hayatabad Phase 7	3 Kohat Bus Stand - Karkhano	4 Kambo Ring Rd. - Karkhano	6-B Kambo Ring Rd. – Bacha Khan Chowk	#10 & #11[5] General Bus Stand GT Road – Jail Road – Suneri Masjid – Saddar – University Road - Karkhano
8	Number of vehicles running on each route[6]	80	100	80	20	30-35	40-50	40-50	25-30	30-35	300
9	Distance – Single Trip (Minutes)	120	75+	90+				60+			90 - 120
10	Distance – Single Trip (Kilometres)		15 -20		13			25		22	
11	Number of Round trips a day	01	02	02	04			02-03			04
12	*Fare*:										

[1] Depending upon condition of vehicle.
[2] As a way of indicating the increasing loss making potential of the business, one respondent, Wakeel Khan, stated that he sold his 'Rocket' as scrap @ of Rs. 35 per Kg.
[3] There are some unofficial routes on which a smaller number of vehicles of different categories ply.
[4] Unofficial route
[5] Due to closure of Khyber road by the Army for security reasons, All wagons ply on the same route
[6] Number of buses on each route have been decreasing with each passing year due to several reasons, including: competition from alternative modes of transport like Taxi's, which operate like public transport picking and dropping different passengers at the same time, and Suzuki vans; low/stagnant fares; increasing frequency and amount of traffic fines; and overall reduction in ridership of Afghan refugee due to closure of refugee camps and stricter controls on Pak-Afghan border. Afghan refugees have typically made up a majority of the ridership on Peshawar's public transport.

#	Description	Bus (Bedford 'Rocket')				Minibus (Mazda)					Station Wagon (Ford Wagon)
a	*Stop-to-Stop*	10	10	10	10			10		10	10
b	*One Segment to Next*		15					15 -20		15	20-30
c	*From End to End*	60-70	30	35				25		20	40[7]
13	Gross Revenue Per Round Trip (Rs)[8]	3000 -4000	1700 - 2000	2000 -3000	2500 - 3000			3500 - 5000		3500 - 4000	3000 - 4000
	Expenses										
14	Owners share of daily revenue (Rs.)	400 – 600				1200 - 1800				600 - 900	1000-1200
15	Drivers salary (Rs.)	500				600 - 800					700-800
16	Conductor's salary (Rs.)	300 x 2 = 600				350 x 2 = 700					400-500
17	Bus Stand "Adda " Fee (Rs.) [9]	120+20				250					250 - 300
18	Food and refreshments (Rs.)	300				300					300
19	Overnight Parking fee per day (Rs.)	30				50					30
20	Vehicle Fuel (CNG) Capacity (Kgs.)	140									55
21	Fuel (CNG) use per round trip	900				700 - 800					1200 per day
22	Tire Change (Months) [10]	36-48				08					12
23	Cost of Tire (Pair) – Cash (Rs.)	56,000				22,000					11,000 Chinese 28,000 Japanese
24	Cost of Tire (Pair) – Instalments (Rs.)	65,000 – 70,000				28,000					+ 3000 - 4000
25	Make of Tire	Birla / CEAT (Indian)				Birla					Chinese / Japanese
26	Oil Change (Days)	20-30				20-30					20-30
27	Cost Oil Change (Rs.)	3400				2200 (Cheaper version); 3500 (Branded)					1200
28	Cost of Oil Filter (Rs.) + Labour	250 + 100				250 + 100					
29	Break Oil Change (Time)[11]	270				200					150
30	Air Filter Change (Time)	Steel mesh filter does not require change				Steel mesh filter does not require change					
31	Air Filter Cost (Rs.)	1500				N/A					
32	Misc. Vehicle upkeep expenses	Rs. 3000 every 03 months for fixing/servicing Kamanee), greasing, break show servicing, etc + labour				Rs. 320 per month for greasing, Rs. 200 for break-pads servicing, new break-pads cost Rs. 800 + labour					

[7] Official rate is Rs. 30.
[8] Fares vary depending on: (1) Fluctuations in # of riders, (2) Season (ridership/trips higher in winter, lower in summer), (3) Whether goods are being carried or not.
[9] Includes *Adda* (Bus Stand) fee for different stands in a day.
[10] Indian manufactured Birla or CEAT last longer than the cheaper Chinese makes.
[11] Refilled up whenever brake oil level goes down

11.6 Transporters impressions of proposed BRT project

Most transporters were of the view that Peshawar was very different from Lahore or the twin cities of Rawalpindi-Islamabad. Unlike Lahore, which is larger in size and has multiple routes on which operators – who had been forced off the BRT route. could operate, after the closure of Khyber road, Peshawar had only one profitable route (i.e., G.T.Road) which if closed off to transporters would prove to be their death kneel. Some also expressed doubts about the viability of introducing a 'sophisticated' system like BRT in Peshawar arguing that the social, cultural and institutional context of Peshawar/KPK was not conducive for effective functioning of such a service.

When asked what the transporters would do if the authorities decided to go down the Lahore/Islamabad route by ignoring local transporters and bringing in outside operators to run a BRT system? They said that they would forcefully resist any action by the government that threated to put them - and the hundreds of individuals who work in the sector- out of their jobs. They claimed to have gone on strikes before which paralyzed the city and would do the same and more if the government took action that threatened the livelihoods of thousands of people who depend on the transport sector. Transporters said they were willing to work with the government to try and make successful the proposed project provided they were given financial and technical support to come up to the level required for a BRT operator.

11.7 Strategic Options for incorporating existing route operators into proposed BRT

The Nazim of Peshawar, Mohammad Asim, said that the government was keen to incorporate current transporters and other individuals directly employed in the sector into the proposed BRT project. Suggesting options, he said that present transporters, in addition to being given preferential points in an application to become BRT route operators, could be allowed to run existing and/or new feeder routes, while workers such as conductors, cleaners, drivers could be trained for different roles that would be required in the operation of a BRT system. But he cautioned against raising expectation or going into any kind of negotiations without a firm plan and strategy on part of the government. It was his opinion that there needs to be a plan with different options that could provide a basis for discussion with transporters and transport workers.

This section seeks to provide an outline of options and a strategy the government may choose to adopt as it goes forward to negotiate with transporters on the subject of integration in the proposed new system.

Rationale for integrating existing bus owners and route operators in the proposed BRT System:

1. Some of the best run and most successful BRT system around the world have the common theme that, in one form or another, some combination of bus owners and operators, and others working in the industry, were integrated into the new BRT system. This is an advisable strategy for Peshawar to pursue not least because the risks associated with thousands of affected people (and their dependents) becoming opponents of the project, and disrupting its implementation and/or functioning, if they view their livelihood as being threatened, is quite high. This risk was one of two highlighted by the Pre-feasibility report[12].

2. Relatedly, in an environment with few and limited jobs opportunities, such as the one prevailing in KPK, the authorities can and should not be seen as taking decisions that deprive hundreds of individuals (and their dependents) of their livelihood.

Prerequisite to formal transition negotiations:

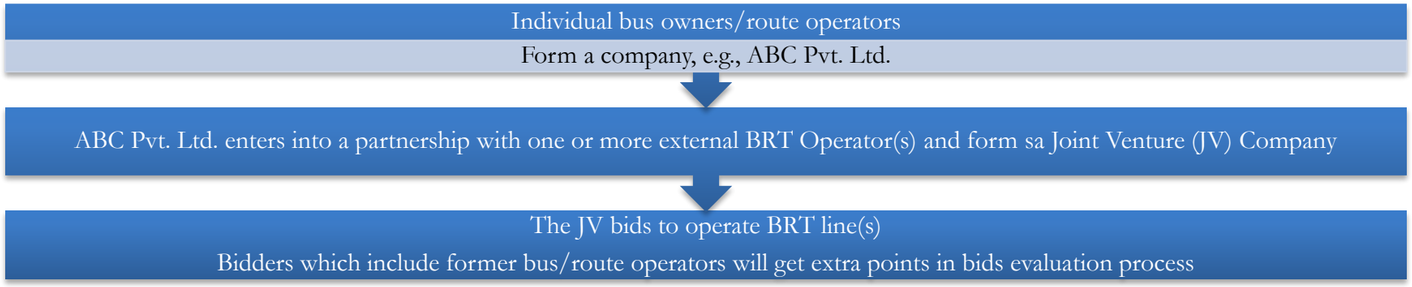
- Government must decide how many BRT operating companies there will be and how the BRT services will be divided between the companies.
- Transporters association(s) will register under relevant government laws and fulfil all requirements related to electing representatives, and empowering them with negotiating (with government and/or incoming bus operators) on behalf of individual owners, route operators, and workers. These routes are as defined in the BRT Service Plan. Government must verify the validity of each of these "affected operators" has holding licenses on affected routes.
- Once registered, affected operators should divide into at least as many groups as there are BRT operating companies and each group should elect representatives
- Government will form a negotiating team tasked and empowered with discussing and agreeing upon a transition roadmap and associated responsibilities and obligations of all concerned stakeholders.
- Peshawar public transport associations will facilitate a survey to (be carried out by a 3rd party) to document the exact number, model, and type of public transport vehicles, and details of owners, drivers, and conductors associated with each vehicle and route.
- Government should issue a BRT operator "prospectus" providing as much information as possible regarding the BRT operator business proposition.

Recognizing the "customary' rights of bus owners and route operators, the government may offer the following **Options for discussion with owners/route operators**.

[12] Final Report - REG-6293: Managing the Cities in Asia, "Urban Transport Pre-Feasibility Study Peshawar, Pakistan" May 2014

Option 1:

The government drafts the BRT operating tender documents to award extra points in the bidding process and makes it mandatory for companies (bidding to be BRT bus operators) to include a minimum number of existing affected owners/route operators[13] as shareholders in the BRT operating company. This arrangement (between current owners/route operators and incoming bus operators) may be in the form of an enterprise led by the affected operators or in the form of joint venture company or under any other mutually agreeable lawful arrangement that makes existing parties and stakeholders in the new BRT system. It might be that an existing owner/route operator may partner with two different bus operator(s) in their bids. The tender may also award additional points for including a management team with experience operating a large integrated fleet in the bidding company, as an incentive to ensure high quality operations



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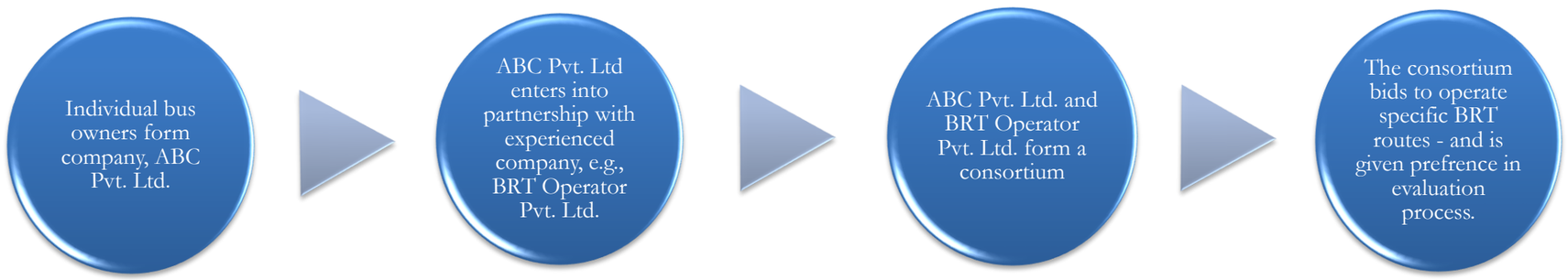


Those affected operators who elect to participate in the tender must turn in their route licences and Current owners/ route operators organize themselves into registered companies and (either independently or as a partnership) bid to run buses on specified corridor(s). The government would award such JV's extra points during bids evaluation.

Government may choose any level of involvement in assisting affected operators to form companies; in some cities, the government's transition team has worked directly with affected operators to help them form companies and find joint venture companies and/or management teams with which to team. In other cities, the government was hands-off and, once they laid out the required process, they allowed the affected operators to organize themselves into companies capable of bidding.

[13] Those plying between Chamkani and Karkhano

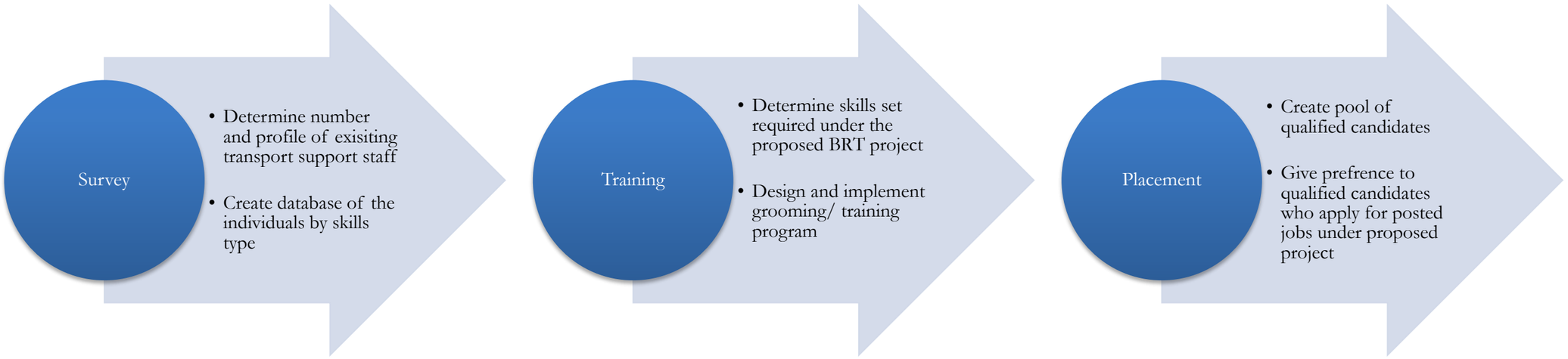
Option 2:

Existing affected bus owners opt out of being part of BRT operations under phase 1. They may choose to participate in bids for operating routes under subsequent phases[14]. Their route license, currently invalid anyway, will not be renewed. The government must decide whether or not to compensate these operators in some way for the loss of their business. As an incentive for delaying their bid for involvement in the Project, the government - through support of ADB, other donors, and/or local banks - may facilitate provision of training in different aspects of bus operations and concessionary loans for purchase of buses.

In either of the two above-mentioned scenarios, owners/operators who are not part of the winning bid(s) and/or unable to become partners due to any reason, may be offered new permits to ply existing or new vehicles on feeder routes and others routes currently being semi-illegally operated within Peshawar by Suzuki van owners[15], who will be disallowed from continuing their current practice of picking/dropping passengers within the jurisdiction of the City.

11.7.1 Recommendation for Inclusion of workers associated with specified route operations

Government will support integration of maximum number of existing public transport workers (i.e., drivers and conductors associated with route operations b/w Chamkani and Karkhano) for appropriate jobs generated under the new BRT system. While such individuals may not be guaranteed a job, those who fulfil requirements of the new jobs, will be given preference in hiring and/or training opportunities that enhance their employment prospects with the BRT project or elsewhere.



[14] The six proposed BRT corridors will be introduced in phases, e.g., routes 1-2 during phase 1; routes 3-4 in phase 2

[15] Most Suzuki's operate RTA permitted routes from within Peshawar to the outskirts and neighbouring districts. However, in contravention of the Permit rules, Suzuki vans pick-and-drop passengers while travelling within the jurisdiction of Peshawar.

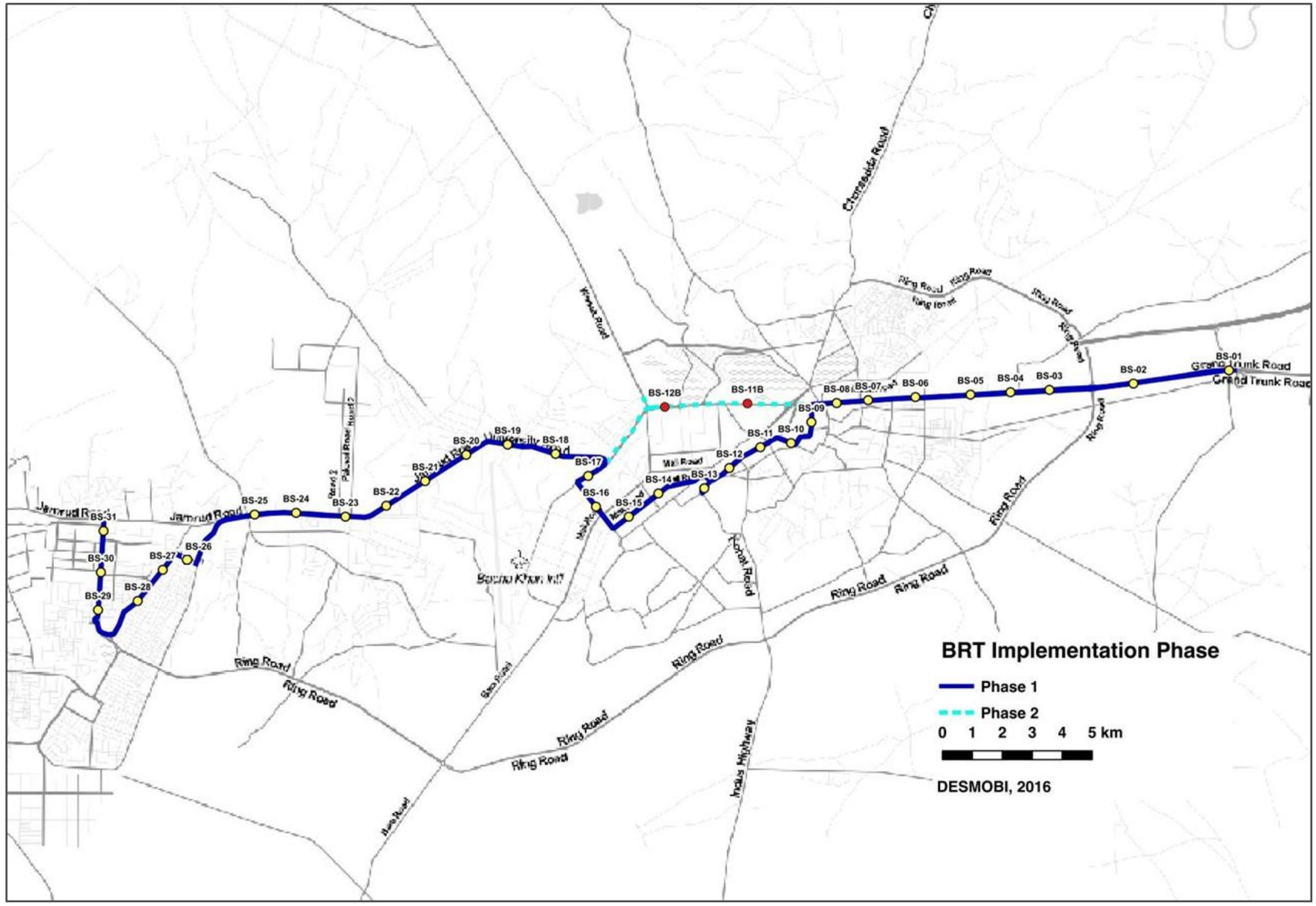
12 Implementation Plan, Summary, Costing & Conclusions

12.1 Implementation Plan

12.1.1 Section Phasing

The Peshawar BRT corridor is proposed for 28.5-kilometer-long, covering the Hospital Road, Saddar Road as well as the Khyber Road. While ideally all 28.5 kilometer need to be built in one phase, we understand that there might be objection over the BRT going through Khyber Road, where currently is treated as high-security zone. Thus, in the implementation plan, this additional 3.85 kilometer BRT corridor with 2 BRT stations will be built once the security clearance is obtained.

Figure 12.1 BRT Implementation Phase



12.1.2 Demonstration Project

To get the public support and understanding of the BRT system in Peshawar, it is important to show some small demonstration to the public. There are many strategies to play on getting this demonstration project brought to public, and the two strategies outline on next page are only the broad examples of the many approaches that can be followed.

The first strategy proposes to penetrate market by advanced procurement of buses prior to the completion of bus lane. Initial operations will see buses mix with general traffic. The second strategy proposes to lay out several demonstration project along with promotional and communication campaigns to raise public awareness and knowledge of the system. We believe the second strategy will be more suitable concerning the implications listed below.

Demonstration Project Model 1: Advanced Procurement of Buses and Initial Operations in Mixed Traffic

- Inefficient operations in mixed traffic can lead to early public distrust
- Rapid deterioration of buses
- Based on first feedback from the on-going tender, risk to enter into contracts which will be incompatible with BRT operations
- Risk of protest from existing operators
- Disruption of services during construction
- Overall counter-productive: High risk, low return, bad image for BRT brand.

Demonstration Project Model 2: Showcase Station, Communication and Public Awareness Campaign

- Do not impair success of the future full BRT system
- Provide high visibility for government of KPK
- Educate public on the features of the BRT system
- Enable easier negotiations with existing operators
- Creates emulation and anticipation for the new system
- Potential financing on grant basis ($2.5 million) from ADB.

The demonstration project strategy for Peshawar BRT will include the following elements:

- Demonstration station in Saddar Road or in Hayatabad
- 7 demonstration BRT vehicles
- Curb-side BRT bus stops
- Map and street signage
- Run pilot service from Saddar/Hayatabad to University
- Free services during initial period

Figure 12.2 Pilot Demonstration Route – Model 2

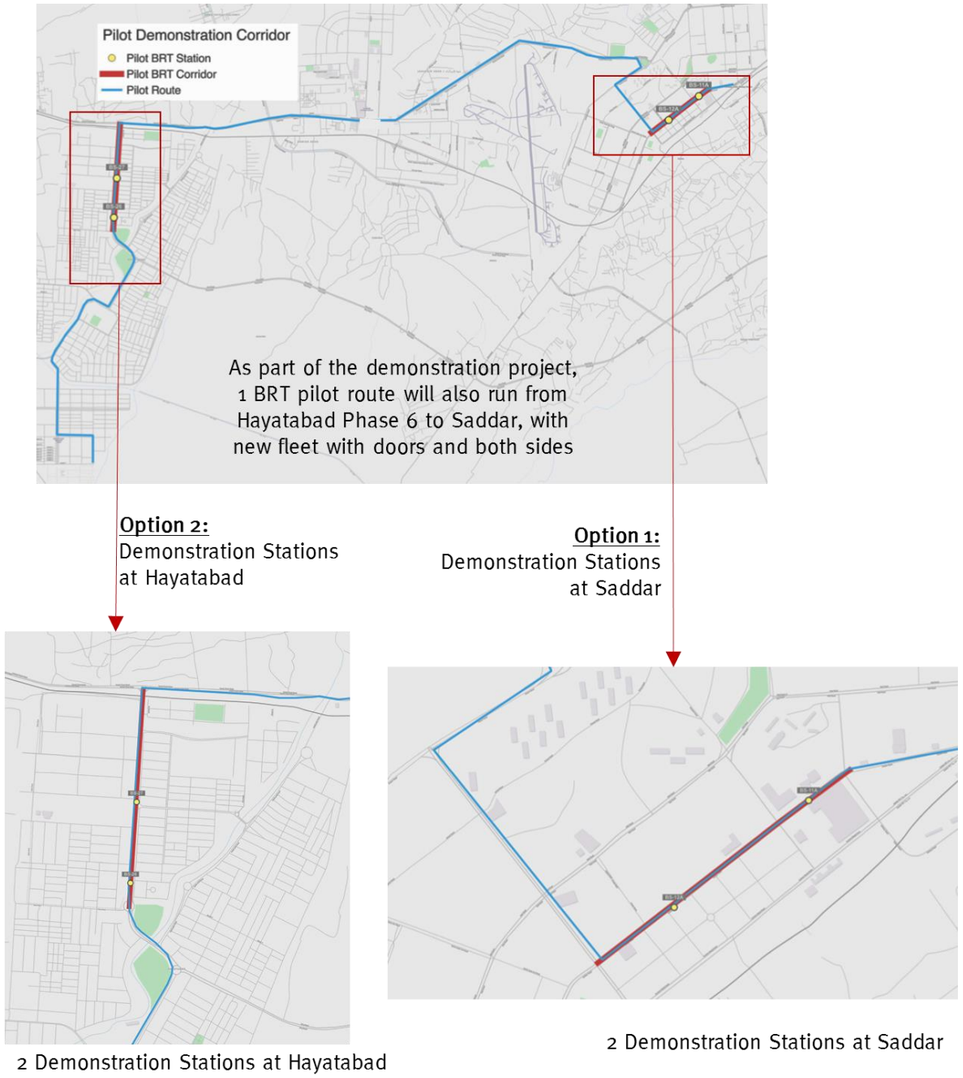


Table 12.1 Project Implementation Timeline

ACTIVITIES	DATE / PERIOD
PPTA - Preliminary engineering design, due diligence, initial operation plan	September 2016
Project Design Advance (PDA) - Detailed engineering design	October 2016 - March 2017
Project Design Advance (PDA) - Procurement of civil works and equipment	January 2017 - August 2017
Relocation of utilities Construction of model stations/service	January 2017 - June 2017
Implementation of the LARP	January 2017 - August 2017
ADB Loan Approval	May 2017
Demonstration project planning Public awareness campaign Ground-breaking ceremony full BRT corridor	June 2017
Construction full BRT corridor	July 2017 - June/October 2018
System opening of full BRT services	**October/December 2018**

12.2 **Costing**

Main Corridor Cost

The initial estimate cost for the main BRT Corridor, which goes via Saddar is PKR 29.07 billion, or USD 276.9 million. With 25.8-kilometer-long, the average cost of BRT on the main BRT corridor is PKR 1.26 billion/kilometer, or USD 10.7 million/kilometer. 75.5% of the direct cost are for the Road Engineering, which involves at-grade, elevated and BRT-only tunnel, as well as pedestrian overpass to access the station. Contingency 3% and price escalation at 6.5% per annum for infrastructure construction. This cost also already includes the cost of Depot, staging facility and control center. The TransPeshawar office building cost is also included in this calculation. The BRT control center room and other important function essential to the BRT operations will be installed in this building.

Table 12.2 Cost Estimates of Main BRT Corridor

Bill No	Description	Amount (Rs.)	Amount (USD)
1.	**Road Works**		
1.1	New Mix Traffic Lane (Asphalt)	754.154.908	7.182.428
1.2	New BRT Lane (Concrete)	886.531.125	8.443.154
1.3	New Side Walk	443.651.295	4.225.250
1.4	New Bike Way	113.344.353	1.079.470
2.	**Elevated BRT**		
2.1	Structures (Elevated BRT)	2.949.874.354	28.094.041
2.2	Structure (RCC Retaining Walls for BRT Elevated)	719.245.646	6.849.959
3.	**Underground BRT**		
3.1	Structure (Under Ground BRT Lane)	2.966.838.614	28.255.606
3.2	RCC Retaining Walls for Under Ground BRT Lane	616.601.386	5.872.394
4.	**Pedestrain Bridges**		
4.1	Pedestrian Bridge (Steel Structure, Escalator, Elevator)	4.357.844.897	41.503.285
5.	**Elevated Bike Lane**		
5.1	Structure (Elevated Bike Lane)	502.174.830	4.782.617
5.2	Structure (RCC Retaining Walls for Elevated Bike Lane)	73.691.407	701.823
6.	**Pedestrain Underpass**		
6.1	Structure (Pedestrian Underpass)	252.082.464	2.400.785
7.	**Elevated U-Turns**		
7.1	Structure (Elevated U-Turns)	1.205.045.440	11.476.623
8.	**BRT Station Shed**		
8.1	Structure (BRT Station Shed)	1.467.766.723	13.978.731
8.2	Structure (Off Corridor Bus Stops)	82.425.000	785.000
9.	**Ancillary Works**		
9.1	New Curb	35.974.603	342.615
9.2	Traffic Signage	14.724.774	140.236
9.3	Pavement Marking	67.875.264	646.431
9.4	Paving Tiles	29.149.085	277.610
9.5	Dismantling works	150.288.285	1.431.317
9.6	Providing and Fixing of BRTS Fencing (Including Painting)	551.475.000	5.252.143
9.7	Pipes (Electricity, Communication and 150mm Dia PVC)	280.554.968	2.671.952
9.8	Greenery	998.469.800	9.509.236
9.9	New drainage along road	56.280.000	536.000

Bill No	Description	Amount (Rs.)	Amount (USD)
10.	**Electric Works**		
10.1	Electrical Work	1.227.644.961	11.691.857
11.	**Fare Collection System**		
11.1	On station BRT ITS System	938.973.456	8.942.604
11.2	Passenger Information	52.080.000	496.000
11.3	Depot, Staging Facilities, Commercial Area, and Park&Ride	1.133.957.304	10.799.593
11.4	TransPeshawar Office	304.500.000	2.900.000
11.5	Smart Card System	126.717.360	1.206.832
11.6	Bike Sharing System	131.901.604	1.256.206
12.	**Parking Plaza**		
12.1	Parking Plaza	1.540.769.230	14.673.993
13.	**Utility Relocation**	500.000.000	4.761.905
14.	**Indirect Cost Expenses**	1.015.736.325	9.673.679
15.	**Contigency**	2.508.868.724	23.893.988
	Total Construction Cost	**29.076.534.145**	**276.919.373**
16.	**Vehicle Procurement Cost**		
	9 Meter Bus*	1.719.375.000	16.375.000
	12 Meter Bus*	6.615.000.000	63.000.000
	Total Cost**	**37.410.909.145**	**356.294.373**

*) The price of bus is not included as part of the project cost. Bus fleet will be procured by private operators.

**) This price is only indicative as buses will not be procured by the government.

Additional Corridor Cost

Additional corridor cost for 5 kilometer of BRT on Khyber road is shown in the table below. It will add another Rs 1.5 billion or USD 13.8 million for this section. The cost per kilometer is significantly higher due to construction of a BRT-only tunnel at Warsak Road/Khyber Road intersection, which will be used to connect Warsak Road to the main BRT corridor, and possibly to connect with future corridor as well.

Table 12.3 Cost Estimates of Additional Section

No	Component	Cost (USD)	Cost (PKR)	%
1.	Road Engineering	**9.611.720**	**953.116.958**	**69.48%**
2.	Greenery	**280.988**	**43.419.333**	**2.03%**
3.	Street Light	**528.778**	**45.444.444**	**3.82%**
4.	Water Drainage	**16.104**	**1.690.920**	**0.12%**
5.	BRT Station Architecture Structure (inside the BRT corridor)	**528.000**	**29.700.000**	**3.82%**
6.	BRT Station power supply and lighting	**252.710**	**27.410.000**	**1.83%**
7.	BRT Station drainage and fire protection	**1.478**	**214.500**	**0.01%**
8.	BRT Station Ventilation and air conditioning	**1.795**	**264.000**	**0.01%**
9.	On-Station BRT ITS System	**325.280**	**34.154.348**	**2.35%**
10.	Passenger Information	**32.000**	**3.360.000**	**0.23%**
11.	Aerial Cable Improvement	**1.160.440**	**124.648.200**	**8.39%**
12.	Project Indirect Cost and Expenses	**601.630**	**63.171.135**	**4.35%**
13.	Project Contingency Reserve	**1.200.252**	**126.026.415**	**8.68%**
	Total	**13.834.479**	**1.452.620.254**	**105.11%**
	Cost/km	**2.766.896**	**290.524.051**	

The Demonstration Project Cost

Table 12.4 Cost Estimates of Additional Section

	Component	Price (PKR)	Price (USD)
A.	**BRT Station at Saddar (1 Station)**		
	BRT Station Architecture Structure and Decoration	52.500.000	500.000
	BRT Station power supply and lighting	10.767.288	102.546
	BRT Station Ventilation and air conditioning	94.248	898
	Bus Lane Separator	118.125	1.125
	Automatic Door	18.117.740	172.550
	Sub Total Station Saddar	**81.597.401**	**777.118**
B.	**BRT Station at Hayatabad (1 Station)**		
	BRT Station Architecture Structure and Decoration	27.720.000	264.000
	BRT Station power supply and lighting	10.767.288	102.546
	BRT Station Ventilation and air conditioning	94.248	898
	Bus Lane Separator	51.975	495
	Automatic Door	9.058.870	86.275
	Sub Total Station Hayatabad	**47.692.381**	**454.213**
C.	**BRT Vehicle**		
	9-meter bus	**44.625.000**	**425.000**
	Sub Total Vehicle	**44.625.000**	**425.000**
D.	**Contingency**	**26.087.217**	**248.450**
	Total Demonstration Project Cost	**200.002.000**	**1.904.781**

12.3 Summary

a. This report shows the Conceptual Plan & Design for Peshawar BRT, complete with Preliminary Engineering Design and Initial Business Model, which is the initial step of implementing BRT in Peshawar.

b. The first BRT corridor in Peshawar will be 30-kilometer-long, starts from Chamkani to Hayatabad. The corridor will pass high demand profile area such as Khyber Bazaar, Shoba Chowk, Saddar Market, University, Board Stop and Hayatabad. Out of the 30 kilometer corridor, 3.85 kilometer will pass Khyber Road, and due to security clearance, this small additional section can be built at the later phase of the project.

c. 77% of the BRT corridor will be at-grade. The elevated section is only built for 3.9-kilometer-long at Railway Road and near Hayatabad. Whereas the BRT-only tunnels will be built on few locations, totaling of 2.7 kilometer long.

d. 8 BRT routes are proposed for the Peshawar BRT, with direct service operation, with daily demand estimated at 473,000 passengers. Most of the demand for BRT are coming from existing public transport service, and some treatment to the existing operators are needed to transition the changes into the BRT.

e. 383 buses are required to accommodate BRT demand, with variation of 9-meter and 12-meter bus types. To ensure BRT run smoothly along the corridor, grade-separation treatments are proposed to separate the BRT movement with U-Turn movement by general traffic.

f. Some of the key design highlights of the Peshawar BRT design are:
    - Multiple sub-stops stations with passing lanes, able to accommodate 4 to 6 buses stopping at the same time on the same direction
    - Designed with almost no conflict between cars and BRT, and dedicated U-Turn for cars and BRT are provided
    - Continuous cycle lane along the corridor, including on the elevated section
    - Followed by pedestrian improvement along corridor
    - Complemented by bike racks and bicycle facilities on most BRT stations

g. If all the design components are applied, Peshawar can be the first Gold BRT system in Pakistan and South Asian region

h. However, the biggest challenge in Peshawar BRT is to take over the existing routes as all of the BRT routes are taken from the existing routes, with few modifications on some sections

i. Few relocation and resettlement work needs to be done, due to impact of pedestrian tunnel market that needs to be demolished in 3 locations, as well as the land acquisition needed for depot and staging facility for BRT

j. To enable a smooth implementation for BRT in Peshawar, a treatment to the existing transporters in Peshawar needs to be made, although in this case, the government would have a stronger bargaining position to negotiate.

k. Whilst 2 depot locations have been proposed, the government needs to start preparing the land, and clearing the area for the construction.

12.4 Next Steps

- Final decision on the land for depot and staging facility needs to be formally made, including create demarcation line to properly secure the land
- Works on utility relocation and shifting also needs to be done quickly, so that by the time the contractors are selected, they can start the mobilization
- The PC-1 document for Peshawar BRT will be done in December, and finalized in January, complete with procurement package, which will be produced separate from this report.
- Communications work to promote the BRT works in Peshawar also needs to happen quickly, to get public buy-in and support, especially during construction period.