FINAL

DETAILED PROJECT REPORT

JAIPUR METRO RAIL PROJECT PHASE-II FROM INDIA GATE TO AMBABARI

Client: Jaipur Metro Rail Corporation Ltd. (JMRC)

Prepared By

Delhi Metro Rail Corporation Ltd.

दिल्ली मैट्रो रेल कोर्पोरेशन लि.

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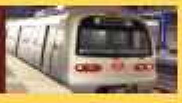

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SALIENT FEATURES

1. GAUGE (NOMINAL): 1435 mm

2. ROUTE LENGTH: 23.51 km (Entirely Elevated)

3. NUMBER OF STATIONS: 21 (All Elevated)

4. TRAFFIC PROJECTION:

YEAR	DAILY RIDERSHIP	AVERAGE LEAD (KM)	MAXIMUM PHPDT
2023	1,20,667	8.37	3,930
2031	2,08,926	8.90	6,993
2041	3,64,200	9.46	12,627
2051	5,95,440	9.64	20,703

5. TRAIN OPERATION:

Particular	2023	2031	2041	2051
Car/Trains	3	3	3	3
Headway (Min)	10.00	7.00	4.0	2.50
Max. PHPDT Demand	3,930	6,994	12,771	20,704
PHPDT Capacity Available	4,584 (5,584)*	6,549 (8,331)*	11,460 (14,580)*	18,336 (23,328)*

* @ 8 persons per square meter of standee area

Year	Headway (min)	No. of Rakes	Rake Consist	No. of Coaches
2023	10.00	12	3 car	36
2031	7.00	15	3 car	45
2041	4.00	26	3 car	78
2051	2.50	41	3 car	123

6.
i. Maximum Design Speed — 90 kmph
ii. Maximum operating Speed — 80 kmph
iii. Scheduled Speed — 33 kmph

7. Traction Power Supply:

a. Traction system voltage — 25 kV AC
b. Current Collection — Over Head Catenary
c. Receiving Sub Stations — One new RSS at Sitapura Depot and Augmentation of existing RSS near Sindhi Camp Station.

Power Demand Estimation (MVA)

Corridor	Load	Year	
		Initial	Ultimate
North - South Corridor: India Gate (SIA) to Ambabari (21 Elevated Stations, 23.51 km)	Traction	3.99	12.66
	Auxiliary	4.45	4.69
	Total	**8.44**	**17.36**

8. ROLLING STOCK:

a. 2.90 m wide rolling stock with Stainless Steel/Aluminium body

b.	Axle load	16 T
c.	Seating arrangement	Longitudinal
d.	Capacity of 3 coach unit With 6 standees / sqm.	764
e.	Class of accommodation	One (Air conditioned)

9. MAINTENANCE FACILITIES:

Maintenance Depot has been proposed at Sitapura Industrial Area on the banks of Dravyavati River. Total land area proposed for maintenance facilities is 27.00 Ha.

10. SIGNALLING, TELECOMMUNICATION AND TRAIN CONTROL:

a) Type of Signalling — 'CATC' (Continuous Automatic Train Control System) based on "CBTC" (Communication based Train Control System) which includes ATO (Automatic Train Operation), ATP (Automatic Train Protection) and ATS (Automatic Train Supervision) sub-systems using radio communication between Track side and Train.

b) Telecommunication —
i. Integrated System with Optic Fibre cable, SCADA, Train Radio, PA system etc.
ii. Train information system, Control telephones and Centralized Clock System.

11. FARE COLLECTION

Automatic Fare collection system with TOM and Smart card etc.

12. STRUCTURE:

i) Viaduct: Segmental Box Girder for the section having road width upto 30m, Double U-Girder for the section having road width more than 30m upto radius 300m and I-Girder for sharper curves (radius less than 300m) and location of Points & Crossings. Superstructure shall be supported on single pier with pile foundation.

ii) Station structure with viaduct columns supporting the girders by a cantilever arm.

13. COST:

i)	Estimated Cost with Land and all Taxes & Duties (At January 2020 prices)	**Rs. 4,133 Crore.**
ii)	Completion Cost with Land and all Taxes & Duties (by November 2023 at 5.0% p.a. escalation) without IDC	**Rs. 4,546 Crore.**
iii)	Completion Cost with Land and all Taxes & Duties (by November 2023 at 5.0% p.a. escalation) with IDC	**Rs. 4,602 Crore.**

14. INDICES:

i)	FIRR	**6.56%**
ii)	EIRR	**14.86%**

EXECUTIVE SUMMARY

0.20 TOD & VCF

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EXECUTIVE SUMMARY

0.1 ASSESSMENT OF EXISTING CITY PROFILE WITH EXISTING TRANSPORT CHARACTERISTICS

0.1.1 Background

Originally the work of preparation of DPR for Jaipur metro was awarded to DMRC in 2009. Accordingly, DPR was submitted in March, 2010. The Proposed Corridor were as under:

Table 0.1: Proposed Corridors in DPR submitted in March 2010

Corridor	Length(km)		Total (km)	Station		Total
	U/G	Ele		U/G	Ele	
Corridor-1: Durgapura to Ambabari	5.095	12.257	17.352	5	13	18
Corridor-2 Mansarovar to Badi Chaupar	2.789	8.777	11.566	3	8	11
Total	**7.884**	**21.034**	**28.918**	**8**	**21**	**29**

Completion Cost at 2018 Price Level was ₹ 7531Cr.

The report submitted in 2010 was revised in April, 2011 and it was decided to extend corridor I upto Sitapura Industrial Area. Accordingly, details of corridors are as under:

Table 0.2: Proposed Corridors in DPR revised in April 2011

Corridor	Length(km)		Total (km)	Station		Total
	U/G	Ele		U/G	Ele	
Corridor-1: Sitapura Industrial Area to Ambabari	5.095	18.004	23.099	5	15	20
Corridor-2: Mansarovar to Badi Chaupar	2.789	9.278	12.067	3	8	11
Total	**7.884**	**27.282**	**35.166**	**8**	**23**	**31**

Completion Cost was Increased to 2019 Price Level = ₹10291Cr.

Meanwhile, it was decided to get implemented the East West corridor from Mansarovar to Chandpole through DMRC on deposit term basis, which has been commissioned in 2013 and remaining underground length of this corridor is being implemented by JMRC through General Consultants and is likely to be commissioned shortly.

In March 2012 it is decided to bifurcate DPR in two parts Corridor 1: Mansarovar to Badi Chaupar as phase I and Corridor II: Sitapura Industrial Area to Ambabari as phase II. Further DPR for Phase II was revised in April, 2014 and July, 2014 in view of passing on Alignment Jaipur Airport Air Funnel and connecting collectorate.

0.1.2 Present Assignment

As original proposal for Phase II was envisaged in 2011, since then a lot of development has occurred along the corridor. Moreover, as per New Metro Rail Policy 2017 some new elements are to be considered while preparing the DPR. Therefore, the DPR prepared in 2011 cannot be taken up for implementation. Hence, JMRC decided for Updation / Review of Detailed Project Report of Jaipur Metro Phase 2 and preparation of DPR for extension of Phase 1B from Badi Chaupad to Ramganj and awarded the assignment to DMRC on 20/06/2019.

0.1.3 Delineation of Study Area

The first and foremost step of a traffic and transportation study for a region is to delineate the influence area which is called as the study area. The study area for the current assignment is the Jaipur Municipal Corporation (JMC) with an area of 467 sq. km.

This study area has been delineated based on the identified MRTS corridors in the CTTS 2018. The identified MRTS corridors as per CTTS 2018 are:

- Manasarovar - Transport Nagar
- Vishwkarma Industrial Area - Sitapura Industrial Area
- Kalwar Road - Kanota (via Gopalpura Bypass)
- Kalwar - Amba Bari
- Jhotwara - Kanota (via Gopalpura Bypass)
- Jhotwara - Kanota (via Durgapura station)
- Kalwar - Sitapura Industrial Area
- Vishwkarma Industrial Area – Kanota (via Gopalpura Bypass)
- Manasarover – Kanota (via Gopalpura Bypass)
- Vishwkarma Industrial Area - Amba Bari
- Amba Bari - Ajmer road
- Ajmer road to B2 Bypass

The above identified corridors are within the JMC area and therefore, JMC area has been considered as the study area. The historic walled city is part of the JMC and is spread over an area of 6.7 sq. km. The walled city (also known as pink city) is characterized by presence of heritage buildings and high commercial activities. It has a high population density of more than 481 persons per hectare (presently, about 580 persons per hectare), while the population density of JMC is 65 persons per hectare.

0.1.4 Regional Connectivity

Jaipur is situated in the eastern part of Rajasthan. The city is at a distance of 260 km from Delhi, 135 km from Ajmer, 225 km from Agra, and 245 km from Kota. Jaipur is located on National Highway 48 (Old NH8) connecting Delhi and Chennai. This is part of the Golden Quadrilateral project which connects four metropolitans Delhi, Mumbai, Chennai and Kolkata. NH52 (Old NH12) links Sangrur, Punjab with Ankola, Karnataka through Jaipur and NH21 (Old NH11) links Jaipur with Agra passing through Jaipur. RSRTC operates bus service to major cities in and out of Rajasthan like Delhi, Agra, Jodhpur, Udaipur, Ahmedabad etc. City buses are operated by Jaipur City Transport Services Limited (JCTSL).

The State Highways passing through the study area that provides connectivity at the State level are SH2C (Kalwar Road), SH12 (Diggi Malpura Road), SH55 (Jamwa Ramgarh Road), SH19 (Jahota Morija Road), SH37 (Chomu-Churu Road), SH24 (Toonga Road) and SH52 (Alwar Road).

Jaipur is the headquarters of north-western zone of the Indian Railways. The city is well connected by railways to the neighbouring cities like Delhi, Agra, and Ahmedabad as well as to the major cities in the country. Jaipur Junction is the major terminal within the study area. Other railway stations within the Jaipur region are:

- Towards Ajmer - Kanakpura, Bindayaka and Dhankya
- Towards Sikar - Dher Ka Balaji, Nindar, Bhaton Ki Gali and Chomu
- Towards Delhi - Gandhi Nagar, Jagatpura, Khatipura, Kanota and Bassi
- Towards Sawai Madhopur - Bais Godam, Durgapura, Sanganer, and Shivdaspura

The city of Jaipur is well connected by air to various metropolitan cities like Delhi, Mumbai, Bangalore, Chennai and Kolkata as well as the other major cities in India; is also connected to various major cities in the world. Jaipur International Airport is located in Sanganer, around 13 km from the city core. The Jaipur airport handled about 4.76 million passengers in 2017-18 whereas 3.78 million passengers in 2016-17 (i.e., about 25.7% of increase in the passengers). Out of 4.76 million passengers in 2017-18, 0.53 million are international passengers and 4.23 million are domestic passengers. Jaipur Airport also provides air cargo services.

0.1.5 Demography

Jaipur Municipal Corporation (JMC) holds a population of around 30.5 lakh as per Census 2011. It has experienced a population growth rate of 31.15% from 2001, which has been declined from 59.25% as observed from the previous decade (1991-2001). The average population density in JMC area is 6,523 persons per sq. km.

0.1.6 Existing Road Network

Total existing vehicular road length within the JMC area is around 1783 km, which includes around 120 km road length within the Walled City. Distribution of vehicular road length by carriageway width within the JMC area shows only 24% road is more than two lane and maximum (38%) road length is single lane. About 62% of Walled City road network has single lane carriageway, 17% has intermediate lane, 13% has 2-lane carriageway and only 8% has 4-lane carriageway. Only 21% of road length within JMC area and only 7% of road length within the Walled City have divided carriageway.

0.1.7 Existing Intra-City Public Transport

The city public transport system in Jaipur consist of government buses, mini buses, metro and Bus Rapid Transit System (BRTS). The government buses are being operated by Jaipur City Transport Services Limited (JCTSL) on contractual basis with RSRTC and private operators whereas mini-buses are being operated by only private agencies. Jaipur Metro is operated by Jaipur Metro Rail Corporation Limited and BRTS is being operated by JDA/ JMC through JCTSL.

0.1.8 Existing Intermediate Public Transport

The IPT scenario in Jaipur consists of the following modes – auto rickshaws, share autos/ tempos and E-rickshaws. Total 4,140 permits for diesel auto rickshaws and 11,595 permits for LPG auto rickshaws issued in Jaipur city. There are around 400 e-rickshaws in Jaipur. The fare structure of e-rickshaws is a simple slab structure with Rs.5/- for 1-2 km, Rs.10/- for 2-3 km and Rs.30/- for 3-6 km of trip length.

0.2 TRAVEL CHARACTERISTICS AND DEMAND ESTIMATES

0.2.1 Option Evaluation

For assessment of alternative MRTS corridor demand, different combinations of MRTS corridors have been considered along the selected demand corridors. These combinations of MRTS corridors are mentioned as alternative options. Mass rapid transit demand for each alternative option has been evaluated for the selection of suitable MRTS corridors in Jaipur. These alternative options are mentioned below:

1. Option-1:
   - Corridor 1: Sitapura Industrial Area to Mansarovar
   - Corridor 2 : Mansarovar to Transport Nagar
2. Option-2:
   - Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road)
   - Corridor 2 : Mansarovar to Transport Nagar
3. Option-3:
   - Corridor 1: Sitapura Industrial Area to Ambabari (on JNL Marg)
   - Corridor 2: Mansarovar to Transport Nagar
4. Option-2A:
   - Corridor 1: Manpur(Ring Road) to Harmada (on Tonk Road)
   - Corridor 2: Mansarovar to Transport Nagar
5. Option-3A:
   - Corridor 1: Manpur(Ring Road) to Harmada (on JNL Marg)
   - Corridor 2: Mansarovar to Transport Nagar
6. Option-4:
   - Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road)
   - Corridor 2: Mansarovar to Badi Chaupar
7. Option-5:
   - Corridor 1: Sitapura Industrial Area to Ambabari (on JLN Marg)
   - Corridor 2: Mansarovar – Badi Chaupar
8. Option-6:
   - Corridor 1: Ambabari – Sitapura Industrial Area to Ambabari (on Tonk Road) without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle
   - Corridor 2: Mansarovar – Transport Nagar

9. Option-7:
   - Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) within air funnel zone on Tonk Road
   - Corridor 2: Mansarovar – Transport Nagar
10. Option-7A:
    - Corridor 1: Manpur (Ring Road) to Harmada (on Tonk Road) within air funnel zone on Tonk Road
    - Corridor 2: Mansarovar – Transport Nagar
11. Option-8:
    - Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) within air funnel zone
    - Corridor 2: Mansarovar to Transport Nagar
    - Corridor 3: Sanganer Thana to Mansarovar
12. Option-8A:
    - Corridor 1: Manpur (Ring Road) to Harmada (on Tonk Road) within air funnel zone
    - Corridor 2: Mansarovar to Transport Nagar
    - Corridor 3: Sanganer Thana to Mansarovar
13. Option-9:
    - Corridor 1: Sitapura Industrial Area to Ambabari (partly on JLN Marg and partly on Tonk Road)
    - Corridor 2: Mansarovar to Transport Nagar
14. Option-9A:
    - Corridor 1: Manpur (ring Road) to Harmada (partly on JLN Marg and partly on Tonk Road)
    - Corridor 2: Mansarovar to Transport Nagar
15. Option-10:
    - Corridor 1: Sitapura Industrial Area to Ambabari (partly on JLN Marg and partly on Tonk Road)
    - Corridor 2: Mansarovar – Transport Nagar
    - Corridor 3: Mansarovar – Sanganer Thana
16. Option-10A:
    - Corridor 1: Manpur (Ring Road) to Harmada (partly on JLN Marg and partly on Tonk Road)
    - Corridor 2: Mansarovar – Transport Nagar
    - Corridor 3: Mansarovar – Sanganer Thana
17. Option-11: Mansarovar – Badi Chaupar

Among the above mentioned 17 options, the last option (Option-11) is a do-nothing option in terms of future MRTS development in Jaipur. Therefore, this option is not for option evaluation and system selection for future proposed MRTS in Jaipur.

From rest of the 16 options Option-7, Option-7A, Option-8 and Option-8A have the highest demand for respective configuration. However, all these four options are with MRTS alignment within air funnel zone on the Tonk Road. Due to limited ROW available on the Tonk Road, proposed MRTS should be elevated or underground on Tonk Road. Underground corridor is difficult to execute for construction limitations and elevated option is not feasible due to restriction of air funnel zone. Therefore, these four options are not considered as feasible options.

Estimated demands for Option-1, Option-4 and Option-5 are very low and therefore these three options are not viable for proposed MRTS corridors in Jaipur.

Option-2 and Option-2A are the revised configurations of Option-9 and Option-9A. Option-9 and Option-9A have higher demand than Option-2 and Option-2A. However, Option-9 and Option-9A have higher corridor length and therefore, have lower demand per km. Therefore, Option-9 and Option-9A are not viable option for proposed MRTS in Jaipur.

Option-10 and Option-10A are the longer configurations (extended network) of Option-9 and Option-9A with additional corridor from Mansarovar to Sanganer Thana connecting the existing phase-1 corridor and proposed corridor on Tonk Road. Therefore, due to similar reason of lower demand per km, Option-10 and Option-10A are also not viable for proposed standalone MRTS configuration in Jaipur. However, the corridor from Mansarovar to Sanganer Thana can be considered as separate corridor along with other viable configuration.

After a detailed evaluation mentioned above, it is concluded that Option-2, Option-3, Option-2A, Option-3A and Option-6 are the viable options for proposed MRTS in Jaipur. Option-2A and Option-3A are the longer configurations (extended network) of Option-2 and Option-3. Therefore, Option-2A and Option-3A are not considered as separate options from Option-2 and Option-3. Further, Option-6 is the improved alignment of Option-2 with ease of construction avoiding some limited ROW section. Therefore, Option-6 is the more viable option in comparison of Option-2.

0.2.2 Suitable Option for Proposed Metro

From the option evaluation section it is clear that Option-2A and Option-3A are the extended network of Option-6 and Option-3. Analysing the detailed ridership of Option-2A and Option-3A, it is suggested to develop the extended part (which are same for both of these options) as metro system beyond 2041 due to insufficient ridership for metro system for these extended parts till the time.

Further, Option-6 has better ridership than Option-3 and the corridor from Mansarovar to Sanganer Thana is not viable for metro like system from demand perspective. Therefore, Option-6 has been selected for immediate development as suitable option for metro like system.

0.2.3 Corridor Brief for Option-6

Option-6 is detailed out as combination of two metro corridors – one is the extension of existing phase-1 corridor which is considered as east-west corridor and the other is the new north-south corridor. East-west corridor is called as Mansarovar-Transport Nagar corridor with total 13 stations. Within these 13 stations, 11 stations are for phase-1 (Mansarovar-Badi Chaupar) corridor. North-south corridor is called as Ambabari – Sitapura Industrial Area corridor with 21 stations. These two corridors intersect each other at Chandpole station. North-south corridor is planned on Tonk Road without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle.

0.2.4 Ridership Details for Optimistic Scenario in Option-6

Corridor (line)-wise ridership summary estimated for Master Plan (optimistic) scenario at an aggregated network level including daily ridership, peak hour peak direction traffic (PHPDT), daily passenger-km and average trip length is given below:

Table 0.3: Proposed Jaipur Metro Phase-2 Ridership Summary (Line Wise) for Master Plan (Optimistic) Scenario

Target Year	Corridor	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger Kilometres (km)	Average Trip Length/ Passenger Lead (km)
2021	Mansarovar - Transport Nagar	68,504	1,920	2,99,716	4.38
2021	Ambabari - India Gate (SIA)	98,602	3,161	7,97,057	8.08
2023	Mansarovar - Transport Nagar	82,495	2,311	3,59,877	4.36
2023	Ambabari - India Gate (SIA)	1,20,667	3,930	10,09,490	8.37
2031	Mansarovar - Transport Nagar	1,38,459	3,995	6,00,524	4.34
2031	Ambabari - India Gate (SIA)	2,08,926	6,993	18,59,223	8.90
2041	Mansarovar - Transport Nagar	2,23,392	6,979	9,49,623	4.25
2041	Ambabari - India Gate (SIA)	3,64,200	12,627	34,43,590	9.46
2051	Mansarovar - Transport Nagar	4,01,776	12,523	17,93,822	4.46
2051	Ambabari - India Gate (SIA)	5,95,440	20,703	57,41,401	9.64

0.3 SYSTEM AND TECHNOLOGY SELECTION

The choice of a particular MRTS will depend on a variety of factors like demand, capacity, cost and ease of implementation. A BRT or LRT systems at grade may require linear pathway to be carved out of existing land if additional space cannot be made available on the sideways and will reduce the space for other traffic depending on the width of existing roads. LRTs and Tramways without horizontal separation will have reduced speed and hence reduced capacity. The capacity of MRTS is generally denoted by passengers per hour per direction (PPHPD). A BRTS typically has a capacity of 10,000-15,000 PPHPD on a single lane but can be enhanced with additional lanes. Comparatively metro rail systems are able to carry much higher passenger volumes of 60,000 PPHPD and can go up to 80,000. Such rail-based systems also generally provide rapid service, a higher quality ride and service regularity due to grade separation. Metro Rail System may be designed for PPHPD demand varying from 25,000 to 80,000.

0.3.1 Selection of Mode

Selection of a particular mode for any pre-determined traffic corridor depends mainly on traffic demand level of a corridor, Right of Way (ROW) on the road and the capacity of the mode. The demand forecast is estimated considering the traffic growth for about 30 years. Other considerations in mode choice are location of building lines, possibility of increasing ROW. Cost of some mode may vary depending upon the location in view of engineering constraints. Therefore, final choice of mode to be adopted for a particular corridor is based on techno economic considerations. As regards the location of a particular mode like at-grade, elevated and underground, depends upon the ROW. If ROW is 20 m or more, elevated alignment is preferred over underground as the cost of underground alignment is 2-2½ times of elevated alignment. Normally rail based MRT corridors are not considered at grade as that separates the city into two parts and providing cross passes for pedestrians and vehicular traffic at various locations is neither cost effective nor desirable from convenience point of view of public.

A detailed analysis of traffic demand forecast is carried out for various permutations and combinations of MRTS corridors to select most eligible corridors as described in chapter 2. The final network of MRT corridors has been selected after discussions with all stake holders of the project. The estimated traffic demand and other requirements like land availability and ease of construction for different options. The selected corridors' option is as under.

Option-6:

Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle

Corridor 2: Mansarovar – Transport Nagar

The PPHPD and average trip length on India Gate (SIA) - Ambabari Corridor are 20703 and 9.64 km respectively in year 2051. Options of technology are:

- BRT
- Metro Neo
- LRT
- Monorail
- Metrolite
- Light Capacity Metro Rail

As PPHPD demand is more than 20,000. Therefore, BRT and Metro Neo are out of consideration. Similarly, LRT also cannot be considered as viable option as ROW of the corridor is not sufficient to accommodate LRT at grade. Monorail system cannot be recommended due to following reasons.

- Technology is not proven.
- It has comparatively high maintenance cost due to wear and tear of rubber

tyres.

- Problems in emergency evacuation thus posing disaster management problems.
- Total dependence on Rolling Stock supplier. No indigenous production of Rolling Stock. Total dependence on manufacturer of spares.
- It has poor ride quality as compared to metro.
- Rolling Stock cannot be purchased from another manufacturer without changing the guide beams.
- Higher Life Cycle Cost

Metrolite may provide adequate capacity only upto 2041 as PPHPD demand is 2051 is 20703. Hence, even if Metrolite is provided now, its upgradation will be necessary before we reach 2051. Moreover, there are indications from Metrolite Rolling Stock manufacturers that cost of Metrolite Rolling Stock will be much higher as compared to regular metro coaches for the same capacity.

Hence, in view the above, it is recommended to adopt a stable, tested and reliable Metro technology i.e. Light Capacity Metro Rail System capable to cater the PPHPD demand upto 30,000, with conventional Rolling Stock but with cost cutting features of the Metrolite. There will be no concourse and arrangement for frisking of the passengers for security at the stations.

0.4 GEOMETRIC DESIGN PARAMETERS AND ALIGNMENT DESCRIPTION

0.4.1 General

0.4.1.1 The geometrical design norms are based on international practices adopted for similar metro systems with standard gauge on the assumption that the maximum permissible speed on the section is limited to 80kmph. Planning for any higher speed is not desirable as the average inter-station distance is kept close to one km and trains will not be able to achieve higher speed.

Desirable minimum horizontal curve radius specified is 200 m but in extreme cases it can be reduced to 120 m. Minimum curve radius at stations is specified as 1000 m.

Vertical curves are proposed at every change of grade. Radii of vertical curves are 2500 m desirable and 1500 m minimum.

The viaduct carrying the tracks will have a vertical clearance of minimum 5.5 m above road level.

0.4.1.2 Gradients

Normally stations should be on a level stretch. In limiting cases, stations may be on a grade of 0.1%. In this corridor all stations are on level gradient.

Between stations, normally grades may not be steeper than 2.0%. However, where existing road gradients are steeper than 2%, gradients up to 4% (compensated) can be provided in short stretches on the main line.

0.4.1.3 Design Speed

Design speed has been proposed as 90 kmph and maximum operating speed 80 kmph. The scheduled speed has been taken as 33kmph.

0.4.2 Track Structure

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations.

Two types of track structures are proposed for any Metro. The normal ballasted track is suitable for At-Grade (surface) portion of Main Lines and in Depot (except inside the Workshops, inspection lines and washing plant lines). The ballastless track is recommended on viaducts as the regular cleaning and replacement of ballast at such location will not be possible. Only in case of the depot, normal ballasted track is proposed for adoption.

Rail Section

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section. Since main lines will have sharp curves and steep gradients, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T- 12-2009. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the grade of rails should be 880, which can be easily manufactured indigenously.

0.4.3 Alignment

- First station on this Corridor is India Gate (SIA) and last station is Ambabari.
- Chainage of India Gate (SIA) station is considered as 0.0 for reference and dead-end chainage of this station is kept as (-) 350m.
- Total length of the corridor from dead end to dead end is 23.51km. The entire corridor proposed is elevated.
- Twenty-one stations have been proposed on this corridor. Names of stations are India Gate(SIA), Kumbha Marg, Haldi Ghati Gate, Pinjra Pole Gaushala, Sanganer Sethu, B2 Bypass Circle, Durgapura, Mahaveer Nagar, Dev Nagar, Gandhi Nagar, Tonk Phatak, Ram Bagh Circle, Narayan Singh Circle, SMS Hospital, Ashok Marg, Government Hostel, Chandpole, Collectorate, Subhash Nagar, Panipech And Ambabari. Attempt has been made to locate stations at about a kilometer apart. However due to various considerations such as ridership, accessibility, availability of land, design considerations etc; few stations could not be located at one km distance apart. The maximum and minimum inter station distances are 2483.011m and 676.801m respectively. Depot for this corridor has been planned at Sitapura.

- This corridor runs in South to North direction. It connects different areas of the city like Sitapura Industrial Area, Shatabdi Nagar, Pratap Nagar, Sanganer, Sitabari, Bapu Nagar, Rambagh, C Scheme, Chandpole, Bani Park, Sirampura, Ambabari, Prominent hospitals like SMS Hospital, Apollo Spectra, Zanana and also connects Jaipur International Airport.

0.4.4 Station Locations

- Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport such as Railway Stations, Bus Terminals, etc. However effort has also been made to propose station locations, such that inter station distances are as uniform as possible. The average spacing of stations is close to one km.

- All stations will be two level stations but without concourse. At lower level there will be a Foot Over Bridge (FOB), providing un-paid connection between left and right side of the road. The FOB will also comprise of passenger facilities and station facilities like ticketing, etc. Platforms along with AFC gates will be provided on the higher level.

0.4.5 Terminals

- **India Gate (SIA) Terminal**
  This Station is proposed along the road median (on Tonk Road) in Sanganer area, near Sanganer Sadar Police Station. Scissors crossovers are proposed at the rear end of station.

- **Ambabari Terminal**
  This Station is proposed on right edge of Sikar Road/Jhotwara Road in Vidyadhar Nagar area. Scissors crossovers are proposed at the front end of the station.

0.4.6 Scissors Crossovers

Scissors Crossovers will be provided at both the terminal stations. In between, crossovers are proposed at Kumbha Marg, Mahaveer Nagar, Ram Bagh Circle and Collectorate station.

0.4.7 Depot

It is proposed to provide a depot on land identified at Sitapura Industrial Area on the banks of Dravyavati River. Total area for depot land will be 27 Ha.

0.5 CIVIL ENGINEERING

It deals with civil structure, geotechnical investigation, construction methods, land requirements, utility services and traffic diversion during construction etc.

0.5.1 Viaduct–Elevated Structure:

The proposed Viaduct Structure is fully elevated. Generally four types of Superstructure are used for construction of elevated section of Metro Corridor, i.e. (i) Segmental Box Girder, (ii) Segmental U Girder, (iii) I Girder and (iv) Double U Girder, depending upon characteristic of the corridor such as traffic congestion on roads, available working space, etc.

In case of this corridor of Jaipur Metro, it is recommended to use Segmental Box Girder for the section having road width upto 30m and for the section having road width more than 30m, it is recommended to use Double U-Girder upto radius 300m. For Radius less than 300 m and at locations where point and crossing are to be provided, it is suggested to use I-Girder.

0.5.2 Grade of Concrete

It is proposed to carry out construction work with 'Design mix concrete' through computerized automatic Batching Plants with following grades of concrete for various members considering the design requirements and durability.

i)	Piles	-	M -35
ii)	Pile cap and open foundation	-	M -35
iii)	Piers	-	M -40
iv)	All precast element for viaduct and station	-	M -45
v)	Cantilever piers and portals	-	M -45/M -60
vi)	Other miscellaneous structure	-	M -30

For all the main structures, permeability test on concrete sample is recommended to ensure impermeable concrete.

0.5.3 Geo-Technical Investigations

Fresh Geotechnical Investigation has not been carried out for this corridor. The geotechnical data available in the DPR prepared in 2009 for this corridor has been used.

0.5.3.1 Recommendations

The top soil is generally silty sand with gravels having variable thickness.

Sub soil/ Rock Profile:

Profile was drawn for each bore hole covered in the scope of geotechnical investigation. Based on sub soil profile pile foundation have been considered for piers.

Foundation in soil:

A foundation must have an adequate depth to avoid adverse environmental influence.

Allowable Bearing pressure:

Considering the proposed structure and taking in to account "N" values are allowable settlement of 25 mm has been adopted.

0.5.4 Utility Diversions

Large number of sub-surface, surface and over head utility services viz. sewers, water mains, storm water drains, telephone cables, O.H electrical transmission lines, electric poles, traffic signals, etc. are existing along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions or by supporting in position. Since these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance. Meticulous planning therefore will have to be taken in tackling the issue of protection/diversion of these utility services. Accordingly, the following engineering items have been studied in details in the chapter:

i) Existing utilities and planning for their diversion during construction, if necessary.

0.5.5 Land

In order to minimise land acquisitions and to provide good accessibility from either directions, the metro alignments are located mostly along the road, which lie on the corridor. But, at some locations the geometrics of the roads especially at road turnings may not match with geometric parameters required for metro rail systems. In such cases, either the alignment will be off the road or some properties abutting the road would get affected. Further, some land is required for various purposes as detailed below.

Land Requirement for following Major Components

- MRTS Structure (including Route Alignment), Station Building, Platforms, Entry/Exit Structures, Traffic Integration Facilities, Depots, etc.
- Receiving/Traction Sub-stations
- Radio Towers
- Temporary Construction Depots and work sites.
- Staff quarters, office complex and operation control center(OCC)

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0.5.5.1 Summary of Land Requirements

Abstract of land requirements for different components of this corridor is given in **Table 0.4 and Table 0.5**.

Table 0.4 Summary of Permanent Land Requirement (All figures in Sq. m)

S. No.	Description	Govt.	Pvt.	Total
1	Stations	4129	659	4788
2	Running Section	13811	79541	93352
3	Depot	0	270000	270000
4	Staff Quarter	0	0	0
5	Office Complex and OCC	0	0	0
6	RSS	0	0	0
	Total (Area in sq m)	**17940**	**350200**	**368140**

Total Permanent Land = 36.814 ha
Permanent Land (Govt.) = 1.794 ha
Permanent Land (Pvt.) = 35.02 ha

Table 0.5- Summary of Temporary Land Requirement

S. No.	Description	AREA (m^2)	OWNER-SHIP
1	Temporary Office/ Site Office	8000	Government
2	Segment Casting Yard	80000	Government
	Total	**88000**	

Total land required for temporary acquisition is **8.8 ha,** which is assumed that it will be government land.

0.5.6 Safety & Security Systems

This chapter lays down the standards and requirements for safety & security, arising out of fire and unauthorized entry into premises. The system will be designed and installed for safe transportation of passengers & premises safety in Metro Railway System.

0.5.6.1 Requirements

i. The System shall protect the passengers against the fire in train services and at the premises of Metro Railway.
ii. The system shall protect vulnerable premises from fire.
iii. The system shall be able to detect the unauthorized entry and exit at nominated places.
iv. The system shall include
   - Fire alarm system.
   - Fire Hydrant and Sprinkler System.
   - Fire Extinguishers.
   - Closed circuit television with video analytics.
   - Security Gates – Metal Detector.
   - Baggage Scanner.

0.6 STATION PLANNING

The proposed Corridor of Jaipur Metro Phase II has 21 Elevated stations covering a distance of 23.51km. Almost all the stations of this corridor are located on or beside the road. This Corridor comprises 21 stations.

The locations of stations are defined so as to serve passenger requirements and to enable convenient integration with other modes of transport. Efforts have been made to propose stations at a uniform inter-station distance wherever possible. Average inter-station distance is 1.153 km, though it varies from 0.677 km to 2.483 km due to land-use and topographic reasons.

0.6.1 Planning and Design Criteria for Stations

1. The stations can be divided into public and non-public areas (those areas where access is restricted). The public areas can be further subdivided into paid and unpaid areas.

2. The platform level has adequate assemble space for passengers for both normal operating conditions and a recognized abnormal scenario.

3. The platform level at elevated stations is determined by a critical clearance of 5.5m under the concourse above the road intersection, allowing 3.4m for the system rooms height, about 0.8m for concourse floor and 0.8 m for structure of tracks above the concourse. Further, the platforms are 1.09-m above the tracks. This would make the rail level in an elevated situation at least 10.2 meters above ground.

4. The mid level of the station provides FOB connection for the unpaid connectivity between both sides of the road. Automatic fare collection system is provided on the platform level which divides the platform in paid and unpaid areas. The "Unpaid Area" is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the "Paid Area" (here only platform area), which provides access to the train.

5. The arrangement of the concourse (here FOB and a small system room space) has easy access on these stations. Stairs, Ticket machines and AFC gates are positioned to minimize cross flows of passengers and provide adequate circulation space.

6. Sufficient space for queuing and passenger flow has been allowed at the AFC gates.

7. Station entrances are located with particular reference to passenger catchment points and physical site constraints allowing for required right-of-way in order to provide a minimum of lane width under the station building on either side of the median.

8. The DG set, Bore Well, Pump House and Underground Water Tanks would be located generally in one area on ground within the Entry / Exit structures.

9. The system is being designed to maximize its attraction to potential passengers and the following criteria have been observed:
   - Minimum distance of travel to and from the platform and between platforms for transfer between lines.
   - Adequate capacity for passenger movements.
   - Convenience, including good signage relating to circulation and orientation.
   - Safety and security, including a high level of protection against accidents.

10. Following requirements have been taken into account:
    - Minimum capital cost is incurred consistent with maximizing passenger attraction.
    - Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.
    - Flexibility of operation including the ability to adapt to different traffic conditions changes in fare collection methods and provision for the continuity of operation during any extended maintenance, repair period, etc.

- Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.
- Provision of display of passenger information and advertising.

11. The numbers and sizes of staircases/escalators are determined by checking the capacity against AM and PM peak flow rates for both normal and emergency conditions such as delayed train service, fire etc.

12. In order to transfer passengers efficiently from street to platforms and vice versa, station planning has been based on established principles of pedestrian flow and arranged to minimize unnecessary walking distances and cross-flows between incoming and outgoing passengers.

13. Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit).

0.6.2 Sequence of Stations

The sequence of stations along with their respective chainages, site and platform characteristics are presented in the Table 0.6.

Table 0.6 Station Sequence with characteristics

S. No.	Station Name	Chainage (m)	Inter-station Distance	REMARKS
	DEAD END	-350.000		
1	INDIA GATE(SIA)	0.000		SIDE PLATFORMS
2	KUMBHA MARG	1599.564	1599.564	SIDE PLATFORMS
3	HALDI GHATI GATE	2439.871	840.307	SIDE PLATFORMS
4	PINJRA POLE GAUSHALA	3357.734	917.863	SIDE PLATFORMS
5	SANGANER SETHU	5431.316	2073.582	SIDE PLATFORMS
6	B2 BYPASS CIRCLE	7914.327	2483.011	SIDE PLATFORMS
7	DURGAPURA	9219.655	1305.328	SIDE PLATFORMS
8	MAHAVEER NAGAR	9984.491	764.836	SIDE PLATFORMS
9	DEV NAGAR	11028.593	1044.102	SIDE PLATFORMS
10	GANDHI NAGAR	11705.394	676.801	SIDE PLATFORMS
11	TONK PHATAK	12819.654	1114.260	SIDE PLATFORMS
12	RAM BAGH CIRCLE	14363.115	1543.461	SIDE PLATFORMS
13	NARAYAN SINGH CIRCLE	15069.586	706.471	SIDE PLATFORMS
14	SMS HOSPITAL	16085.106	1015.520	SIDE PLATFORMS
15	ASHOK MARG	17516.843	1431.737	SIDE PLATFORMS
16	GOVERNMENT HOSTEL	18332.952	816.109	SIDE PLATFORMS
17	CHANDPOLE	19372.919	1039.967	SIDE PLATFORMS
18	COLLECTORATE	20252.507	879.588	SIDE PLATFORMS
19	SUBHASH NAGAR	21382.664	1130.157	SIDE PLATFORMS
20	PANIPECH	22223.813	841.149	SIDE PLATFORMS
21	AMBABARI	23060.000	836.187	SIDE PLATFORMS
	Dead End	23160.000		

0.6.2 Typical Elevated Station

The stations are generally located on the road median. Total length of the station is ~80 m. All the stations are two-level stations. The Technical room area with unpaid FOB connection is planned at one side of the platform with staircases leading from either side of the road. The maximum width of the station at concourse is ~14.5-m. Passenger facilities like ticketing, information, etc. as well as Technical room area is provided at the FOB level.

All the stations are at the median of the road except one station i.e. Ambabari which is at one side of the road. Minimum vertical clearance of 5.5-m has been provided under the concourse above the road. Platforms are at a level of about 11.2 meters from the road. To reduce physical and visual impact of the elevated station, stations have been designed as cantilevered structures with single column located at the central verge of the road.

With respect to its spatial quality, an elevated Metro structure makes a great impact on the viewer as compared to At-grade or underground station. The positive dimension of this impact has been accentuated to enhance the acceptability of an elevated station and the above ground section of tracks. Structures that afford maximum transparency and are light looking have been envisaged. A slim concrete form is proposed, as they would look both compatible and modern high-rise environment as well as the lesser-built, low-rise developments along some parts of the metro corridors.

Platform roofs, that can invariably make a structure look heavy, have been proposed to be of steel frame with sleek Galvalume Sheets to achieve a light look. Platforms would be protected from the heat and rains by providing slopped overhang of the roof and sidewalls are avoided, thereby enhancing the transparent character of the station building.

It is proposed to install solar panels on the station roof to reduce energy demand of the station and to recharge the entire Rain water of the station and the viaduct for recharging the Underground aquifers.

0.7 TRAIN OPERATION PLAN

The underlying operation philosophy is to make the Metro System more attractive and economical, the main features being:

- Selecting the most optimum frequency of Train services to meet sectional capacity requirement during peak hours on most of the sections.
- Economical & optimum train service frequency not only during peak period, but also during off-peak period.
- Optimization of train's reliability for achieving best possible availability on line.
- A train consists of 3 coaches with high frequency service.
- Multi-tasking of train operation and maintenance staff.

List of stations for Jaipur Metro Corridor (India Gate (SIA) to Ambabari) is given below:

Table 0.7 -List of Stations

S. No.	Station Name	Chainage(m)	Inter Distance	Station Type
1	India Gate (SIA)	0.000		Elevated
2	Kumbha Marg	1599.564	1599.564	Elevated
3	Haldi Ghati Gate	2439.871	840.307	Elevated
4	Pinjra Pole Gaushala	3357.734	917.863	Elevated
5	Sanganer Sethu	5431.316	2073.582	Elevated
6	B2 Bypass Circle	7914.327	2483.011	Elevated
7	Durgapura	9219.655	1305.328	Elevated
8	Mahaveer Nagar	9984.491	764.836	Elevated
9	Dev Nagar	11028.593	1044.102	Elevated
10	Gandhi Nagar	11705.394	676.801	Elevated
11	Tonk Phatak	12819.654	1114.260	Elevated
12	Ram Bagh Circle	14363.115	1543.461	Elevated
13	Narayan Singh Circle	15069.586	706.471	Elevated
14	SMS Hospital	16085.106	1015.520	Elevated
15	Ashok Marg	17516.843	1431.737	Elevated
16	Government Hostel	18332.952	816.109	Elevated
17	Chandpole	19372.919	1039.967	Elevated
18	Collectorate	20252.507	879.588	Elevated
19	Subhash Nagar	21382.664	1130.157	Elevated
20	Panipech	22223.813	841.149	Elevated
21	Ambabari	23060.000	836.187	Elevated

0.7.1 Salient Features

- Running of services for 19 hours of the day (5 AM to Midnight) with a station dwell time of 30 seconds.
- Make up time of 5-10% with 8-12% coasting.
- Scheduled speed for this corridor has been considered as 33 kmph.

0.7.2 Train Formation

To meet the above projected traffic demand, the possibility of running trains with composition of 3 cars in year 2023, 2031, 2041 and 2051 with different headway has been examined.

The basic unit of 3-car train comprising of DMC-TC-DMC configuration has been selected for this corridor for the year 2023, 2031, 2041 & 2051.

Composition

DMC : Driving Motor Car
TC : Trailer Car
DMC : Driving Motor Car
3-car train composition: DMC+TC+DMC

Capacity (@ 6 passengers per square meter of standee area)

Driving Motor Car (DMC) - 247 (43 seated + 204 standing)
Trailer Car (TC) - 270 (50 seated + 220 standing
3 Car Train - 764 (136 seated + 628 standing)

The PHPDT capacity provided on this corridor in different years of operation is given in Table 0.8:

Table 0.8 - PHPDT Capacity Provided

Particular	2023	2031	2041	2051
Car/Trains	3	3	3	3
Headway(min)	10.00	7.00	4.0	2.50
Max. PHPDT Demand	3,930	6,994	12,771	20,704
PHPDT Capacity available	4,584 (5,584)*	6,549 (8,331)*	11,460 (14,580)*	18,336 (23,328)*

* @ 8 persons per square meter of standee area

0.7.3 Year-Wise Rake Requirement

Based on Train formation and headway as given above to meet Peak Hour Peak Direction Traffic Demand, Rake requirement has been calculated and has been tabulated below in Table 0.9:

Table 0.9 - Year wise Rake requirement

Year	Headway (min)	No. of Rakes	Rake Consist	No. of Coaches
2023	10.00	12	3 car	36
2031	7.00	15	3 car	45
2041	4.00	26	3 car	78
2051	2.50	41	3 car	123

0.8 MAINTENANCE DEPOT

One Depot-Cum-Workshop is proposed for this corridor at Sitapura.

0.8.1 Depot- Cum- Workshop

It is proposed to establish one depot- cum- workshop with following functions:

(i) Major overhauls of all the trains.
(ii) All minor schedules and repairs.
(iii) Lifting for replacement of heavy equipment and testing thereafter.
(iv) Repair of heavy equipments.

The Depot planning is based on following assumptions:

(i) Enough space should be available for establishment of a Depot- Cum-workshop.
(ii) All inspection lines, workshop lines, stabling lines are designed to accommodate one train of 3- Car.
(iii) All Stabling lines are designed to accommodate two trains of 3- Car each.

(iv) All stabling lines are planned in the proposed depot-cum-workshop assuming adequate space availability. In case of space constraints, if any, stabling facilities may need to be created at terminal stations or elsewhere (preferably as close to depot as possible) to cater to the required stability facilities.
(v) In case of space constraint for depot two storeyed Stabling lines can also be planned

In broad terms, based on the planned Rolling Stock requirements, this chapter covers conceptual requirements on following aspects and will work as a guide for detailed design later:

- Layout of Stabling-shed, Inspection-shed, minor repairs and heavy repair overhauling workshop and cleaning of Rolling Stock.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage.

0.8.2 Maintenance Philosophy

- ➢ Monitoring of the performance of equipment by condition monitoring of key parameters. The concept is to evolve the need based maintenance regime, which can be suitably configured in the form of schedules like daily check, "A" checks, "B" type checks, "IOH" and "POH".
- ➢ Labour intensive procedures are kept to the minimum. Automation with state of the art machinery to ensure quality with reliability.
- ➢ Multi skilling of the Maintenance staff to ensure quality and productivity in their performance.
- ➢ Periodic review of maintenance practices to update replacement cycle of critical components based on experience.
- ➢ Energy conservation is given due attention.

0.9 ROLLING STOCK

The required transport demand forecast is the governing factor for the choice of the Rolling Stock. The forecasted Peak Hour Peak Direction Traffic for a Medium Rail Transit System (MRTS).

0.9.1 Optimization of Coach Size

The following optimum size of the coach, as opted for this corridor, has been chosen for this corridor as mentioned in Table 0.10.

Table 0.10: Size of the coach

	Length*	Width	Height
Driving Motor Car (DMC)	21.64 m	2.9 m	3.9 m
Trailer car (TC)/Motor Car (MC)	21.34 m	2.9 m	3.9 m

**Maximum length of coach over couplers/buffers = 23 m*

0.9.2 The recommended performance parameters are:

Motorisation of 67% for all categories of Metro Rolling Stock.

Table 0.11: Performance Parameters

Item	Values
Minimum Design Average Acceleration rate for fully loaded (seating plus standees @8 persons per sqm) train on level tangent track shall be as under: 0 to 40 kmph 0 to 60 kmph 0 to 80 kmph	 $1.0 m/s^2$ $0.6 m/s^2$ $0.3 m/s^2$
Minimum Operational Average Acceleration rate for (seating plus standess @6 persons/sq.m) loaded on level tangent track shall be as under: 0 to 35 kmph 0 to 60 kmph 0 to 80 kmph	 $1.20 m/s^2$ $0.65 m/s^2$ $0.35 m/s^2$
Service braking rate from 80 kmph to standstill for fully loaded (seating plus standees @8 persons per sqm) train on level tangent track:	$1.0 m/s^2$
Service braking rate from 80 kmph to standstill for fully loaded (seating plus standees @6 persons per sqm) train on level tangent track:	$1.1 m/s^2$
Emergency braking rate from 80 kmph to 0 kmph for fully loaded train on level tangent track:	$1.3 m/s^2$
Jerk rate (maximum)	$0.75 m/s^2$

Axle Load

The axle load @ 6persons/sqm of standing area works out in the range of 14.51T to 14.38T. Heavy rush of passenger, having 8 standees per sq. meter can be experienced occasionally. It will be advisable to design the coach with sufficient strength so that even with this overload, the design will not result in over stresses in the coach. Coach and bogie should, therefore, be designed for **16T axle** load.

0.9.3 Coach design and basic parameters

The important criteria for selection of rolling stock are as under:

(i) Proven equipment with high reliability
(ii) Passenger safety feature
(iii) Energy efficiency
(iv) Light weight equipment and coach body
(v) Optimized scheduled speed
(vi) Aesthetically pleasing Interior and Exterior
(vii) Low Life cycle cost
(viii) Flexibility to meet increase in traffic demand
(ix) Anti-telescopic

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

0.10 POWER SUPPLY

0.10.1 Electricity is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, signaling & telecom, etc.) and workshops in depots & other maintenance infrastructure within premises of metro system. The power requirement of following proposed corridor has been determined by peak-hour demands of power for traction and auxiliary applications. Broad estimation of auxiliary and traction power demand is based on the following parameters/requirements and assumptions.

Table 0.12: Design Requirements/Parameters

Parameter/Requirement	Value/Assumption
Maximum Passenger Hour Peak Direction Traffic (PHPDT)	20,704 in 2051
Headway in the Ultimate Year	2.50 minutes
Specific energy consumption of rolling stock at Pantograph/ Current Collector	50 kWh/1000 GTKM for 25 kV ac system as per MOUD guidelines
Elevated/at –grade station load	100 kW
Proposed Voltage Levels for Grid Supply (high grid voltage)	132 kV

Keeping in view of the train operation plan and demand of traction and auxiliary power, power requirements projected for the initial Year and Ultimate Year are summarized in table 0.13 below:

Table 0.13: Power Demand Estimation (MVA)

Corridor	Load	Year	
		Initial	Ultimate
North South Corridor: India Gate (SIA) to Ambabari (21 Elevated, 23.51 km)	Traction	3.99	12.66
	Auxiliary	4.45	4.69
	Total	**8.44**	**17.36**

0.10.2 Sources of Power Supply

The high voltage power supply network of the city was studied in brief. The details of the Network are summarized as follows: -

Table 0.14: High Voltage Network Details

Power Transmission Company	Grid Supply Network Voltage Levels available
M/s Jaipur Vidyut Vitran Nigam Ltd.	132 kV

Keeping in view the reliability requirements and the length of the corridor, following Receiving Sub-Station is proposed to be set up for the line: -

GSS of DISCOM	Metro Authority RSS	Distance between GSS & RSS (km)
Sitapura Industrial Area GSS	Sitapura Depot RSS	5 kms approx. (Subject to verification)

The second source for this corridor is proposed from the existing Sindhi Camp RSS, by suitable augmentation/modification.

This is an economical solution without compromising reliability. It is proposed to receive power supply for traction from the grid sub-station and auxiliary services loads through Direction connection from DISCOMs at Station/Depot level. RSS location and Grid Sub-Station Power Supply Source may be finalized during Project execution stage after detailed Survey. Projected Power demand is calculated on each RSS and furnished below –

Table 0.15: Power Demand projections for various sources

Corridor	Input Source	Peak demand – Normal (MVA)		Peak demand** – Emergency (MVA)	
		Year (2023)	Year (2051)	Year (2023)	Year (2051)
India Gate (SIA) to Ambabari	**RSS at Sitapura Depot**				
	Traction	2.49	6.83	3.99	12.66
	RSS Near Sindhi Camp Station (Augmentation of Existing RSS)				
	Traction	1.50	5.83	3.99	12.66

**In case of failure of other source of power

Traction Power Supply (1 Φ 25 kV): -
The Grid supply will be stepped down to 1 Φ 25 kV level at the proposed RSS location. The 1 Φ 25 kV will be fed to the OHE to cater to traction load.

Auxiliary Power Supply at Stations and Depot (3 Φ 415 V): -
Auxiliary Power Supply will be availed through Direct connection from DISCOM at all stations and Depot at 3 Φ 415 V at suitable load. For economy 33 kV Ring Main and 33 kV ASS will not be provided.

For Depot Power Supply at 33 kV or 11 kV may be availed from DISCOMs further build one ASS in Depot with 2 Transformers of 33 kV / 415 V or 11 kV / 415 V with maximum capacity of 2.5 MVA each.

In case of tripping of one RSS of this section owing to fault or input supply failure, train services can be maintained from standby source from RSS of the same line. However, in case of total grid failure, all trains may come to a halt but station lighting, fire detection & other essential services can be catered to by stand-by DG sets. However, no train services can be run with power supply received from these DG Sets. Therefore, while the proposed scheme is expected to ensure adequate reliability, it would cater to emergency situations as well, except for the train running.

0.10.3 Proposed Traction System

In view of existing traction system in already operational corridor, 25 kV AC traction system is suggested for this corridor.

0.10.4 Standby Diesel Generator Set

In the unlikely event of simultaneous tripping of all the input power sources or grid failure, the power supply to stations as well as to trains will be interrupted. It is, therefore, proposed to provide a standby DG set of following: -

DG Capacity at Elevated/ at – grade stations	70 kVA approx. (actual capacity to vary based on calculations)
DG Capacity in Depot	500 KVA approx. (actual capacity to vary based on calculations)
UPS Capacity	20 KVA approx. (actual capacity to vary based on calculations)

Silent type DG sets with low noise levels are proposed, which do not require a separate room for installation.

UPS Supply to also be considered for following emergency services:

- Emergency Lighting
- Fire Detection & Fire Alarm system.
- Station Control Room
- Control Supply

Actual capacities will be calculated at detailed design stage based on the emergency loads.

0.10.5 Supervisory control and Data Acquisition (SCADA) system

The entire system of power supply (receiving, traction & auxiliary supply) shall be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system. Modern SCADA system with intelligent remote terminal units (RTUs) shall be provided. Optical fiber provided for telecommunications will be used as communication carrier for SCADA system.

SCADA is proposed for providing data acquisition, data processing, overall protection control, interlocking, inter-tripping and monitoring of the entire power supply system consisting of AC switchgear, transformers, 25 kV ac switchgear and associated electrical equipment. SCADA will utilize microprocessor-based fast-acting numerical relays & Programmable Logic Controllers (PLCs) with suitable interface.

0.10.6 Energy Saving System

Energy charges of any metro system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic.

0.10.7 Electric Power Tariff

The cost of electricity is a significant part of Operation & Maintenance (O&M) charges of the Metro System, which constitutes about 30-38% of total annual working cost. Therefore, it is the key element for the financial viability of the Project.

The annual energy consumption is assessed as follows:

Year	2023 (million Units)	2051 (million Units)
Energy Consumption	21.14	55.59

In addition to ensuring optimum energy consumption, it is also necessary that the electric power tariff be kept at a minimum in order to contain the O & M costs. Therefore, the power tariff for Metro should be at effective rate of purchase price at proposed voltage level plus nominal administrative Charges i.e. on a no profit no loss basis.

The power tariff applicable for this Metro Corridor are as follows: -

Regulatory Commission	Rajasthan State Electricity Regulatory Commission for Jaipur
For Financial Year	FY 2019 – 2020
Demand charges	Rs. 185/ - per KVA
Energy charges	Rs. 7.30 / - per Unit

It is proposed that Government takes necessary steps to fix power tariff for Metro at "No Profit No Loss" basis. Similar approach has been adopted for Delhi Metro.

0.11 SIGNALLING AND TRAIN CONTROL SYSTEM

The Signalling and Train Control System shall provide the highest security level for means of an efficient Train Control, ensuring safety in train movements. It assists in optimization of rail infrastructure investment and running of efficient train services on the network.

0.11.1 Signalling

The Signalling shall provide the highest security level to ensure that the operational activities are developed following strict safety requirements. At the same time, it shall meet the requirements for efficient train operations and high quality of service.

The proposed Signalling System design for this corridor of Jaipur Metro Phase -2 will cater the following:

- Continuous Automatic Train Control System (CATC)
- Automatic Train Protection (ATP) System
- Automatic Train Operation (ATO)System
- Communication based Automatic Train Control (ATC) System
- On board equipment
- Cab Signalling
- Fall-Back Block Working System
- Interlocking device (Computer based Interlocking)

- Track side Radio equipment
- Track Vacancy Detection System
- Electric Point Machine
- Track Side Signals
- Centralized Traffic Control System
- OCC & BCC equipments
- Power Supply of signalling
- Cable for signalling
- Display of CCTV images from Train to OCC
- Onboard Radio Antennas, Large Video Screen, MMIs etc.

0.11.2 Overview of Signalling System

It is expected to carry large number of passengers by maintaining shorter spacing between trains requiring a very high level of safety enforcement and reliability. At the same time heavy investment in infrastructure and Rolling stock necessitates optimization of its capacity to provide the best services to the people.

The requirements of the Jaipur Metro Corridors planned to be achieved by adopting following basic principles of signaling System: -

- The Train Control and Monitoring shall be ensured from Centralized Traffic control System located at Operation Control Centre (OCC). OCC equipment shall be connected to station equipment room through optical fiber network.
- Computer Based Interlocking System shall be designed on failsafe philosophy. In case of failure of any equipment, the equipment shall fail on safe side or more restrictive state. In such case the Signalling System shall authorize movement of train in normal and degraded operations.
- Track side equipment shall be connected through Electronic Interlocking (to Station Equipment Room) by secure links to ensure safe movement of trains.
- Provide high level of safety with trains running at shorter headways ensuring continuous safe train separation.
- Eliminate accidents due to driver passing Signal at Danger by continuous speed monitoring and automatic application of brake in case of disregard of signal / warning by the driver.
- Provide safety and enforce speed limit on the sections having permanent and temporary speed restrictions.
- Improve capacity with safer and smoother operations. Driver will have continuous display of Target Speed in his cab enabling him to optimize the speed potential of the track section. It provides signal / speed status in the cab even in bad weather.
- Increased productivity of rolling stock by increasing line capacity and train speeds, and enabling train to arrive at its destination sooner. Hence more trips will be possible with the same number of rolling stocks.
- Improve maintenance of Signalling and Telecommunication equipment by monitoring System status of trackside and train borne equipment and enabling preventive maintenance.
- Signalling & Train Control System on the line shall be designed to meet the required headway during peak hours.

- For monitoring inside train saloon, signaling system shall provide radio transmission media to transfer live streams to OCC controller on large video screen & MMI.

0.11.3 Signaling Mode of Operation

There are five signalling modes of operation which shall be available but only one single signalling mode shall be active at any one instant of time. These five Modes are mentioned as under:-

a) Automatic Train Protection (ATP) Mode
b) Automatic Train Operation (ATO) Mode
c) Restricted Manual (RM) Mode for Depot.
d) Run on Sight Mode (ROS) Mode
e) Automatic Train Reversal / Turn Back (ATB) Mode

0.11.4 Space Requirement for Signaling Installations

Adequate space for proper installations of all Signalling equipment and Platform screen doors at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system.

The areas required at Interlocking stations for Signalling Equipment Room shall be generally 40 sqm. For UPS Room (common for Signalling, Telecommunication, AFC and PSD systems) at all stations, the area required shall be approximately minimum 50 sqm. UPS room will be provided by Electrical wing.

At Non-interlocking stations, Signalling & PSD Equipments shall be installed in the Telecommunication Equipment Room (TER) available at the station.

At the OCC and the Depot, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion.

0.11.5 Maintenance Philosophy for Signalling systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and Telecommunication equipment shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to a centralized S&T repair lab suitably located in the section/depot. This lab will be equipped with appropriate diagnostic and test equipment to rectify the faults and undertake minor repairs. Cards / modules / equipment requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

0.12 TELECOMMUNICATION & AUTOMATIC FARE COLLECTION:

0.12.1 Telecommunication System

The Telecommunication system acts as the communication backbone for Signalling Systems and other systems such as SCADA, AFC etc. and provides Telecommunication services to meet operational and administrative requirements of the metro network.

0.12.1.1 Overview

The Telecommunication facilities proposed are helpful in meeting the requirements for operation of trains:

1. Supplementing the Signalling System for efficient train operation.
2. Exchange of managerial information
3. Crisis management during emergencies
4. Passenger information system

The proposed Telecom system will cater to the following requirements:

- Radio System
- Backbone network using Optical Fiber Cable (OFC)
- Ethernet & WAN Network.
- Station to Station dedicated communication
- Telephone System with Telephone Exchanges (IPPBX), Telephones and their Recording
- Centralized Recording System (CDRS)
- Centralized Clock System
- Closed Circuit Television (CCTV) System
- Passenger Information & Display System within the station from Central Control to each station, Integrated Passenger Announcement System
- Central Telecommunication Fault Reporting System
- Train Traffic Control, Maintenance Control, Emergency Control, Assistance to Train Traffic Control.
- Data Channels for Signalling, SCADA, Automatic Fare Collection
- Power Supply of Telecommunications, and
- Cables for Telecommunications etc.

0.12.1.2 Space Requirement for Telecom Installations

Adequate space for proper installations of all Telecommunication equipment at each station has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations for Telecommunication equipments shall be approximately 40 sqm. The Telecommunication Room shall be used for Signaling, Telecommunication, AFC & PSD systems equipments at non- interlocking stations. In interlocking station, Telecommunication Room shall be used for Telecommunication, AFC & PSD systems equipments. Uninterrupted Power Supply (UPS) System shall be common for Signaling, Telecommunication, AFC & PSD systems equipments at input stage and installed in UPS room at every station, depot and OCC which is approximately 50 sqm at station. These areas shall also cater to local storage and space for maintenance personnel to work.

At the OCC, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion.

0.12.1.3 Maintenance Philosophy for Telecom Systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and Telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to the existing centralized S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to rectify the faults and undertake minor repairs. Cards / modules / equipment requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

0.12.2 Automatic Fare Collection System

Metro System handles large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use / operate and maintain, easy on accounting facilities, capable of issuing single / multiple journey tickets, amendable for quick fare changes and require overall less manpower. In view of the above computer based automatic fare collection system is proposed**.** Seamless ticketing is now being thought of for Jaipur Metro Rail.

Automatic Fare Collection system is recommended to be adopted as this will enable the commuters to travel hassle free by different modes of transport viz. Metro, suburban trains, buses, water transport (whenever introduced) and even taxies without purchasing multiple tickets for each mode separately.

Automatic fare collection systems have the following advantages:

1. Less number of staff required.
2. Less possibility of leakages of revenue due to 100% ticket check by control gates.
3. Recycling of ticket fraudulently by staff avoided.
4. Efficient and easy to operate.
5. System is amenable for quick fare changes.
6. Management information reports generation is easy.
7. System has multi operator capabilities. Same Smart Card can be used for other applications also.
8. AFC systems are the world wide accepted systems for Metro environment.

The proposed AFC system shall be of Contactless Smart Token / Card type. For multiple journeys, the stored value smart card shall be utilized and for the single journey, the smart media shall be as utilized as contactless smart token (or media used on existing operational corridor of Jaipur Metro).

For extension corridor, the system should be compatible with the contactless smart chip supplied by at least 2 chip OEMs. The system needs to support the smart cards and single journey ticket working on existing operational line. The AFC system shall be seamlessly integrated with existing Phase 1 network of Jaipur Metro.

The equipments for the same shall be provided at each station counter / booking offices and at convenient locations and will be connected to a local area network with a computer in the Station Master's room. Equipment and installation cost of Contactless Smart Card / Token based AFC system is similar to magnetic ticket-based AFC system, but Contactless system proves cheaper due to reduced maintenance, less wear and tear and less prone to dusty environment.

The AFC System should support the following ticketing media:

a) NCMC (National Common Mobility Card) media for multiple Journey/Single Journey as per NPCI standard specifications.
b) Integrated QR Based ticketing solution
c) Type A DMRC Closed Loop Cards
d) Type A Token
e) NFC (Near Field Communication)

As a prescriptive, for acquiring and settlement of bank card transactions, DMRC will select a financial institution. The scope of services may be defined based on industry best practices and suitable Business requirements.

0.12.2.1 Gate

Retractable Flap Type/Paddle Type Control Gates are proposed which offer high throughput, require less maintenance and are latest in modern systems internationally. All these gates will have a functionality of Auto Top on smart cards in case balance goes below the threshold value (as per choice / business rule).

The gate should also capable to NFC enabled Mobile Tickets or any latest type of Ticket media at the time of procurement/installation. The AFC system shall provide access control solutions, offering both access control devised and hardware which can be tailored to accept any ticket media readily available in market (Barcode, QR code, NFC, etc.).

0.12.2.2 Gate Function

a) Gate arrays shall be the normal-means of controlling entry to and exit from the paid areas. Control shall be by means of actuating a physical barrier on recognition of a valid ticket or card by the gate. The barrier may be a bi-parting leaves, centre flaps, end flaps or other configuration however the use of tripod or turnstile type gates is not acceptable. The gate shall be capable of operating either in normally open or normally closed mode.

b) Where required, barriers shall be provided to separate paid and unpaid areas of the concourse. The barriers shall meet local public safety requirements and be aesthetically merged with station engineering.

0.12.2.3 Features

a) Power Failure - In the event of a total power failure to the gates, the gates shall open to allow unrestricted user access. All latch gates shall automatically unlatch where electric locks are installed.

b) Concourse Emergency Mode - All AFC gates shall open whenever the Concourse Operating Mode is in emergency. An Emergency Push Button independent of the SC shall be provided in each Excess Fare Office.

c) Ergonomics - The engineering of the gate arrays should be such that the passenger uses reader placed on the right hand side while passing through the gate. The display and Contact less Smart Card (CSC) reader associated with each gate shall be grouped such that they bias the passenger towards the aisle through which the passenger should pass.

0.12.2.3 Types of Gates

(a). Passenger Entry Gate: - The Passenger Entry Gate shall control the entry of passengers into the paid area by validating the fare media.

(b). Passenger Exit Gate: - The Passenger Exit Gate shall control the exit from the paid area by validating the fare media.

(c). Swing Gates/Barriers: - Situated in each entry array or centre of the Z-type array, for movement of handicapped (wheelchair), the motorized Swing Gates can be operated from EFO (Excess Fair Office) through customer care system.

0.12.2.5 Integration of AFC with other Lines and Modes of Transport:

In Jaipur, different mode of transport is being constructed and operated by different operators. In view of passenger convenience and operational efficiency, it is proposed that AFC for different metro lines should be integrated and smart card based fare products should be inter-operable. AFC system shall take into account revenue sharing mechanism among different operators based on journeys performed at each system. The single ride tickets (tokens) may not be inter-operable and may be limited to each operator's system.

The proposed AFC system shall provide interfaces to other operators such as Suburban Rail, Bus, Waterway, Parking, Toll etc. so that these systems may also be integrated with common smart card based fare products. This will facilitate the passengers as they need not carry different cards for different applications.

0.13 FRIENDLY FEATURES FOR DIFFERENTLY ABLED:

The objective of making this chapter is to create a user-friendly mass transport system in India which can ensure accessibility to persons with disabilities, people travelling with small children or are carrying luggage, as well as people with temporary mobility problems (e.g. a leg in plaster) and the elderly persons.

The design standards for universal access to Public Transport Infrastructure including related facilities and services, information, etc. would benefit people using public transport.

The access standards given here are extracted from Indian Roads Congress Code, IRC 103: 2012, Guidelines for Pedestrian Facilities; Model Building Bye-Laws, 2011 and National Building Code, 2005. Central Public Works Department's (CPWD) "Harmonised Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disabled and Elderly Persons", 2016 (by MoUD), and international best practices / standards.

Further, it has also been attempted to provide guidelines/ standards for alighting and boarding area, approach to station, car parking area, drop-off and pick-up areas, taxi/auto rickshaw stand, bus stand/stop, footpath (sidewalk), kerb ramp, road intersection, median/pedestrian refuge, traffic signals, subway and foot over bridge etc. to achieve a seamless development around Metro stations.

0.13.1 Contents

1. Metro Rail Station
    - Way finding
    - Signage
    - Automated Kiosks
    - Public Dealing Counters
    - Audio-visual Displays
    - Public Telephones
    - Rest Areas/Seating
    - Tactile Paving - Guiding & Warning
    - Doors
    - Steps & Stairs
    - Handrails
    - Ramps
    - Lifts/Elevators
    - Platform/Stair Lift
    - General and Accessible toilets
    - Drinking Water Units
    - Visual Contrasts
    - Emergency Egress/Evacuation

2. Street Design
    - Footpath (Sidewalk)
    - Kerb Ramp
    - Road Intersection
    - Median/Pedestrian Refuge
    - Traffic Signals
    - Subway and Foot Over Bridge

3. Alighting and Boarding Area
    - Approach
    - Car Park
    - Drop-off and Pick-up Areas
    - Taxi/Auto Rickshaw Stand
    - Bus Stand/Stop

0.14 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

0.14.1 Objective and Scope of the Study

The objective of the study is to facilitate the Jaipur Metro Rail Corporation (JMRC) evaluate the environmental impacts of its proposed activity. The objective of the study is to conduct Environmental Impact Assessment as per requirement of FIs. The scope of EIA includes the impacts resulting from pre-construction, during construction and operation phases of India Gate (SIA) - Ambabari Metro corridor at Jaipur. In addition, it is proposed to establish environmental baseline and safeguard measures for protection of environment for sustainable development during project cycles.

0.14.2 Approach and Methodology

The JMRC has considered different alternative corridors. The final alternative was fixed based on Technical Feasibility, Socio-economic acceptability, and Environmental sustainability for Metro Corridors. The environmental study is carried out for the alignment proposed by JMRC. The approach is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The analysis of assessment depends upon the reliable data generated/ available on environmental attributed. This study has documented the baseline data for various parameters of physical, ecological and environmental pollution (air, water and noise). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,
- Impacts due to project design,
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs were estimated and budgeted for.

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The national acts, legislation and laws along with guidelines were consulted with a view to ensuring compliance with various requirements. Environmental baseline data for environmental attributes from primary and secondary sources were collected and compiled. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the chapter.

0.14.3 Positive Environmental Impacts

Various positive impacts have been listed as under:

- Employment Opportunities;
- Enhancement of Economy;
- Mobility, Safety and reduced accidents;
- Traffic Congestion Reduction;
- Reduced Noise Levels
- Reduced Fuel Consumption;
- Reduced Air Pollution;
- Reduction in Number of Buses/ Auto rickshaws

0.14.4 Socio-Economic Survey

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed metro alignment on their conditions. There can be two types of impacts on the PAPs. One is the displacement of residential house and another is displacement of commercial establishments. The survey has been undertaken on the corridors using structured questionnaire in December 2019 and January 2020.

There are 11 residential Pucca buildings along Dravyavati River near Gaushala and Ambabari. Additionally, there are 6 small shops having 15 employees. Another 9 small tin structures and two sheds are there at different locations. Part of 1 Kapda mill is also likely to be affected by the proposed alignment between between India Gate SIA) and Ambabari. Parmanand Hall near Government Hostel is also likely to be acquired and dismantled. The valuation of all the properties will be done by PWD. Additionally, these shall be compensated as per the provision of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resttlement Act, 2013.

0.15 DISASTER MANAGEMENT MEASURE:

0.15.1 Introduction

"Disaster is a crisis that results in massive damage to life and property, uproots the physical and psychological fabric of the affected communities and outstrips the capacity of the local community to cope with the situation." Disasters are those situations which cause acute distress to passengers, employees and outsiders and may even be caused by external factors. As per the disaster management act, 2005 "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area". As per World Health Organization (WHO):

"Any occurrence that causes damage, economic disruption, loss of human life and deterioration of health and services on a scale sufficient to warrant an extra ordinary response from outside the affected community or area."

A disaster is a tragic event, be it natural or manmade, which brings sudden and immense agony to humanity and disrupts normal life. It causes large scale human suffering due to loss of life, loss of livelihood, damages to property and persons and also brings untold hardships. It may also cause destruction to infrastructure, buildings, communication channels essential services, etc.

0.15.2 Need for Disaster Management Measures

The effect of any disaster spread over in operational area of Metro Rail System is likely to be substantial as Jaipur Metro will be dealing with thousands of passengers daily. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of Metro Rail System. Therefore there is an urgent need to provide for an efficient disaster management plan.

0.15.3 Objectives

The main objectives of this Disaster Management Measures are as follows:

- Save life and alleviate suffering.
- Provide help to stranded passengers and arrange their prompt evacuation.
- Instill a sense of security amongst all concerned by providing accurate information.
- Protect Metro Rail property.
- Expedite restoration of train operation.
- Lay down the actions required to be taken by staff in the event of a disaster in VMRT in order to ensure handling of crisis situation in coordinated manner.

- To ensure that all officials who are responsible to deal with the situation are thoroughly conversant with their duties and responsibilities in advance. It is important that these officials and workers are adequately trained in anticipation to avoid any kind of confusion and chaos at the time of the actual situation and to enable them to discharge their responsibilities with alertness and promptness.

0.15.4 Provisions at Metro Stations/Other Installations

To prevent emergency situations and to handle effectively in case 'one arises' there needs to be following provisions for an effective system which can timely detect the threats and help suppress the same.

(A) FIRE DETECTION AND SUPPRESSION SYSTEM
(B) SMOKE MANAGEMENT
(C) ENVIRONMENTAL CONTROL SYSTEM (ECS)
(D) TRACK-WAY EXHAUST SYSTEM (TES)
(E) STATION POWER SUPPLY SYSTEM
(F) DG SETS& UPS
(G) LIGHTING SYSTEM
(H) STATION AREA LIGHTS
(I) SEEPAGE SYSTEM
(J) WATER SUPPLY AND DRAINAGE SYSTEM
(K) SEWAGE SYSTEM
(L) ANY OTHER SYSTEM DEEMED NECESSARY

The above list is suggestive not exhaustive actual provisioning has to be done based on site conditions and other external and internal factors.

0.16 MULTI MODAL TRAFFIC INTEGRATION

Ridership of a Mass Rapid Transit System is directly or indirectly dependent on the accessibility of the trip generating and trip attracting areas within catchment zone. Importance of Last mile connectivity becomes crucial. A well connected, integrated network of footpath, cycle and bus feeder system acts as complimentary modes to generate ridership of Metro. The steps that need to be considered for preparing an efficient multimodal integration plan for metro stations are:

i. Defining requirement of last mile connectivity for multimodal integration at metro stations
ii. Assessment of existing and proposed land use to identify major trip demand points and trip attraction points
iii. Assess correlation of placement of station location and possibility of multimodal integration within station area
iv. Understand the road network and possibility of area level integration
v. Assess presence of pedestrian network, NMT lanes, IPT connectivity and Bus stops within catchment area.

0.16.1 Need for Multi Modal Integration

Multimodal Integration ensures the smooth movement of commuters by various transportation modes like buses, IPT, private vehicles, NMT in such a way that efficiency is achieved in terms of time, cost, comfort, safety & accessibility. A successful multimodal integration can result in increased demand for public transportation by optimizing travel cost & time and allow seamless interchange between the various modes.

Multimodal Integration consists of combining and coordinating the operation of varied transport modes in order to offer continuous and door-to-door services. Intermodal facilities are infrastructures where people who use public transit can shift between different modes of transport. These infrastructure are especially planned to allow for the operation of at least two transport modes at the same time.

The approach to be adopted while planning for multi modal integration is to focus on last mile connectivity and ensure seamless travel from door to door.

0.16.2 Last Mile Connectivity

Last mile connectivity services enables commuters to easily plug in or transfer to main metro line at the start or at the end of their trips. They complement rapid transit services by offering commuters the complete trip they require. The quality of the last mile to a great extent influences transit ridership and the choice opted by users. Last mile connectivity ensures ease of availability of mode and options reduce time and cost incurred in the last mile, ease of changing the mode and ease of walking/cycling to and from stops or stations.

0.16.3 Multi Modal Integration at Corridor Level

At a corridor level analysis, the important criterion is to understand the present transport and transit scenario along the proposed study corridor. The availability of various transit options/modes and their characteristic is pivotal to carryout multi modal integration plans.

0.16.4 NMT and Public Bicycle Sharing

Public Bicycle Sharing (PBS) systems are a flexible public transport service that is created by a dense network of cycles to provide last mile connectivity. Along with having vehicular and pedestrian network along all vertical and horizontal networks, provision of cycle lane or non-motorized lane is necessary to boost use of sustainable and non-motorized modes. To facilitate use of cycles as last mile connectivity to metro station, provision of cycle docking station should be made at metro station, and also in major residential, commercial, institutional areas. A cycling network is incomplete without facilitating docking stations at places beyond metro stations.

PBS has to be segregated from main carriageway and to accommodate the same along the metro corridor land needs to be acquired. Also docking stations has to be proposed at stations which cannot be accommodated in the existing scenario due to non availability of extra land parcels. Hence it is suggested that the proposal of cycle track to be incorporated in future proposals of road widening along the metro corridor and its catchment area so as to improve the last mile connectivity.

0.16.5 Multi Modal Integration at Station Area Level

Multimodal integration at station areas is crucial as it aims at seamless integration of modes at metro station. It is generally an integration of spaces and its relation between accessible modes to and from metro station. It should also be sustainable and provide affordable mobility solution to metro users. Thus, station area planning and design should ensure integration with Public Transport (PT), Intermediate Public Transport (IPT) and NMT provisions.

Station area should include provision of safe, accessible and comfortable infrastructure provision. Station area infrastructure includes bus stops, IPT stops, continuous and connected pedestrian network, information board with feeder timings, adequate lighting and interactive public space outside metro with seating area with self-explanatory signage's and symbols. Purpose of a station area plan is to make last mile more accessible.

0.17 COST ESTIMATE

Project Cost estimates for India Gate (SIA) to Ambabari Corridor of Jaipur Metro has been prepared covering civil, electrical, signaling and telecommunication works, rolling stock, environmental protection, rehabilitation, considering 25 kV AC traction etc. at January 2020 price level.

The overall Capital Cost for this Corridor of Jaipur Metro at January 2020 price level works out to **Rs.3669 Crores** excluding applicable Taxes & Duties of **Rs. 464 crores** as tabulated hereunder.

Table 0.16 –Summary of Cost Estimate

Sr. No.	Name of the corridor	Capital Cost (Rs. Crore)	Taxes & Duties (Rs. Crore)	Total (Rs. Crore)
1.	India Gate (SIA) – Ambabari	3669	464	4133

Table 0.17- Capital Cost Estimate

Total length = 23.51 km (Entirely Elevated); Total Stations (All Elevated) =21

January 2020 level

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.0	**Land and R & R incl. Hutments etc.**				
1.1	Permanent				
a	Government (As per Annex-17.1)	ha	0	1.794	0
b	Private (As per Annex-17.1)	ha	---	33.02	462
1.2	Temporary Land (@5% pa for 4 years)				
a	Government (As per Annex-17.1)	ha	0	8.8	0

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.3	**R & R incl. Hutments etc.**	R. Km.	5.00	23.510	117.55
	Subtotal (1)				**579.55**
2.0	**Alignment and Formation**				
2.1	Elevated section (viaduct) including in station portion (Including Cost of Rain Water Harvesting)	R. Km.	37.00	23.510	869.87
2.2	Depot Entry connection	R. Km.	37.00	0.70	25.90
2.3	Cost for Dismantling of Tonk Phatak and reconstruction of integrated structure, Additional Cost due to height of Durgapura Station over Durgapura Flyover, Provision for additional height of Piers at Gopalpura Bypass Crossing, Construction of portals at certain locations of the corridor	LS			30.00
	Subtotal (2)				**925.77**
3.0	**Station Buildings**				
3.1	Elevated stations (including finishes)	Each			
a	Civil works excluding viaduct in station portion	Each	16.00	21	336.00
b	EM works including lifts and escalators	Each	8.00	21	168.00
	Subtotal (3)				**504.00**
4.0	**Depot and Admin Building**				
a	Civil works	LS			70.00
b	E&M and M&P works	LS			68.25
	Subtotal (4)				**138.25**
5.0	**P-Way**				
5.1	Ballast less track	R. Km.	6.60	24.210	159.79
5.2	Ballasted track for Depot, At Grade Section	T. Km.	3.90	9.00	35.10
	Subtotal (5)				**194.89**
6.0	**Traction & Power Supply** **25 kV Overhead Catenary System (OCS)**				
6.1	Elevated Section	R.Km.	4.20	24.210	101.68
6.2	Depot	T.Km.	2.10	9.00	18.90
6.3	Catenary Maintenance Vehicle	LS			6.63
6.4	RSS without AMS (AIS Type)	Each	32.25	1	32.25
6.5	Bay Cost by DISCOMs	Each	5.00	1	5.00
6.6	Augmentation on RSS (Sindhi Camp)	LS			5.00
6.7	132 kV double run double circuit cable from GSS to RSS (Approx. Length of 5 km is taken, will be finalized after Survey)	R.Km.	6.00	5	30.00
	Subtotal (6)				**199.46**
7.0	**Signalling and Telecom.**				
7.1	**Signalling**				
	Main line	R.Km.	3.40	24.21	82.31
	Depot including DCC	T.Km.	3.20	9	28.80
	On Board Equipment	Per Train	1.70	16	27.20
7.2	**Telecom**				

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
	Station	Per Station	3.50	21	73.50
	Depot	Per Depot	3.50	1	3.50
7.3	**Automatic Fare Collection (AFC) system**	Per Station	3.50	21	73.50
	Subtotal (7)				**288.81**
8.0	**Shifting of Miscellaneous Utilities**				
a	Civil and EM works	R. Km.	4.00	24.210	96.84
	Subtotal (8)				**96.84**
9.0	**Rolling Stock (2.9 m wide Coaches)**	Each	8.40	48	403.20
	Subtotal (9)				**403.20**
10.0	**Staff quarter for O & M**				
a	3 BHK Flats	Each	0.35	25.000	8.75
b	2 BHK Flats	Each	0.25	100.000	25.00
	Sub Total (10)				**33.75**
11.0	**Multimodal Integration and Last mile connectivity**				
a	Multimodal Integration and Last mile connectivity	Per Station	3.00	21	63.00
	Sub Total (11)				**63.00**
12.0	**Total of all items except Land**				**2965.52**
13.0	**General Charges incl. Design charges @ 5 % on all items except land**				**148.28**
14.0	**Total of all items including G. Charges except land**				**3113.80**
15.0	**Contingencies @ 3 %**				**93.41**
16.0	**Gross Total**				**3207.21**
	Cost without land			**=**	**3207**
	Cost including land			**=**	**3669**

Table 0.18 - Details of Taxes and Duties

Basic Customs duty =	5.500
CGST Customs Duty=	9.495
SGST Customs Duty=	9.495
Total Customs Duty=	**24.490**
General IGST=	12
General CGST =	6
General SGST =	6

S. No.	Description	Total cost without Taxes & duties (Cr.)	Taxes and duties		Total Taxes & Duties (Cr.)
			Total Customs Duty (Cr.)	Total GST (CGST & SGST) (Cr.)	
1	**Alignment & Formation**				
	Elevated & At-Grade	925.77		111.09	**111.09**

S. No.	Description	Total cost without Taxes & duties (Cr.)	Taxes and duties		Total Taxes & Duties (Cr.)
			Total Customs Duty (Cr.)	Total GST (CGST & SGST) (Cr.)	
2	**Station Buildings**				
	a) Elevated station - civil works	336.00		40.32	**40.32**
	b) Elevated station-EM works	168.00	8.23	16.13	**24.36**
3	**Depot**				
	Civil works	70.00	5.14	5.88	**11.02**
	E&M and M&P works	68.25	3.34	6.55	**9.89**
4	**P-Way**	194.89	38.18	4.68	**42.86**
5	**Traction & power supply**				
	Traction and power supply	199.46	19.54	14.36	**33.90**
6	**S and T Works**				
	S & T	215.31	42.18	5.17	**47.35**
	AFC	73.50	13.50	2.21	**15.71**
7	**R & R hutments**	117.55		14.11	**14.11**
8	**Misc. (Shifting of Utilities, Staff Quarters and MMTI)**				
	Civil works	128.63	0.00	15.44	**15.44**
	EM works	64.96	0.00	7.80	**7.80**
9	**Rolling stock**	403.20	59.52	3.98	**63.50**
10	**Rent on Temporary Land**	0.00		0.00	**0.00**
11	**General Consultancy charges**	148.28		26.69	**26.69**
	Total	**3113.80**	**189.64**	**274.39**	**464.03**
	Total Taxes & Duties				**464**
Rate of Taxes & Duties on Total cost without taxes & duties					**14.90%**
Total Central GST & Basic Customs duty					253.31
Total State GST					210.72
Total Taxes & Duties					**464.03**

0.18 FINANCING OPTIONS, FARE STRUCTURE AND FINANCIAL VIABILITY:

The India Gate (SIA) to Ambabari metro project is part of Jaipur Phase-2 MRTS project being proposed to be constructed with an estimated cost of Rs 4133.03 Crore including taxes and land cost. The route length of the metro system and estimated cost at January-2020 price level is placed in table 0.19 as under:

Table 0.19 Cost Details

Name of Corridor	Route Length (km)	Estimated cost without Land and taxes (Rs/Crore)	Estimated cost with land cost (Rs/Crore)	Estimated cost with all taxes & land cost (Rs/Crore)
India Gate (SIA) to Ambabari	23.51	3207.21	3669.00	4133.03

It is assumed that the construction work of the line will commence from October-2020 and is expected to be completed by 30.11.2023 with Revenue Opening Date (ROD) as 01.12.2023. The total completion costs duly escalated and shown in the table 0.20 below have been taken as the initial investment.

Table 0.20 Year –wise Investment

Figures in Rs. Crore

Financial Year	Cost at January-2020 Price Level including all Taxes & Land cost	Completion Cost including all Taxes & land cost
2020-21	521.05	530.23
2021-22	1,255.30	1,337.90
2022-23	1,622.43	1,809.66
2023-24	734.25	868.34
Total	**4,133.03**	**4546.14**

The cost of Land including Rehabilitation and Restoration of Rs. 461.79 crore on completion cost basis included in the above cost shall have to be provided free of cost by the JDA, Government of Rajasthan.

0.18.1 Additional Investment

Total investment provided in the FIRR calculation towards requirement of additional rolling stock duly escalated @5% PA is placed in **Table 0.21** as under: -

Table 0.21 - Additional Investment towards Rolling Stock

(Rs. in Crore)

Financial Year	No. of Cars	Amount
2041-42	33	670.41
Total	**33**	**670.41**

0.18.2 Fare Structure

The fare structure of Jaipur Metro prevailing in 2019 has been considered during traffic survey and ridership projections; hence, the same has been used as base fare for calculation of FIRR of the project. The FIRR has been calculated by using an escalation factor @14.00% once in every two years on the existing fare structure considering the average trend in the Consumer Price Index (CPI) and for the last ten years and input costs of operation. While estimating revenue, it is presumed that 70% of the commuters will be using smart card and therefore the existing arrangement of providing 10% additional discount on smart card travelers for tickets costing more that Rs. 10 and 15% discount on tickets costing more than Rs. 20 have been considered as per existing practice in Jaipur Phase-I. The fare structure assumed for the Year 2023 with an escalation @ 14% once in two years on the existing fare structure as per the proposed fare slabs is shown in the Table 0.22 below**:**

Table 0.22: Fare Structure in 2023-24

	2019	2023
Stations	**Fare in week days**	**Fare in week days**
0-2	6	8.00
3-5	12	16.00
6-8	18	23.00
9-11	24	31.00
12-14	30	39.00
15-17	36	47.00
18-20	42	55.00
More Than 20 Station	48	62.00

0.18.3 Other Sources of Revenue

Other revenues from Property Business and advertisement have been estimated at 15 % of the fare box revenues during operations. Apart from development of property on metro stations and depot it is possible to raise resources through leasing of parking rights at stations, advertisement on trains and tickets, advertisements within stations and parking lots, advertisements on viaducts, columns and other metro structures, co-branding and naming rights to corporate, film shootings and special events on metro premises.

0.18.4 Financial Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) based on SPV model for 30 years business model is 6.56%.

0.18.5 Alternative Models of Financing:

The financing option shall depend upon selection of the dedicated agency created to implement the project. The prominent models are: -

(i) Special Purpose Vehicle (SPV) under the State Government Control (Delhi Metro Rail Corporation (DMRC) /Bangalore Metro Rail Corporation (BMRC)

(ii) Built, Operate and Transfer (BOT)

(i) SPV model

The proposed corridor is an independent line from India Gate (SIA) to Ambabari with interchange at Chandpole metro station of the existing network. The funding pattern for India Gate (SIA) to Ambabari project under SPV model with loan assistance from multilateral/bilateral agencies is shown in Table 0.23. Besides, land including R&R should be made available free from all encumbrances by the JDA/JMRCL when the project starts. Accordingly, the funding pattern under SPV model assumed is placed in table 0.23 as under: -

Table 0.23: Funding pattern under SPV model (with all taxes)

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by GOI	615.85	**16.39%**
SD for CT by GOI (50%)	135.69	**3.61%**
Equity by GoR	615.85	**16.39%**

Sources of Funds	Amount (Rs/Crore)	% of contribution
SD for CT by GoR (50%)	135.69	**3.61%**
Bilateral/Multilateral Loan	2,254.63	**60.00%**
Sub-Total (A)	**3,757.72**	**100.00%**
Land including R&R by State Government	461.79	
State Taxes by State Government	227.38	
PPP Contribution	99.25	
Sub-Total (B)	**4546.14**	
IDC	52.12	
Total including IDC	**4598.26**	

(ii) SPV of Government of Rajasthan

The proposed corridor is an independent line from India Gate (SIA) To Ambabari with interchange at Chandpole metro station of the existing network. The funding pattern for India Gate (SIA) To Ambabari project under present model of JMRC as SPV of Government of Rajasthan with loan assistance from multilateral/bilateral agencies is shown in Table 0.24. Besides, land including R&R should be made available free from all encumbrances by the JDA/JMRC when the project starts. Accordingly, the funding pattern under SPV model assumed is placed in table 0.24 as under: -

Table 0.24: Funding pattern under SPV model (with all taxes)

Sources of Funds	Amount (Rs/Crore)	% of contribution
Grant by GOI	398.51	**10.00%**
Equity by GoR	697.27	**17.50%**
SD for GST from GoR	99.75	**2.50%**
Bilateral/Multilateral Loan	2,789.57	**70.00%**
Sub-Total (A)	**3,985.10**	**100.00%**
PPP	99.25	
Land Cost to be borne by SG	461.79	
Sub-Total (B)	**4,546.14**	
IDC	56.35	
Total including IDC	**4602.48**	

(iii) Design-Build-Finance-Operate-Transfer (DBFOT) Model: - In this model, the private firm will be responsible for designing, building, financing, operating and maintaining of the entire project. Such a project shall be eligible for funding assistance under the Viability Gap Funding (VGF) scheme upto 20% of the project cost excluding cost of land and state taxes from the Central Government provided the state government also contributes same or more amounts towards the project. The Metro Rail being a social sector project not many private parties are likely to bid for such a project. Besides, the private operator may demand assured rate of return on his equity, which is in the range of 20% to 22% (pre-tax) or a comfort of guaranteed ridership, sweeteners in the form of huge parcels of land free of cost for commercial exploitations. The funding pattern under the above model has been worked out with a pre-tax Equity Internal Rate of Return (EIRR) @ 18% is shown in the table 0.25 below:

Table 0.25: Funding pattern under DBFOT model (EIRR 18%)
(With all taxes and land cost)

Particulars	Amount (Rs/Crore)	% of contribution
VGF by GoI	816.87	20.00%
VGF by GoR	2330.66	57.06%
Equity by Concessionaire	312.27	7.65%
Concessionaire's debt @12% PA	624.55	15.29%
Sub-Total (A)	**4084.35**	**100.00%**
Land including R&R by State Government	461.79	
Sub-Total (B)	**4546.14**	
IDC	145.78	
Total including IDC	**4691.92**	

The total fund to be contributed by GoI & GoR, excluding bilateral/multilateral loan, is shown in Table 0.26 below under SPV and BOT model.

Table 0.26: Fund Contribution of GOI & GOR *Rs. In crore*

Particulars	SPV Model	SPV of GoR	DBFOT
GoI	751.54	398.51	816.87
GoR	1440.71	1258.81	2792.45
Total	**2192.25**	**1657.32**	**3609.32**

0.18.6 Recommendations

The project is operationally viable since the FIRR for a period of 30 years period including construction period with all the taxes is 6.56%. However, FIRR is not the only criteria to take up the metro project. As per Metro Rail Policy 2017, issued by the Ministry of Housing and Urban Affairs, (MOH&UA), GOI, apart from financial viability, the economic and social viability of the project is also required to be assessed. The Economic Internal Rate of Return (EIRR) for any metro rail project proposal should be 14% and above for consideration of its approval. Considering the positive FIRR as well as social considerations of requirement of reliable public transport, it is recommended for its implementation. In case of operational losses, the Govt. of Rajasthan will provide funds for the viability gap.

From Table 0.26, it is evident that the VGF required to be contributed by GOI & GoR for executing the project through a DBFOT operator is the highest as compared to the SPV models. The fund requirement under DBFOT model has been made with the assumption of 18% pre-tax EIRR. However, the DBFOT operator may expect the pre-tax EIRR of at least 20%, in such a situation, the VGF amount will only increase further. Out of the two SPV models discussed above, SPV under GoR would require lesser contribution from both GoI and GoR as compared to the SPV model under GoI and GoR and hence, it is recommended to implement the project through SPV model under GoR as per the funding pattern shown in Table 0.24.

0.19 ECONOMIC APPRAISAL

0.19.1 Introduction

Economic appraisal aims to represent a complete view of contribution of upcoming Metro system benefiting the society in form of monetary value. Thus, calculating Economic Internal Rate of Return measures viability of the project.

Economic benefits are social and environmental benefits which are quantified and then converted into money cost and discounted against the cost of construction and maintenance for deriving Economic Internal Rate of Return (EIRR). This part of study quantifies benefits by saving of time, saving in cost of public and private transport, saving in fuel consumption, increasing safety of passengers, reduction in traffic congestion and reduction in air pollution. Thus, EIRR is viewed from socio-economic angle.

Jaipur Metro corridor from India Gate (SIA) to Ambabari is proposed to be operational from 2023. Thus, economic benefits are estimated from this year onward for coming 30 years. 2051 is considered as horizon year for the project.

0.19.2 Result of Economic Analysis

The years of construction is assumed as 2020 to 2023. Estimated total cost is subtracted from total benefit to arrive at net benefit. The cash flow is prepared in discounting process to evaluate internal rate of return. The result proves this project to be economically viable. Estimated EIRR for Jaipur Metro Rail Corridor from India Gate (SIA) to Ambabari is **14.86%**.

0.20 TOD & VCF

India is urbanizing at a rapid pace with urban population rising much faster than its total population. Level of urbanisation has increased from 17.29% in 1951 to 31.6 % in 2011. India is competing with the fastest growing countries in the world. The urban population in India, which is nearly 377 million is poised to grow to 600 million by 2030. The urban population of India contributes 65% of country's Gross Domestic Product (GDP), which is expected to grow to 75% in the next 15 years. With India witnessing a high economic growth, Indian cities are growing at a rate faster than other cities in the world.

Urbanization has led to horizontal growth of the cities thus creating problems of urban sprawl. This has resulted in increase of trip lengths and higher usage of private vehicles, problems of pollution and increased demand of infrastructure. To address these issues, many cities have strengthened their public transport by developing mass rapid transit systems (MRTS) such as metro rails and Bus Rapid Transit Systems (BRTS). It is however, important to efficiently use these systems by integrating the land use with the transport infrastructure to make the cities livable, healthy and smart.

0.20.1 Objectives Of TOD

TOD integrates land use and transport planning to develop compact growth centers within the influence zone of 500-800 m on either side of the transit stations i.e. areas within walking distance, to achieve the following objectives:

- To promote the use of public transport by developing high density zones in the influence area, which would increase the share of transit and walk trips made by the residents/ workers to meet the daily needs and also result in reduction in pollution and congestion in the influence area.

- To provide all the basic needs of work/ job, shopping, public amenities, entertainment in the influence zone with mixed land-use development which would reduce the need for travel.

- To establish a dense road network within the development area for safe and easy movement and connectivity of NMT and pedestrians between various uses as well as to transit stations.

- To achieve reduction in the private vehicle ownership, traffic and associated parking demand.

- To develop inclusive habitat in the influence area so that the people dependent on public transport can live in the livable communities within the walkable distance of transit stations.

- To integrate the Economically Weaker Sections (EWS) and affordable housing in the influence zone by allocating a prescribed proportion of built-up area for them in the total housing supply.

- To provide all kinds of recreational/entertainment/ open spaces, required for a good quality of life in the influence area.

- To ensure development of safe society with special attention to safety of women, children, senior citizen and differently abled by making necessary amendments to the building bye laws.

- To prevent urban sprawl by accommodating the growing population in a compact area with access to the transit corridor, which would also consolidate investments and bring down the infrastructure cost for development.

- To reduce carbon footprints by shifting towards environmentally friendly travel options for the line haul as well as for access and egress trips.

0.21 IMPLEMENTATION PLAN

World over Metro projects cannot be financially viable and depend upon generous concessions and subsidies. The financial rate of return for this corridor based on SPV model for 30 years business model is **6.56%**.

The only Metro which has been implemented on BOT model so far is the Rapid Metro in Gurgaon. Financially this Metro has been a total failure since the revenues are not able to meet even the interest payment on the loans raised. It is therefore recommended that the project is implemented fully as a Government initiative. By this route the project can be completed at the shortest time and at the lowest cost. This is important because then only ticket can be priced low, affordable to the common citizens and make the system truly a popular public transport.

0.21.1 Implementation Schedule

Suggested project implementation schedule are given in Table 0.27 and 0.28 below

Table 0.27 Project Implementation on Turnkey basis (Deposit Terms)

Sl. No.	Item of Work	Completion Date
1	Submission of Final DPR to State Govt.	D
2	Approval of DPR by State Government	D+15 days
3	Submission of DPR for Approval of Ministry of Housing and Urban Affairs (MoHUA).	D+30 days
4.	Sanction of Project by GOI	D+60 days
5.	Appoint an agency on deposit terms	D+30 days
6.	Implementation of the project	D+42 months
7.	Testing and Commissioning	D+43 months
8.	CMRS Sanction	D+44 months
9.	ROD	D+44 months

Table 0.28 Project Implementation Schedule through SPV Model

Sl. No.	Item of Work	Completion Date
1	Submission of Final DPR to State Govt.	D
2	Approval of DPR by State Government	D+0.5 month
3	Submission of DPR for Approval of Ministry of Urban Development (MoHUA).	D+1 month
4.	Sanction of Project by GOI	D+2 months
5.	Selection of GC	D+8 months
6.	Tendering	D+14 months
7.	Implementation of the project	D+41 months
8.	Testing and Commissioning	D+43 months
9.	CMRS Sanction	D+44 months
10.	ROD	D+44 months

0.21.2 Institutional Arrangements

Since JMRC is an existing SPV which has already implemented E-W corridor, therefore the State Govt. of Rajasthan may approve the implementation of this project also through JMRC.

0.21.3 Legal Cover for Jaipur Metro

Implementation of proposed corridor can now be done under "The Metro Railways (Amendment) Act 2009".

0.22 CONCLUSIONS AND RECOMMENDATIONS

0.22.1 DMRC submitted DPR for Jaipur Metro Rail Project consisting of 2 corridors (Corridor-1: Durgapura to Ambabari and Corridor-2: Mansarovar to Badi Chaupar) in March 2010. The report submitted in March 2010 got revised in April 2011, in which Corridor-1 extended till Sitapura Industrial Area. In March 2012 it was decided to bifurcate DPR in two parts i.e. Corridor-2: Mansarovar to Badi Chaupar as Phase I and Corridor-1: Sitapura Industrial Area to Ambabari as phase II. Further DPR for Phase II was revised in April, 2014 and July, 2014. As original proposal for Phase II was envisaged in 2011 since then a lot of development has occurred along the corridor. Moreover, as per New Metro Rail Policy 2017, some new elements are to be considered while preparing the DPR. Therefore, the DPR prepared in 2011 cannot be taken up for implementation. Hence JMRC decided for Updation / Review of Detailed Project Report for Jaipur Metro Phase 2 and preparation of DPR for extension of Phase 1B from Badi Chaupad to Ramganj and awarded the assignment to DMRC on 20/06/2019.

0.22.2 The proposal of this corridor is technically feasible but involves acquisition of land as well as rehabilitation of some hutments and shops. This is a socio-economic problem and has to be tackled for execution of the project.

0.22.3 Project Cost

Estimated Cost of the project at January 2020 price level is **Rs. 4133 Crore** with all taxes & duties and land cost. Completion cost with all taxes & duties and land cost and escalation at 5% p.a. works out to Rs. 4546 Crore (excluding IDC) and **Rs. 4602 Crore** (including IDC).

0.22.4 After examining the various options for execution of the project, it has been recommended that the project should be got executed through SPV model under GoR, however AFC system shall be provided through PPP mode.

0.22.5 Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR)

The Financial Internal Rate of Return (FIRR) for the project has been assessed as **6.56%** and Economic Internal Rate of Return (EIRR) works out to **14.86%.**

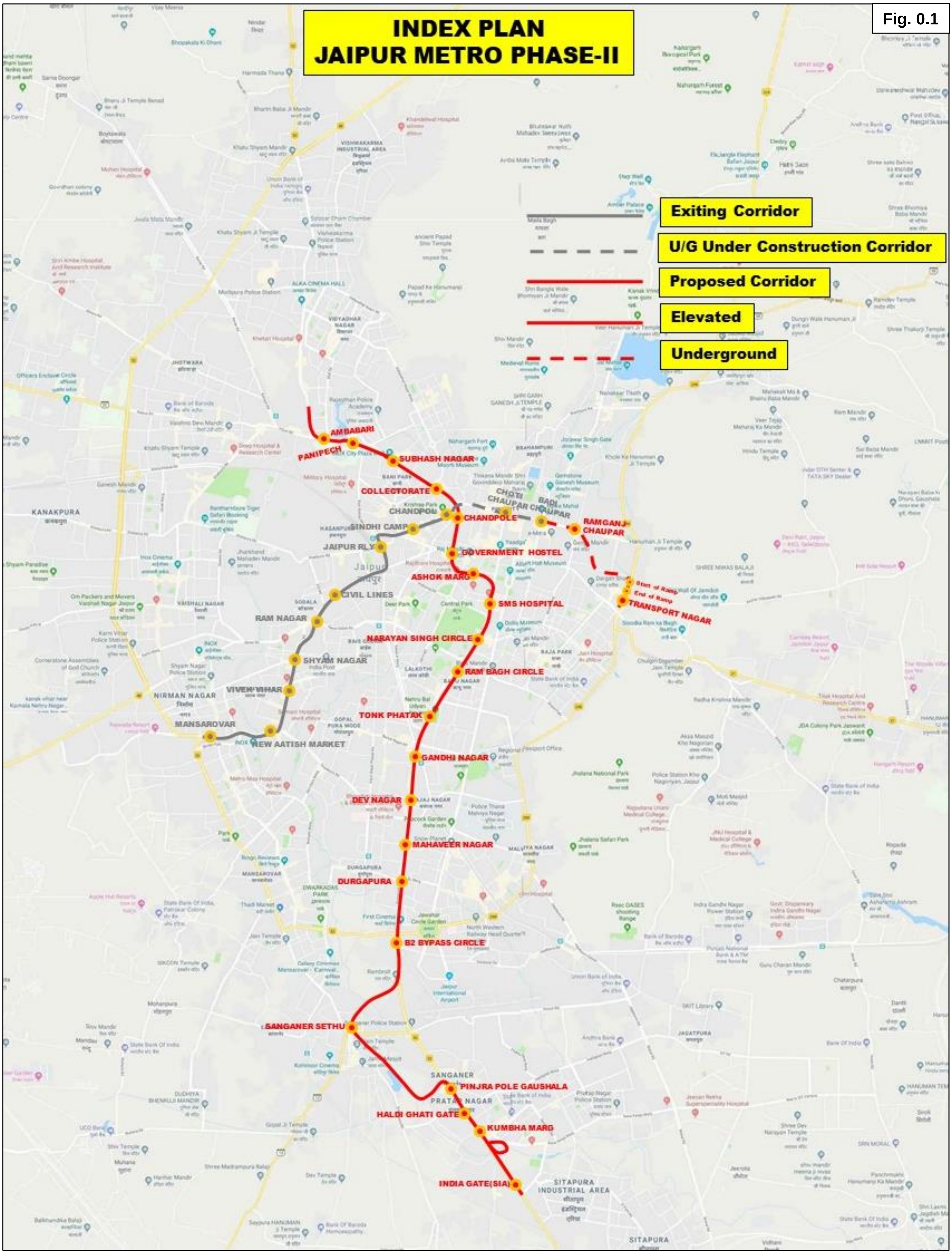
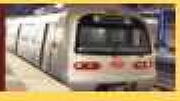


Fig. 0.1
INDEX PLAN
JAIPUR METRO PHASE-II
Exiting Corridor
U/G Under Construction Corridor
Proposed Corridor
Elevated
Underground
AMBABARI
PANIPECH
SUBHASH NAGAR
COLLECTORATE
CHANDPOLE
CHHOTI CHAUPAR
BADI CHAUPAR
RAMGANJ CHAUPAR
SINDHI CAMP
JAIPUR RLY
GOVERNMENT HOSTEL
ASHOK MARG
SMS HOSPITAL
TRANSPORT NAGAR
CIVIL LINES
RAM NAGAR
NARAYAN SINGH CIRCLE
SHYAM NAGAR
RAM BAGH CIRCLE
VIVEK VIHAR
TONK PHATAK
MANSAROVAR
NEW AATISH MARKET
GANDHI NAGAR
DEV NAGAR
MAHAVEER NAGAR
DURGAPURA
B2 BYPASS CIRCLE
SANGANER SETHU
PINJRA POLE GAUSHALA
HALDI GHATI GATE
KUMBHA MARG
INDIA GATE(SIA)
SITAPURA INDUSTRIAL AREA



CHAPTER 1 - INTRODUCTION

CHAPTER - 1

ASSESSMENT OF EXISTING CITY PROFILE WITH EXISTING TRANSPORT CHARACTERISTICS

1.1 BACKGROUND

Originally the work of preparation of DPR for Jaipur metro was awarded to DMRC in 2009. Accordingly, DPR was submitted in March, 2010. The Proposed Corridor were as under:

Corridor	**Length(km)**		**Total (km)**	**Station**		**Total**
	U/G	Ele		U/G	Ele	
Corridor-1: Durgapura to Ambabari	5.095	12.257	17.352	5	13	18
Corridor-2 Mansarovar to Badi Chaupar	2.789	8.777	11.566	3	8	11
Total	**7.884**	**21.034**	**28.918**	**8**	**21**	**29**

Completion Cost at 2018 Price Level was ₹ 7531Cr.

The report submitted in 2010 was revised in April, 2011 and it was decided to extend corridor I upto Sitapura Industrial Area. Accordingly, details of corridors are as under:

Corridor	Length(km)		Total (km)	Station		Total
	U/G	Ele		U/G	Ele	
Corridor-1: Sitapura Industrial Area to Ambabari	5.095	18.004	23.099	5	15	20
Corridor-2: Mansarovar to Badi Chaupar	2.789	9.278	12.067	3	8	11
Total	**7.884**	**27.282**	**35.166**	**8**	**23**	**31**

Completion Cost was Increased to 2019 Price Level = ₹10291Cr.

Meanwhile, it was decided to get implemented the East West corridor from Mansarovar to Chandpole through DMRC on deposit term basis, which has been commissioned in 2013 and remaining underground length of this corridor is being implemented by JMRC through General Consultants and is likely to be commissioned shortly.

In March 2012 it is decided to bifurcate DPR in two parts Corridor-2: Mansarovar to Badi Chaupar as phase I and Corridor-1: Sitapura Industrial Area to Ambabari as phase II. Further DPR for Phase II was revised in April, 2014 and July, 2014 in view of passing on Alignment Jaipur Airport Air Funnel and connecting collectorate.

As original proposal for Phase II was envisaged in 2011, since then a lot of development has occurred along the corridor. Moreover, as per New Metro Rail Policy 2017 some new elements are to be considered while preparing the DPR. Therefore, the DPR prepared in 2011 cannot be taken up for implementation. Hence, JMRC decided for Updation / Review of Detailed Project Report of Jaipur Metro Phase 2 and preparation of DPR for extension of Phase 1B from Badi Chaupad to Ramganj and awarded the assignment to DMRC on 20/06/2019. Kickstart meeting in this regard happened on 28/06/2019. The issue of potential MRTS corridors in the light of CTTS prepared by L&T discussed with JMRC and it is concluded that traffic surveys to be conducted to find out potential MRTS corridors. Further next meeting was held with 23/08/2019 regarding conducting traffic surveys, location of survey points and number of them were discussed in the meeting. The views of various JMRC and GoR officers were sought regarding probable future MRTS corridors. A presentation to the Honourable Chief Minister of Rajasthan was also given on 18/09/2019 to sought views of political leadership in this regard. On receipt of preliminary traffic figures base on the traffic surveys again a presentation was given to JMRC on 25/10/2019 regarding selection of the MRTS corridors. Finally, a meeting was held in the chairmanship of Chief Secretary, Rajasthan on 25th November 2019. Deliberations of this meeting are placed on **Annexure 1.1.**

1.2 DELINEATION OF STUDY AREA

The first and foremost step of a traffic and transportation study for a region is to delineate the influence area which is called as the study area. The study area for the current assignment is the Jaipur Municipal Corporation (JMC) with an area of 467 sq. km.

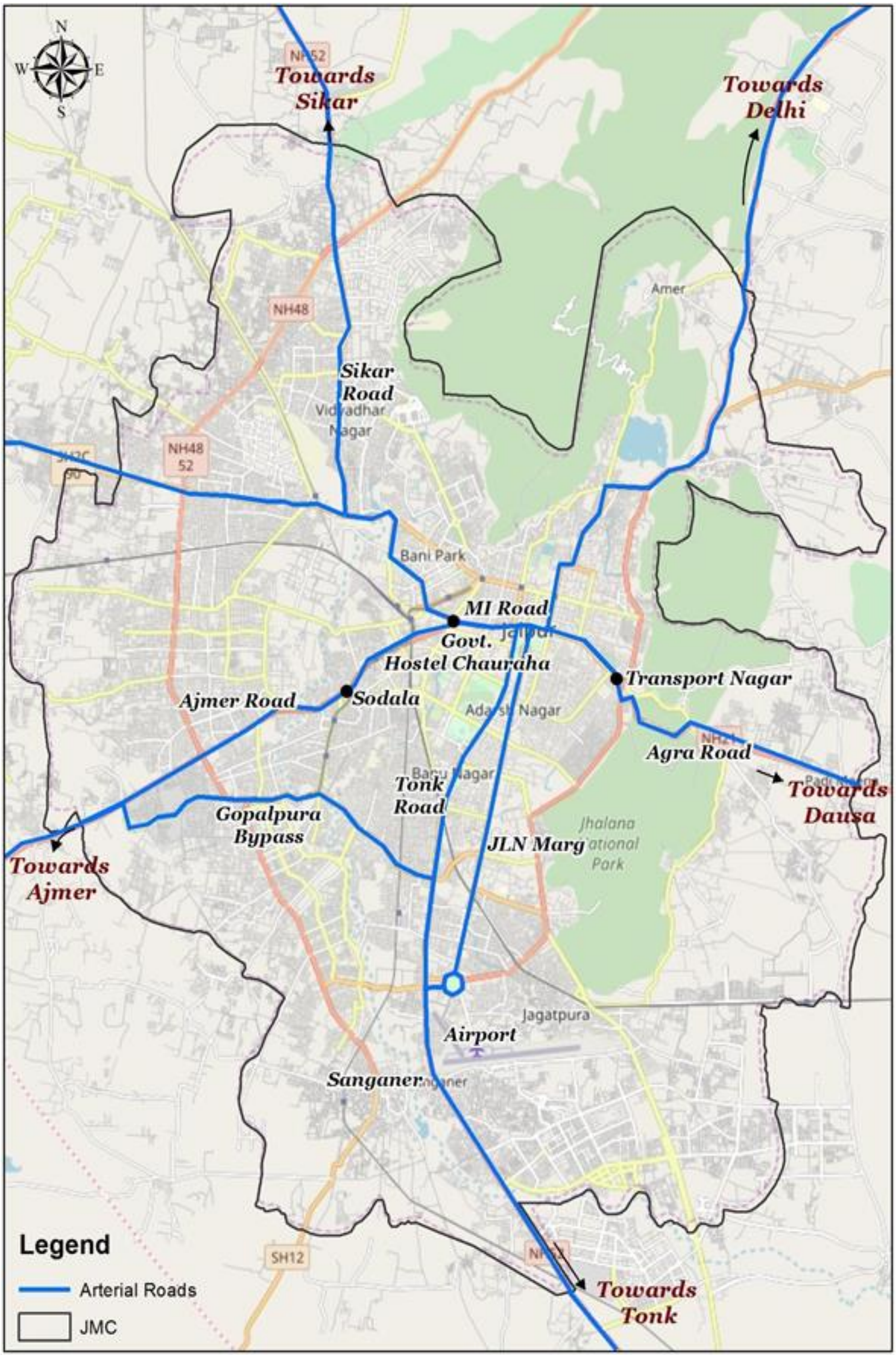


Figure 1.1: Map of the Study Area

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

This study area has been delineated based on the identified MRTS corridors in the CTTS 2018. The identified MRTS corridors as per CTTS 2018 are:

- Manasarovar - Transport Nagar
- Vishwkarma Industrial Area - Sitapura Industrial Area
- Kalwar Road - Kanota (via Gopalpura Bypass)
- Kalwar - Amba Bari
- Jhotwara - Kanota (via Gopalpura Bypass)
- Jhotwara - Kanota (via Durgapura station)
- Kalwar - Sitapura Industrial Area
- Vishwkarma Industrial Area – Kanota (via Gopalpura Bypass)
- Manasarover – Kanota (via Gopalpura Bypass)
- Vishwkarma Industrial Area - Amba Bari
- Amba Bari - Ajmer road
- Ajmer road to B2 Bypass

The above identified corridors are within the JMC area and therefore, JMC area has been considered as the study area. The historic walled city is part of the JMC and is spread over an area of 6.7 sq. km. The walled city (also known as pink city) is characterized by presence of heritage buildings and high commercial activities. It has a high population density of more than 481 persons per hectare (presently, about 580 persons per hectare), while the population density of JMC is 65 persons per hectare. The map of study area is shown in the Figure above.

1.3 REGIONAL CONNECTIVITY

Jaipur is situated in the eastern part of Rajasthan. The city is at a distance of 260 km from Delhi, 135 km from Ajmer, 225 km from Agra, and 245 km from Kota. Jaipur is located on National Highway 48 (Old NH8) connecting Delhi and Chennai. This is part of the Golden Quadrilateral project which connects four metropolitans Delhi, Mumbai, Chennai and Kolkata. NH52 (Old NH12) links Sangrur, Punjab with Ankola, Karnataka through Jaipur and NH21 (Old NH11) links Jaipur with Agra passing through Jaipur. RSRTC operates bus service to major cities in and out of Rajasthan like Delhi, Agra, Jodhpur, Udaipur, Ahmedabad etc. City buses are operated by Jaipur City Transport Services Limited (JCTSL).

The State Highways passing through the study area that provides connectivity at the State level are SH2C (Kalwar Road), SH12 (Diggi Malpura Road), SH55 (Jamwa Ramgarh Road), SH19 (Jahota Morija Road), SH37 (Chomu-Churu Road), SH24 (Toonga Road) and SH52 (Alwar Road).

Jaipur is the headquarters of north-western zone of the Indian Railways. The city is well connected by railways to the neighbouring cities like Delhi, Agra, and Ahmedabad as well as to the major cities in the country. Jaipur Junction is the major terminal within the study area. Other railway stations within the Jaipur region are:

- Towards Ajmer - Kanakpura, Bindayaka and Dhankya
- Towards Sikar - Dher Ka Balaji, Nindar, Bhaton Ki Gali and Chomu
- Towards Delhi - Gandhi Nagar, Jagatpura, Khatipura, Kanota and Bassi

- Towards Sawai Madhopur - Bais Godam, Durgapura, Sanganer, and Shivdaspura

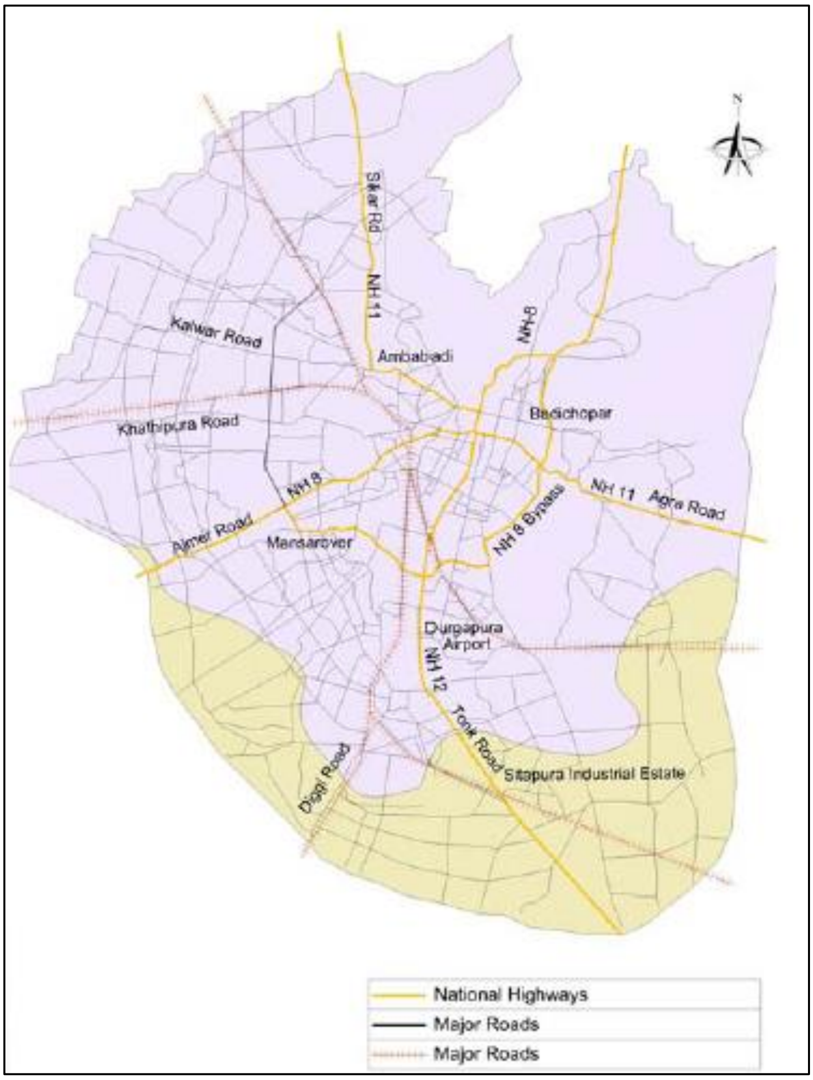


Figure 1.2: Regional Connectivity Map of Jaipur

Source: Traffic and Transportation Study for DPR for Proposed Jaipur Metro-2010

The city of Jaipur is well connected by air to various metropolitan cities like Delhi, Mumbai, Bangalore, Chennai and Kolkata as well as the other major cities in India; is also connected to various major cities in the world. Jaipur International Airport is located in Sanganer, around 13 km from the city core. The Jaipur airport handled about 4.76 million passengers in 2017-18 whereas 3.78 million passengers in 2016-17 (i.e., about 25.7% of increase in the passengers). Out of 4.76 million passengers in 2017-18, 0.53 million are international passengers and 4.23 million are domestic passengers. Jaipur Airport also provides air cargo services.

1.4 SOCIO-ECONOMIC PROFILE

1.4.1 Demography

Jaipur Municipal Corporation (JMC) holds a population of around 30.5 lakh as per Census 2011. It has experienced a population growth rate of 31.15% from 2001, which has been declined from 59.25% as observed from the previous decade (1991-2001). The average population density in JMC area is 6,523 persons per sq. km.

Table 1.1: Population Statistics of JMC Area

Horizon Year	Population	Decadal Growth Rate	CAGR
1991	14,58,483	-	-
2001	23,22,575	59.25%	4.76%
2011	30,46,163	31.15%	2.75%

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

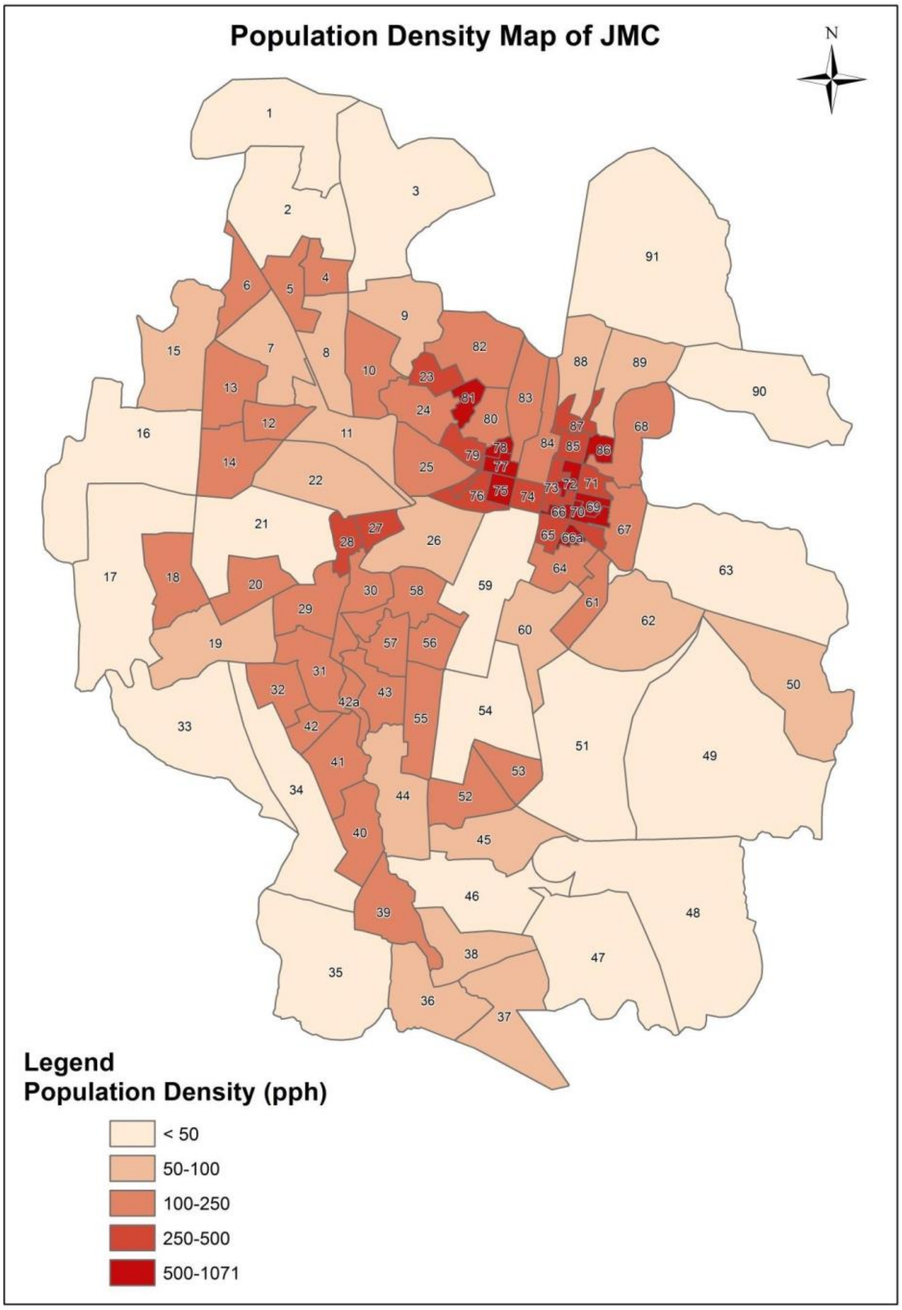


Figure 1.3: Population Density Map of JMC Area (Census 2011)

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.4.2 Work-Force Participation Ratio

The total workers in JMC area was observed to be 9,85,494 as per Census 2011 with 9,19,409 Main Workers and 66,085 Marginal Workers resulting in a work-force participation ratio (WFPR) of 32.4%. Service sector employment in JMC area is having the highest share of about 44% of the total employment, followed by retail/ wholesale trade with 21.5%.

1.4.3 Household Income

The average household income in JMC region is observed to be Rs.30,046/-. The distribution of households under various income groups shows that about 38% of households fall in the income range of Rs.5,000-20,000/- in JMC region. Around 47% of the households are in the income range of Rs.20,000-50,000/- in JMC Region and the income range having above Rs.50,000/- in JMC region is 13%.

1.4.4 Industrial Areas

Jaipur is encompassed with many industries which include manufacturing industry, engineering industry, textile industry, chemical industry, food industry and more. Jaipur District falls under the Delhi-Mumbai Industrial Corridor (DMIC), the purpose of which is to enhance development of Industries. Major industrial areas within JMC limit are Vishwakarma, Jhotwara, Bais Godam, Malviya Nagar, Mansarovar and Sitapura.

1.4.5 Trade and Commerce

The main commercial centre in the city is the Walled City where more than 60% of the commercial activities are concentrated. Some of the main commercial centres/ roads in Walled City are Bapu Bazar, Nehru Bazar, Johari Bazar, Tripolia Bazar and Sanjay Bazar. Apart from the walled city, there are few planned commercial centers in the study area, which are: Lal Kothi District Centre, Subhash Nagar District Centre, Vidhyadhar Nagar Central Spine, Indira Place, JLN Marg, Jagatpura Central Spine and New Aatish Market.

1.4.6 Heritage Areas

Jaipur attracts a large number of tourists owing to its rich and varied heritage. Jaipur is famous for its palaces, forts, museums, temples etc. Most of the heritage areas are within the Walled City and in the JMC area.

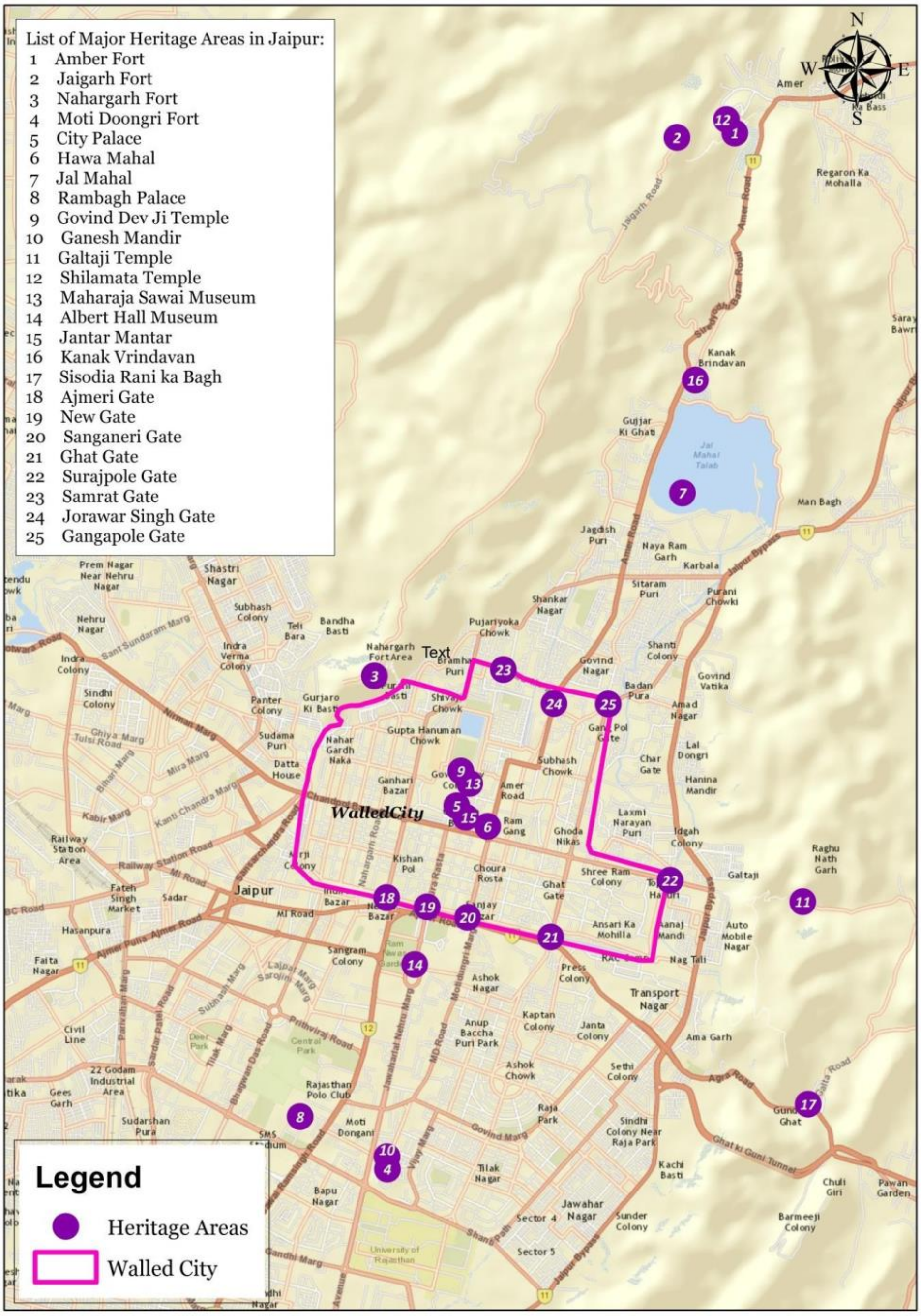


Figure 1.4: Heritage Areas within the JMC Area

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.5 EXISTING ROAD NETWORK

Total existing vehicular road length within the JMC area is around 1783 km, which includes around 120 km road length within the Walled City. Distribution of vehicular road length by carriageway width within the JMC area shows only 24% road is more than two lane and maximum (38%) road length is single lane. About 62% of Walled City road network has single lane carriageway, 17% has intermediate lane, 13% has 2-lane carriageway and only 8% has 4-lane carriageway. Only 21% of road length within JMC area and only 7% of road length within the Walled City have divided carriageway.

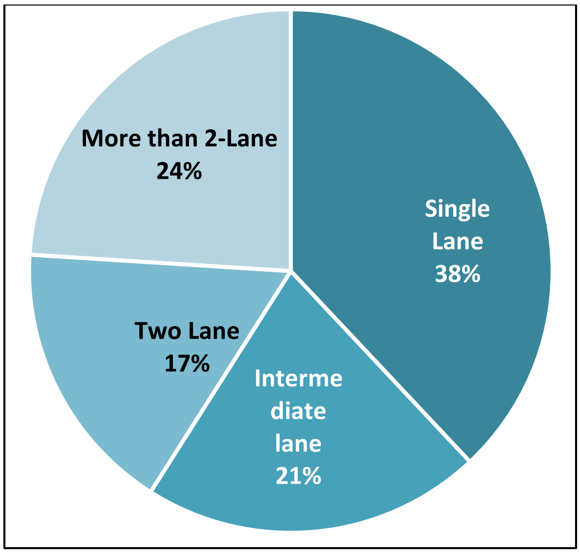


Figure 1.5: Distribution of Road Length by Carriageway Width within the JMC Area

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

The distribution of road length with respect to ROW shows that only 14% of total road length within the JMC area has more than 20m ROW and only 3% of Walled City roads have more than 20m ROW. More than 20m ROW is necessary for planning of road based MRTS. Only 27% of road length within JMC area and only 8% of road length within the Walled City have bus routes.

Table 1.2: Distribution of Existing Road Length by ROW within the JMC Area

ROW (m)	Walled City Road Length (km)	Percentage of Walled City Road Length	JMC Road Length (km)	Percentage of JMC Road Length
Less than 3	6.2	5%	10.9	1%
3 to 5	47.3	40%	283.8	16%
5 to 10	48.5	41%	745.1	42%
10 to 20	13.8	12%	484.2	27%
20 to 40	3.7	3%	239.7	13%
More than 40	0	0%	18.9	1%

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.6 REGISTERED VEHICLE

Total Registered Vehicle in Jaipur city was 21.35 lakh in 2017. City was observed to be dominated by two-wheeler amounting to about 15 lakhs (70%) followed by cars amounting to about 4 lakhs (18%).

Table 1.3: Number of Registered Vehicle of Jaipur City in 2017

Vehicle Class	RTO Jhalana	ARTO Jagatpur	DTO Vidhyadhar Nagar	Total
Agricultural tractor	28,092		1,288	29,380
Ambulance	1	1,713	6	1,720
Articulated vehicle	1	10,830	1	10,832
Bus	6	3,664	69	3,739
Carrier van/ trailer	1	4		5
Cash van		24	3	27
Crane mounted vehicle	63	1	9	73
Dumper		1,735	1	1,736
Earth moving equipment	2,854		253	3,107
E-rickshaw (P)				0
E-rickshaw with cart (G)				0
Excavator (commercial)	9			9
Fire fighting vehicle	4	6		10
Fire tenders		3		3
Goods carrier	1,579	56,447	668	58,694
Harvesters	3			3
Hearses	1	3		4
Invalid carriage	30		13	43
Library van		1		1
Maxi cab	187	4	2	193
Mobile clinic		1		1
Motor cycle/ scooter	15,17,307		24,747	15,42,054
Motor cycle/ scooter with side car	6,860		14	6,874
Moped	6,734		7	6,741
Motor Cab	23,367	19	239	23,625
Motor car	3,99,264		10,893	4,10,157
Motor cycle/ scooter-used for hire	926		2	928
Motor cycle/ scooter-with side car (T)	1			1
Omni bus	3	7,775	117	7,895
Omni bus (private use)	1			1
Private service vehicle	2			2
Road roller	1			1
Three-wheeler (personal)	3			3
Three-wheeler (passenger)		22,707	624	23,332

Vehicle Class	RTO Jhalana	ARTO Jagatpur	DTO Vidhyadhar Nagar	Total
Three-wheeler (goods)		4,017	61	4,078
Tow truck	4			4
Tractor (commercial)	1	1		2
Tractor- trolley (commercial)	61			61
Trailer (agricultural)	1	5	1	7
Vehicle fitted with compressor	4		1	5
Vehicle fitted with rig	4		1	5
Total	**19,87,375**	**1,08,960**	**39,020**	**21,35,355**

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

Trend of registered vehicle from 2012 to 2017 shows more than 10% CAGR for all private and IPT modes.

Table 1.4: CAGR of Registered Vehicle from 2012 to 2017 within Jaipur City

Vehicle Type	CAGR (%)
Two Wheelers	12%
Auto Rickshaw	16%
Car/Jeep	14%
Buses	10%
Passenger Tempo	12%
Goods Tempo	5%
Trucks	13%
Tractors/ Tractor-Trailers	11%
Other	10%

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.7 EXISTING INTRA-CITY PUBLIC TRANSPORT

The city public transport system in Jaipur consist of government buses, mini buses, metro and Bus Rapid Transit System (BRTS). The government buses are being operated by Jaipur City Transport Services Limited (JCTSL) on contractual basis with RSRTC and private operators whereas mini-buses are being operated by only private agencies. Jaipur Metro is operated by Jaipur Metro Rail Corporation Limited and BRTS is being operated by JDA/ JMC through JCTSL.

1.7.1 City Bus Transport

There are about 400 buses plying in the city under JCTSL. Other than the JCTSL bus services, estimates indicate that about 3,950 mini-buses are plying on 136 routes through the city roads by private operators. At present, three depots (Vidhyadhar Nagar, Sanganer and Todi) are operational for JCTSL buses and the fourth depot (Bagrana) is under construction. Bus shelters are available along major roads like Tonk

Road, JLN Marg and along BRTS corridors (i.e., Sikar Road, Ajmer Road and 200 feet Bypass Road).

In the year 2016-17, JCTSL operated city buses on 29 routes serving 556.55 lakhs of passengers with an average daily ridership of 1.6 lakhs. The average daily ridership among the routes ranges from 17,000 to mere 500. The most dominated route is the Panchawala to Transport Nagar (17,017), followed by Pratap Nagar to Choti Chaupar (14,167) and Agarwal Farm to Dadi Ka Phatak (12,396). Average daily ridership of major routes has been presented below.

Table 1.5: Route-wise Average Daily Ridership of JCTSL Buses within Jaipur City

Sl. No.	Routes	Average Daily Ridership
1	Panchawala – Transport Nagar	17,017
2	Pratap Nagar – Choti Chaupar	14,167
3	Agarwal Farm – Dadi Ka Phatak	12,396
4	Malviya Nagar – Kirni Phatak	11,667
5	Sanganer – Choti Chaupar	11,667
6	Jagatpura – Ajmeri Gate	11,529
7	Matma Gandhi Hospital - Heerapura	8,300
8	Matma Gandhi Hospital – Ajmeri Gate	7,500
9	Pannadhay Circle – Choti Chaupar	5,833
10	Niwaru – Galta Gate	5,683
11	Pratap Nagar – Badi Chaupar – Transport Nagar - Jagatpura	3,333
12	Pratap Nagar – Badi Chaupar – Todi	1,767
13	Siwad Mod – Sanganer – Goner	1,333
14	Pratap Nagar – Railway Station – Galta Gate	833
15	Pratap Nagar – Badi Chaupar – VKI	500
16	Railway Station – Lal Chandpura	500

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.7.2 BRTS

At present 15.3 km of BRTS is operational in Jaipur on two corridors – C-Zone Bypass to Pani Petch via Sikar Road (7.1 km) and Amruth Nagar to Queens Road (8.2 km). As per the master plan of BRTS, around 138 km corridor is proposed in three phases. Out of which 41.75 km is proposed in the first phase.

1.7.3 Metro

Jaipur Metro is operated by JMRC which came into service in May 2015 between Mansarovar and Chandpole (Phase IA) – 9.718 km corridor with 9 stations. Phase IB which is under construction is underground corridor of 2.349 km with additional 2 stations. The average daily ridership of Jaipur Metro is 20,000.

Stated preference survey of existing metro users shows that major share of shift to metro is from bus (51%) followed by two wheelers (33%). About 53% of users are accessing the metro stations by walk followed by two wheeler (13%), share auto (12%)

and other modes. About 60% of the metro passengers are having a metro station within 1 km of distance whereas only 9% of users have access distance of more than 5 km to reach a metro station.

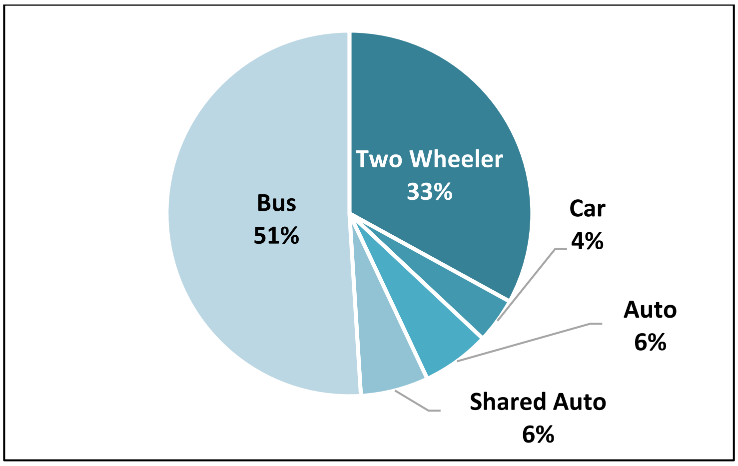


Figure 1.6: Shift to Existing Jaipur Metro from Different Modes

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

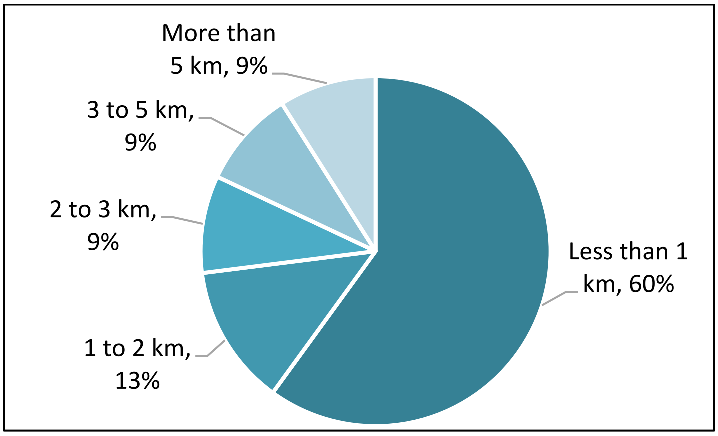


Figure 1.7: Distribution of Access Distance of Passengers from Existing Jaipur Metro Stations

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.8 EXISTING INTERMEDIATE PUBLIC TRANSPORT

The IPT scenario in Jaipur consists of the following modes – auto rickshaws, share autos/ tempos and E-rickshaws. Total 4,140 permits for diesel auto rickshaws and 11,595 permits for LPG auto rickshaws issued in Jaipur city. There are around 400 e-rickshaws in Jaipur. The fare structure of e-rickshaws is a simple slab structure with Rs.5/- for 1-2 km, Rs.10/- for 2-3 km and Rs.30/- for 3-6 km of trip length.

1.9 EXISTING TRAFFIC

As per CTTS-2018, total incoming and outgoing traffic through 8 major roads to and from JMC area is about 2,26,752 vehicles (3,03,278 PCUs) per day. Out of which two-wheeler is 41%, car is 29%, goods vehicle is 22% and bus is only 4%.

Total north-south and east-west interactions for 16 hours within the JMC area across the major 16 screen lines along north-south and east-west corridors are about 5,83,389 vehicles (5,14,675 PCUs) in north-south direction and 6,15,044 vehicles (5,47,124 PCUs) in east-west direction. Location-wise screen line traffic at 16 major locations are presented below. The average traffic composition details show that the share of private modes (car and two-wheeler) is almost 87% of the total traffic at screen-lines followed by IPT mode, which contributes to about 6% share. Whereas public transport modes (bus) contribute 1% only.

Table 1.6: Existing Screen Line Traffic (16 Hours) at 16 Major Locations in JMC Region

S. No.	Type of Screen Line	Screen Line Location	Vehicles in Direction-1	PCUs in Direction-1	Vehicles in Direction-2	PCUs in Direction-2
1	Railway Line (East-West)	Ajmer Puliya	62,496	54,674	64,193	56,251
2		Tonk Phatak	60,136	54,792	57,366	52,232
3		JLN Marg (near Gourav Tower)	47,222	42,376	46,652	41,975
4		Khatipura Road (near Army Golf Course)	38,698	33,101	38,197	32,631
5	River Line (East-West)	Sanganer Bridge	38,871	33,487	37,566	32,653
6		Janpath	15,540	13,824	19,152	17,135
7		Shatabdi Nagar	15,993	13,919	15,229	12,870
8		Haldi Ghati Marg-1	13,702	12,015	12,376	10,740
9	Railway Line (North-South)	Gopalpura Flyover	53,485	47,961	53,310	47,847
10		Jhotwara Road (Near Triton Mall)	54,216	48,076	50,504	45,118
11		New Sanganer Road ROB	34,192	29,479	37,226	32,169
12		Durgapura Flyover	33,431	29,527	33,076	29,155
13	River Line (North-South)	Sahakar Marg (Near HP Regional Office)	49,001	43,589	46,244	41,546
14		Bhawani Singh Road	40,679	36,750	41,701	37,441
15		Ashok Marg (Near SVC Bank)	1,805	1,439	51,216	46,873
16		Jamnalal Bajaj Road (Near CCD)	18,549	15,961	16,409	14,193

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

1.10 EXISTING TRIP CHARACTERISTICS

As per CTTS-2018, existing overall Per Capita Trip Rate (PCTR) observed in JMC region is 1.22, while the vehicular PCTR (excluding walk) in JMC region is 0.84 and motorized vehicular PCTR (excluding walk, cycle and cycle rickshaw) is 0.81. Existing modal split in the JMC region shows PT share as low as 14.4% only (motorized trips).

Table 1.7: Existing Modal Split in JMC Region

Mode of Travel	Percentage of Trips Including Walk	Percentage of Trips Excluding Walk	Percentage of Motorized Trips
Walk	28.80%	-	-
Cycle	2.20%	3.20%	-
Cycle Rickshaw	0.04%	0.05%	-
Two-Wheeler	36.10%	50.70%	52.48%
IPT	6.90%	9.70%	10.04%
Car	15.90%	22.30%	23.08%
Bus	9.90%	13.80%	14.29%
Metro	0.10%	0.10%	0.10%
Total	**100.00%**	**100.00%**	**100.00%**

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

The average trip lengths are observed to be 4.53 km (including walk trips) and 6.51 km (excluding walk trips) in JMC region. Trip Length Frequency Distribution (TLFD) shows that around 48% trips have trip lengths more than 5 km (excluding walk trips) in JMC area.

Table 1.8: Distribution of Existing Trips by Trip Length in JMC Region

Distance Range (km)	Percentage of Trips Including Walk	Percentage of Trips Excluding Walk
0-0.5	14%	1%
0.5-1	13%	5%
1-2	12%	10%
2-3	9%	11%
3-4	7%	10%
4-5	11%	15%
5-6	6%	8%
6-7	5%	7%
7-8	7%	10%
8-9	2%	3%
9-10	5%	7%
More than 10	9%	13%

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

Mode-wise analysis of the existing trip characteristics within JMC area shows average trip length (ATL) for bus-based PT trips is 7.3 km and IPT trips is 6.8 km. ATL for two-wheeler in JMC area is also more than 6 km with an average travel cost of around Rs. 20/-. Existing bus-based PT trips within JMC area have an average travel cost of around Rs. 17/-.

Table 1.9: Mode-wise ATL, Average Travel Time and Average Travel Cost in JMC Region

Mode of Travel	Average Trip Length (km)	Average Travel Time (minutes)	Average Travel Cost (Rs.)
Walk	1	11.73	-
Cycle	2.71	15.57	-
Cycle Rickshaw	2.11	13.44	16.11
Two-Wheeler	6.6	21.76	20.46
Auto Rickshaw	4.85	19.26	35.08
Share Auto	6.45	19.58	24.05
E-Rickshaw	2.11	10.96	27.24
Car/ Jeep/ Van	7.83	23.09	46.2
Office Car/ Cab	9.23	23.26	33.92
Taxi	6.53	21.41	57.11
State Bus	9.17	27.25	13.3
Company Bus	7.07	25.85	21.4
Mini Bus	6.12	24.48	14.04
Private Bus	6.95	25.19	19.73
Metro	3.77	12.46	15.77

Source: Comprehensive Traffic and Transportation Study for Jaipur Region-2018

Annexure - 1.1

Government of Rajasthan

Urban Development & Housing Department

F. 10(06)UDH/UMTA/2019

Jaipur, Date: 09 JAN 2020

Minutes of Meeting

Minutes of the meeting held under the Chairmanship of Chief Secretary, Rajasthan on 25.11.2019 for finalization of the route alignment for Jaipur Metro Phase-2 (North-South Corridor)

1. A meeting was held on 25.11.2019 under the chairmanship of Shri D.B. Gupta, Chief Secretary, Rajasthanto finalize the route alignment for Jaipur Metro Phase-2 (North-South Corridor).

2. Following officials were in attendance during the meeting:-

   1. Sh. Bhakar A. Sawant, Principal Secretary, UDH cum Chairman, JMRC
   2. Sh. T. Ravikant, Commissioner, Jaipur Development Authority
   3. Sh. Sudhir Kumar Sharma, Special Secretary, Finance (Expenditure)
   4. Sh. M.K. Singhal, Managing Director, JMRC
   5. Sh. S.K. Jindal, Director (Project), JMRC
   6. Sh. N.C. Mathur, Director (Engineering-I), Jaipur Development Authority
   7. Sh. R.K. Vijavargiya, Chief Town Planner, Rajasthan
   8. Sh. Rajesh Kumar Agerwal, Director (Corporate Affairs), JMRC
   9. Sh. Mohan LalAcharya, Director (Finance), JMRC
   10. Sh. S.K. Yadav, Executive Director (Electrical/E&M), JMRC
   11. Sh. R.G. Sharma, General Manager (Consultancy), DMRC
   12. Sh. Rahul Goswami, DGM (Town Planning), JMRC
   13. Sh. Mrinmay Das, iMaCS (DMRC Consultant)

3. At the outset of the meeting,PS, UDH welcomed the Chair and gave a brief introduction about the meeting agenda i.e. to finalize the route for Jaipur Metro Phase-2 and selection of apt metro technology/system for the proposed route. He also informed that DMRC was engaged by JMRC on single source basis for:

   a) Updation/Review of DPR of Jaipur Metro Phase 2; and
   b) Preparation of DPR for extension of Jaipur Metro Phase 1B from Badi Chaupar to Ramganj.

4. DMRC gave a presentation and informed about the background of the earlier DPRs which were prepared by DMRC in 2011 and later a revised version in 2014. It was also informed that during the meeting held on 18.09.2019 under chairmanship of Hon'ble Chief Minister, Rajasthan where Hon'ble Minister UDH was also present, it was instructed that all possible efforts should be made towards cost reduction while ensuring the most viable route is selected in the study.

5. **Route Selection:** DMRC informed that based on inputs received from above said meetings, they have carried out and completed Traffic & Transport Survey and Topography Survey of various options and presented the following three options for routes alongwithother relevant details.

Option	Route	Length (km)	PHPDT* (For Year 2051)	Daily Ridership (For Year 2051)
Option-01	(i) Mansarovar to Sitapura via New Sanganer Road (200 ft road)	15 *(All elevated)*	11,026	2,33,619
	(ii) Badi Chaupar to Transport Nagar	04 *(3UG/ 1 Elevated)*	14,601 *(Above figures are for Mansarovar to Transport Nagar)*	4,08,327
	Total length	19 km		
Option-02	(i) Sitapura to Ambabari *(via Tonk Road & Ashok Marg)*	25.4 *(All elevated)*	21,358	6,13,521
	(ii) Badi Chaupar to Transport Nagar	04 *(3 UG / 1 Elevated)*	12,880 *(Above figures are for Mansarovar to Transport Nagar)*	4,12,172
	Total length	29.4 km		
Option-03	(i) Sitapura to Ambabari *(via JLN Marg & Ashok Marg)*	25.7 *(All elevated)*	17,850	5,41,390
	(ii) Badi Chaupar to Transport Nagar	04 *(3UG/ 1 Elevated)*	15,937 *(Above figures are for Mansarovar to Transport Nagar)*	4,78,207
	Total length	29.7 km		

**PHPDT: Peak Hour Per Direction Traffic*

6. **System Selection:** It was apprised that Ministry of Housing and Urban Affairs, Govt. of India while emphasizing spread of metro systems in Indian cities have also been advising about prudent selection of transport systems strictly based on traffic study. This is very important in order to economize costs while ensuring spread of metro network. Four types of systems are under operation/envisaged and selected based on projected ridership and PHPDT in the horizon of 30 years.

Parameter	Conventional Metro	Light Metro	Metro Lite	Metro Neo (Trolly Bus)
Train Capacity (passenger)	1000-2500	750	400-500	150-250
Train Length (meters)	90-180	70	40-50	18-25
Alignment	Elevated /Underground	Mostly Elevated	Mostly At-Grade/partly elevated	Mostly At-Grade/partly elevated
Peak Hour Capacity (PHPDT)	25000-80000	15000-25000	Upto 15000	Upto 9000

Station Detail				
a) Design	Heavy with Concourse level	Light (minimum Facility)	Very light structure like Bus shelter	
b)Ticketing	Automatic Fare Collection system (AFC)	AFC (Optional)	No AFC Proposed	Optional (Like BRTS)
c)Security	Scanning+ Frisking	Scanning+ Frisking (Optional)	No Security	
Estimated Cost/km (INR in Crore)	Elevated : 300; UG: 500-600;	180-200	130-160	60-80
Status	Functional and proven in Indian conditions	Functional and proven in Indian conditions	Not yet operational in Indian cities Specification issued by MoHUA. Metro Corporations have reservations on At-Grade and without AFC System.(DMRC Dwarka-Kirti Nagar) Section under DPR Stage.	Not yet operational in Indian cities. Specification presented by Nagpur Metro for Nasik. DPR yet to be approved by MoHUA.

7. On the basis of the PHPDT, other geographical features, constraints and above discussed aspects, it was decided that DMRC should be asked to prepare the detailed DPR for the route suggested under Option 2 i.e. **'Sitapura to Ambabari *(via Tonk Road& Ashok Marg)*& Badi Chaupar to Transport Nagar'** and with system and concept of Light Metro.

8. It was also decided that keeping in mind that the local traffic and public scenario, provision of Automatic Fare Collection system should be proposed. Since full corridor will be elevated, security frisking may be done away with. Frisking at interchange station of Mansarovar to Badi Chaupar line may be provided.

9. Further, DMRC apprised that they have carried out studies for extension of proposed corridors (Sitapura to Ambabari) from Sitapura to Manpura (Ring Road - 7 Kms) and Ambabari to Harmada (9 Kms). The traffic projections further strengthensthe justification of Light Metro system on this corridor during horizon period uptoyear 2051. However, since the traffic projections on these extensions in the initial years are not adequate, DMRC have suggested keeping the provision of these extensions for future depending upon actual traffic requirements and experience.

10. Further, DMRC presented the proposed alignment of option-2 **'Sitapura to Ambabari *(via Tonk Road& Ashok Marg)*& Badi Chaupar to Transport Nagar'**. The following were discussed:-

    i. To avoid Air Funnel Zone near Airport as well as underground construction due to cost consideration, DMRC proposed to divert alignment from Tonk Road while coming from Sitapura at Pinjra Pol Gaushala towards Dravyavati river wall and return to Tonk Road near Gupta Nursery via

Sanganer Setu. DMRC was asked to prepare cost comparison analysis between this diversion as against going underground along Tonk Road for appraisal.

Regarding Airport connectivity, it was suggested that a Metro Station near B-2 Bypass crossing shall serve the Airport connectivity by providing a dedicated air-conditioned Jaipur Metro bus service for metro passengers only. A metro kiosk may be provided at Airport.

ii. While crossing on Durgapura Flyover the existing piers made exclusively for metro shall be utilized.

iii. For crossing the Tonk Phatak Flyover, Director (Engineering), JDA stated that the flyover is around 40 years old and has almost outlived its useful life and has also become congested. It was proposed to be dismantled and reconstructed with widening of road to cater to metro system as well as for road traffic.

iv. DMRC apprised that after Maharani College, they have proposed the alignment to move along Ashok Marg and turn right towards Govt. Hostel to proceed on Sansar Chandra Road till Chandpole. This will capture traffic near Ahinsa Circle which is a commercial hub and has potential for future development. For certain stretches having issues related to ROW where central median metro piers will not be possible, DMRC has suggested provision of portal viaducts (metro pillars on either side of the road) to avoid hindrance to road traffic.

v. While crossing Chandpole Station, DMRC apprised that the alignment will cross before existing Chandpole Station Building, thus much ahead of walled city boundaries, thereby avoiding apprehensions related to heritage issues.

vi. DMRC have proposed connecting Collectorate Circle by taking alignment from Jhotwara Road via Shiv Marg and Sawai Jai Singh Marg till Panipech. Since Shiv Marg is very congested road, DMRC was asked to explore the feasibility of providing a Station on Jhotwara Road at entry of Shiv Marg and directly moving along Jhotwara Road to Panipech. Connectivity between Shiv Marg and Collectorate Circle shall be provided with dedicated air-conditioned Jaipur Metro bus service for metro passengers only. A metro kiosk may be provided at Collectorate Circle. A comparative cost analysis with existing proposal also should be included in DPR for appraisal.

vii. The proposed Ambabari Station should be integrated with elevated road under construction by JDA to keep the feasibility of future extension towards Harmada.

11. **Multimodal Integration**: Chief Secretary, Rajasthan emphasized that while working on the DPR adequate attention must be provided for first &last mile connectivity through feeder transport, etc. as well as by providing multimodal

integration for seamless transition of passengers through walkways, FOBs, etc. For this, a separate chapter should be provided in the DPR with adequate details and recommendations. Also various local civic agencies namely JDA, Nagar Nigam, JCTSL etc. should be consulted.

12. **Working Group on UMTA**: With regard to formation of Unified Metropolitan Transport Authority (UMTA), MD JMRC informed that as per the New Metro Rail Policy 2017 following is stated:

> *"For integrated approach in planning and management of urban transport, State Governments should constitute Unified Metropolitan Transport Authority (UMTA) as a statutory body. This Authority would prepare Comprehensive Mobility Plan for the city, organize investments in urban transport infrastructure, establish effective coordination among various urban transport agencies, manage the Urban Transport Fund (UTF) etc."*

Further, it was informed that Secretary, MoHUA, GoI has emphasized on this need for sanction of any metro project. Accordingly, it was decided that:

a) Draft UMTA Bill, shall be piloted for early finalization and legislative sanction.

b) Since, at present already there is an active UMTA as per State Government's Executive Order of year 2007, a proposal may be sent to State Government to constitute a Special Working Group under chairmanship of PS UDH, GoR for planning, coordination of works related to Public Transport of Jaipur having representation from concerning Departments and stakeholders.

13. **DPR for MRTS in other cities**: The matter of providing modern public transport system for remaining routes of Jaipur as well as Tier-2 cities of the State like Kota and Jodhpur was also discussed. It was apprised that various State Governments are now entrusting the task of getting the DPRs for metro to leading metro companies of the respective States e.g. Nagpur Metro (renamed as Maharashtra Metro) are working on Pune Metro and Nasik Metro Neo system. Similarly, Lucknow Metro (now renamed as UP Metro) is working on Kanpur, Agra, Gorakhpur and Allahabad Metro systems. In line with this, it was decided that JMRC may be mandated to get the DPRs for prospective metro systems in Rajasthan State prepared after approval of State Govt. In this regard, a proposal is to be sent to the Govt. of Rajasthan for providing mandate to JMRC.

14. **Transit Oriented Development Policy**: Chief Town Planner Rajasthan informed that as per Metro rail Policy, 2017 under "Enhancing Revenues" there is mention that Transit Oriented Development (TOD) and Value Capture Financing (VCF) to be mandatorily integral part of the Metro Rail project proposals.

In this regard, Government of India has already issued the guidelines for TOD & VCF framework. The Unified Building Byelaws, 2017 of GoR has the provision for allowing higher density of development with higher FAR/BAR & higher heights of building along a major transit corridors enhancing metro and BRTS.

It was therefore decided to identify TOD zone along the finalized route of Metro Rail project and permit higher density of development, mixed land use, higher FAR/BAR & higher heights of buildings as per TOD Policy.

It was also decided that the State Government will prepare Rajasthan TOD Policy based on the national policy. The detailed policy/guidelines shall be issued by Department of Urban Development, GoR in consultation Town Planning Department, Rajasthan.

It was also discussed that the BettermentLevy, so charged on the additional FAR/BAR be allowed under their policy.The amount collected thereon under this head shall be shared between JMRC & JDA/JMC/RHB (whosoever is concerned Authority).

15. **Formation of Dedicated Metro Fund (DMF):** Director (Project)/JMRC informed that in the Cabinet Order no. 132/2010, it was decided to form a DMF and even the sources of revenue to this fund were deliberated upon. It was emphasized that work on constitution of DMF should be expedited.

16. **Formation of 50: 50 SPV with GoI**:Chief Secretary, Rajasthan directed to actively follow up with MoHUA, GoI regarding formation of 50:50 SPV between GoI and GoR for Jaipur Metro Phase-2.

The meeting concluded with note of thanks to the Chair.

(Maneesh Goyal)
Joint Secretary-I

Copy for information to:-

1. Sr. PS to Chief Secretary, Rajasthan, Secretariat, C-Scheme, Jaipur
2. PS to Additional Chief Secretary/Finance, GoR
3. PS to Principal Secretary to Hon'ble Chief Minister, GoR
4. PS to Principal Secretary/UDH, GoR
5. PS to Commissioner, Jaipur Development Authority
6. PS to Managing Director, JMRC
7. Director (Corporate Affairs) / Director (Finance), JMRC
8. Director (Engineering-I), Jaipur Development Authority
9. Chief Town Planner, JLN Marg, Near JDA Building, Jaipur
10. Director (Business Development), DMRC, 25, Ashoka Road, Near Patel Chowk Metro Station, New Delhi-01

Joint Secretary-I

CHAPTER 2- TRAVEL CHARACTERISTICS & DEMAND ESTIMATES

CHAPTER – 2

TRAVEL CHARACTERISTICS AND DEMAND ESTIMATES

2.1 PRIMARY SURVEYS

Relevant primary surveys were conducted as per the terms of reference of the study so as to develop an understanding of the traffic and transportation characteristics of the study area. This section discusses the major findings of the primary surveys carried out as part of the study. The following primary surveys and their specifications have been finalised to carry out passenger forecasting of Jaipur metro phase-2 corridors.

Table 2.1: List of Primary Surveys

Survey	Duration/Samples	Number of Locations
Traffic Volume Count including Occupancy Survey at midblock locations	16 hours for 1 day	27
Traffic Volume Count including Occupancy Survey at midblock locations	24 hours for 1 day	10
Traffic Volume Count –Videography at midblock locations	24 hours for 1 day	15
Traffic Volume Count including Occupancy Survey at screen line	24 hours for 1 day	10
Traffic Volume Count including Occupancy Survey at cordon points	16 hours for 1 day	10
Road side OD Survey including Willingness to shift	16 hours for 1 day	12
Speed and Delay by Moving Car Observer Method	Morning and Evening Peak	-

2.1.1 Traffic Volume Count Survey including Occupancy Survey

Classified Traffic Volume Count (TVC) Survey was carried through manual and videographic methods. TVC surveys (including occupancy surveys) provide information regarding traffic characteristics and the average Occupancy on the study corridor.

Manual Classified Traffic Volume Count Surveys were undertaken at 57 identified locations across the study area. Out of 57 locations, 27 locations have been marked as Midblock location, 10 as Screen line and 10 as cordon point locations. For the purpose of validation and accuracy of manual count data collect, videographic TVC Survey was carried out across 15 midblock locations.

This section discusses the salient aspects of the data collated as part of the traffic volume count surveys. TVC Survey details including the dates of conduction of survey are listed in the following table.

Table 2.2: Survey Locations

Survey	Duration (Hour)	Location ID	Location	Date
Midblock TVC with Occupancy	16	M1	Manpur	09/09/2019
	16	M2	Beelwa	09/06/2019
	16	M3	Sahara City	09/09/2019
	16	M5	Sitapura Industrial Area	04/09/2019
	16	M7	Sanganer	04/09/2019
	16	M8	Airport (Tonk Road)	04/09/2019
	16	M10	Mahaveer Nagar	06/09/2019
	16	M12	Tonk Phatak	06/09/2019
	16	M14	Sawai Mansingh Stadium	06/09/2019
	16	M16	Ashok Marg	06/09/2019
	16	M17	Government Hostel	06/09/2019
	16	M18	Ambabari	11/09/2019
	16	M19	Madhyam Marg	09/09/2019
	16	M20	B2 Bypass near Mansarovar	12/09/2019
	16	M23	Pani Petch	11/09/2019
	16	M25	Muralipura	11/09/2019
	16	M26	Shekhawati Nagar	11/09/2019
	16	M27	Badi Chaupad	09/09/2019
	16	M29	Anaj Mandi	09/09/2019
	16	M30	Transport Nagar	09/09/2019
	16	M31	Madhyam Marg near VT Road	16/09/2019
	16	M32	New Sanganer Road near VT Road	16/09/2019
	16	M33	New Sanganer Road near Vijay Path	16/09/2019
	16	M34	New Sanganer Road near Sumer Nagar	16/09/2019
	16	M35	JLN Marg near Jawahar Circle	15/11/2019
	16	M36	JLN Marg near Mahesh Nagar	15/11/2019
	16	M37	JLN Marg near SMS School	15/11/2019
Midblock TVC with Occupancy	24	M4	Laxmipura	30/08/2019
	24	M6	Haldi Ghati Gate	09/09/2019
	24	M9	Durgapura	29/08/2019
	24	M11	Gopalpura along Tonk road	03/09/2019
	24	M13	Gandhi Nagar Mode	02/09/2019
	24	M15	SMS Hospital	30/08/2019
	24	M21	Chandpole	11/09/2019
	24	M22	Collectorate Circle	09/09/2019

Survey	Duration (Hour)	Location ID	Location	Date
	24	M24	Bandhu Nagar	30/08/2019
	24	M28	Ramganj Chaupar	02/09/2019
Screen Line TVC with Occupancy	24	SL1	Ajmer Puliya	04/09/2019
	24	SL2	Tonk Phatak ROB	11/09/2019
	24	SL3	Sanganer Bridge	11/09/2019
	24	SL4	Shatabdi Nagar Bridge	13/09/2019
	24	SL5	Jhotwara Road (Near Triton Mall)	12/09/2019
	24	SL6	New Sanganer Road ROB	30/08/2019
	24	SL7	Bhawani Singh Road Bridge	13/09/2019
	24	SL8	Khatipura Road (near Army Golf Course)	13/09/2019
	24	SL9	Gopalpura ROB	29/08/2019
	24	SL10	Durgapura ROB	03/09/2019
Outer Cordon TVC with Occupancy	16	CP1	Ajmer Road (NH48) near Kanchan Kesari	09/09/2019
	16	CP2	Kalwad Road (SH2C)	12/09/2019
	16	CP3	Sikar Road (NH52)	13/09/2019
	16	CP4	NH48 near Laxminarayanpura	13/09/2019
	16	CP5	NH248 near Hathi Gaon	13/09/2019
	16	CP6	Alwar Road (SH55)	13/09/2019
	16	CP7	Tonk Road (NH52)	11/09/2019
	16	CP8	Diggi-Malpura Road (SH12)	11/09/2019
	16	CP9	Agra Road (NH21)	09/09/2019
	16	CP10	Khatipura Road	12/09/2019
Videographic TVC	24	VD1	Beelwa	13/09/2019
	24	VD2	Haldi Ghati Gate	06/09/2019
	24	VD3	Airport (Tonk Road)	04/09/2019
	24	VD4	Mahaveer Nagar	09/09/2019
	24	VD5	Tonk Phatak	05/09/2019
	24	VD6	Gandhi Nagar Mode	05/09/2019
	24	VD7	Ramganj Chaupar	05/09/2019
	24	VD8	Ashok Marg	05/09/2019
	24	VD9	Government Hostel	06/09/2019
	24	VD10	Ambabari	09/09/2019
	24	VD11	Bandhu Nagar	05/09/2019
	24	VD12	Shekhawati Nagar	09/09/2019
	24	VD13	Anaj Mandi	04/09/2019
	24	VD14	SMS Hospital	06/09/2019
	24	VD15	Collectorate Circle	09/09/2019
Origin Destination	16	OD1	Laxmipura	06/09/2019
	16	OD2	Haldi Ghati Gate	06/09/2019
	16	OD3	B2 Bypass-Tonk Road Junction	09/09/2019
	16	OD4	Mahaveer Nagar Chouraha	05/09/2019

Survey	Duration (Hour)	Location ID	Location	Date
	16	OD5	Sahakar Marg-Tonk Road Junction	09/09/2019
	16	OD6	Gandhi Nagar Mode	05/09/2019
	16	OD7	Narayan Singh Circle	05/09/2019
	16	OD8	Maharani College Junction	05/09/2019
	16	OD9	MI Road Junction	06/09/2019
	16	OD10	Ambabari	09/09/2019
	16	OD11	Smriti Park Junction	09/09/2019
	16	OD12	Transport Nagar Junction	09/09/2019

Directional classified traffic volume counts are analyzed to obtain:

Average Daily Traffic (ADT) - ADT provides an insight to the amount of traffic moving on various stretches of the corridors and is further appropriately used for assessment.

Peak Hour flows - From observing the peak hour values, the observed peak hour time, its associated traffic and also the peak hour factor the location are obtained.

Directional distribution by hour of the day - Directional distribution presents the directional split in traffic at each survey location.

Traffic composition - Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area.

In addition, Occupancy survey was carried out along with the TVC Survey wherein the mode wise occupancy values were also recorded. These in conjunction with one another are further used for the traffic assessment.

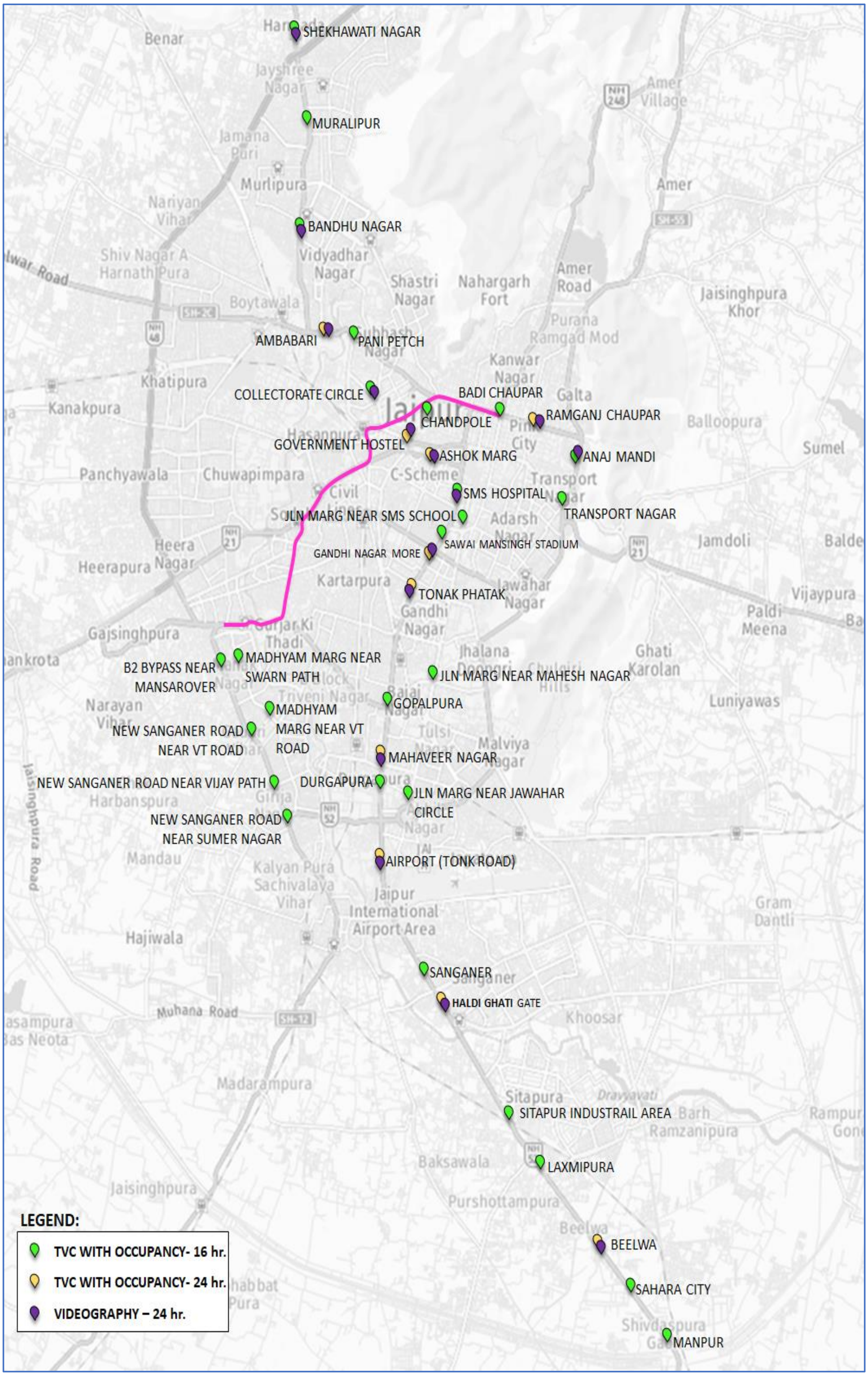


Figure 2.1: Midblock Survey Location Map

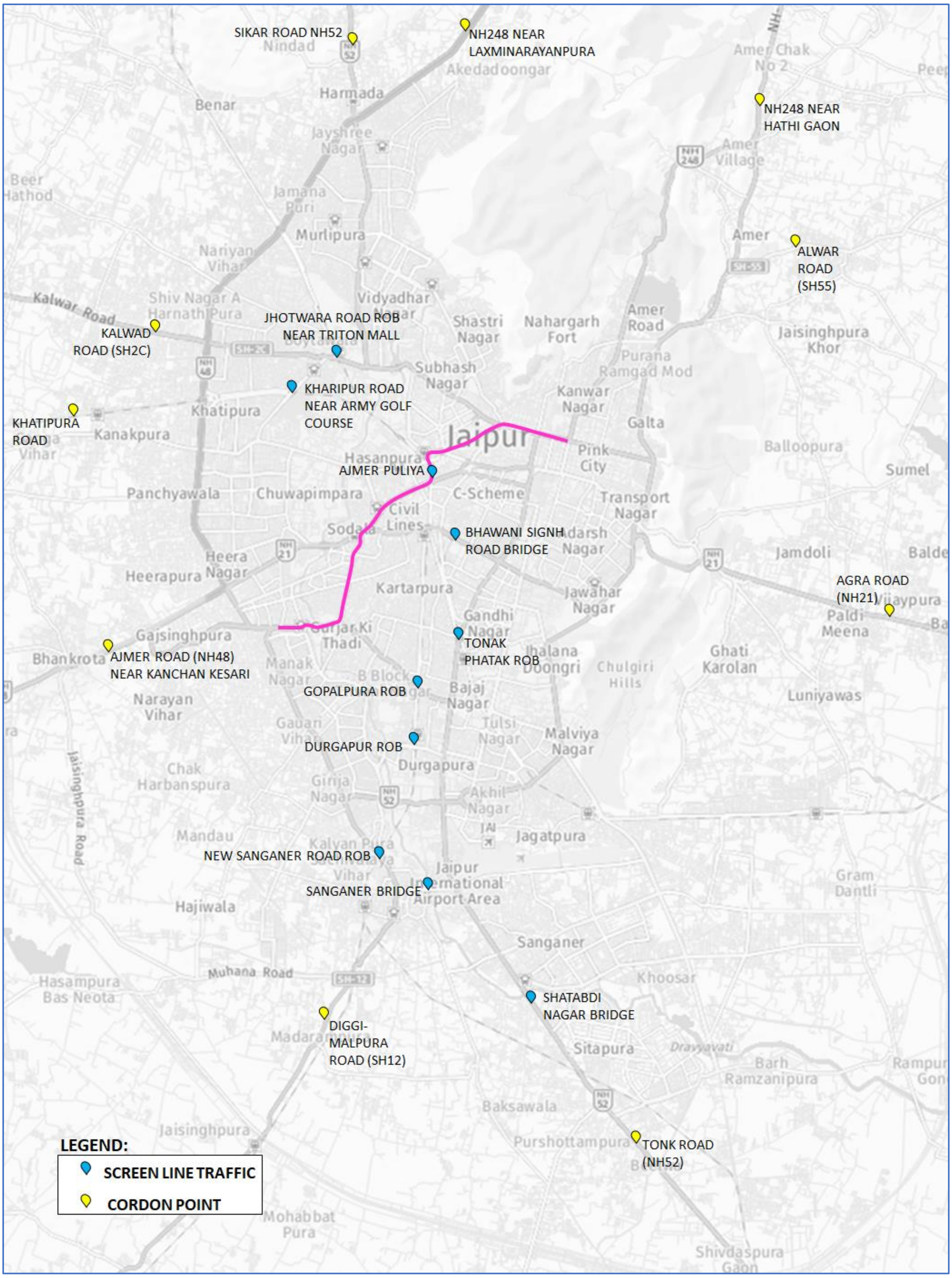


Figure 2.2: Screen Line and Cordon Point Location Map

2.1.2 Observed Traffic Volumes

Traffic Volume counts conducted at various locations along the project corridor provided an insight to the amount of traffic moving on various stretches of the corridor. Tables below show the average traffic volume observed at all individual locations.

Table 2.3: Traffic Volume at Midblock Locations (16-Hours Volumes)

Location ID	Mid-Block	Total PCU	Total Vehicles
MB1	Manpur	12,500	16,553
MB2	Sahara City	12,645	17,443
MB3	Beelwa	18,622	26,136
MB5	Sitapura Industrial Area	22,434	30,245
MB7	Sanganer	45,987	61,106
MB8	Airport (Tonk Road)	76,202	109,681
MB10	Mahaveer Nagar	57,830	76,056
MB12	Tonk Phatak	51,929	70,628
MB14	Sawai Mansingh Stadium	50,768	63,555
MB16	Ashok Marg	30,781	42,769
MB17	Government Hostel	36,961	45,231
MB18	Ambabari	50,177	61,142
MB19	Madhyam Marg near Swarn Path	24,324	31,912
MB20	B2 Bypass near Mansarovar	41,335	59,574
MB23	Pani Petch	48,548	24,895
MB25	Muralipura	35,040	46,305
MB26	Shekhawati Nagar	32,113	40,384
MB27	Badi Chaupad	43,112	55,194
MB29	Anaj Mandi	48,681	60,532
MB30	Transport Nagar	41,903	51,336
MB31	Madhyam Marg near VT Road	19,544	25,576
MB32	New Sanganer Road near VT Road	32,420	45,402
MB33	New Sanganer Road near Vijay Path	33,867	47,869
MB34	New Sanganer Road near Sumer Nagar	30,316	39,933
MB35	JLN Marg near Jawahar Circle	45,944	63,515
MB36	JLN Marg near Mahesh Nagar	40,822	56,493
MB37	JLN Marg near SMS School	46,825	62,890

Table 2.4: Traffic Volume at Midblock Locations (24-Hours Volumes)

Location ID	Location	Vehicle	PCU
MB4	Beelwa	26,883	21,822
MB6	Haldi Ghat Gate	51,960	38,257
MB9	Airport (Tonk Road)	99,644	72,192
MB11	Mahaveer Nagar	91,290	70,892
MB13	Tonk Phatak	85,716	65,905
MB15	Gandhi Nagar Mod	49,854	39,928

Location ID	Location	Vehicle	PCU
MB21	Ramganj Chaupar	51,230	40,563
MB22	Ashok Marg	80,936	61,515
MB24	Government Hostel	51,373	42,088
MB28	Ambabari	67,491	44,850

Table 2.5: Traffic Volume at Screen Line Locations (24-Hours Volumes)

Location ID	Scree Line	Total (24 Hours)	
		Vehicles	PCU
SL1	Ajmer Puliya	98,562	77,575
SL2	Tonk Phatak ROB	91,950	67,581
SL3	Sanganer Bridge	54,674	38,244
SL4	Shatabdi Nagar Bridge	61,743	45,905
SL5	Jhotwara Road (Near Triton Mall)	57,648	43,847
SL6	New Sanganer Road ROB	52,707	36,934
SL7	Bhawani Singh Road Bridge	29,016	22,862
SL8	Khatipura Road (near Army Golf Course)	44,523	32,398
SL9	Gopalpura ROB	48,033	37,341
SL10	Durgapura ROB	49,769	35,758

Table 2.6: Traffic Volume at Outer Cordon Locations (16-Hours Volumes)

Location ID	Codon Point	Total PCU	Total Vehicles	Total Passengers
CP1	Ajmer Road (NH48) near Kanchan Kesari	30,370	40,977	101,651
CP2	Kalwad Road (SH2C)	24,588	33,899	91,132
CP3	Sikar Road (NH52)	35,873	44,714	162,329
CP4	NH48 near Laxminarayanpura	17,841	23,440	71,108
CP5	NH248 near Hathi Gaon	19,824	26,691	80,478
CP6	Alwar Road (SH55)	12,003	16,803	45,762
CP7	Tonk Road (NH52)	37,577	51,428	127,875
CP8	Diggi-Malpura Road (SH12)	34,254	46,923	115,402
CP9	Agra Road (NH21)	35,416	46,192	151,966
CP10	Khatipura Road	20,329	28,494	64,478

The above Tables represent average weekday volume observed at individual locations for 16 hours and 24 hrs. It can be noted that highest vehicular flow of 109,681 (76,2020 PCU) for 16 hours is observed at Midblock location no. 8 i.e. Airport (Tonk road). The lowest vehicular flow of 16,803 (12,003 PCU) is observed at Cordon point location no. 6 i.e. Alwar road.

The Passenger Car Unit (PCU) values adopted for the study are provided in the following table.

Table 2.7: PCU Values Adopted for the Study

Vehicle Type	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus
PCU	0.5	1.00	1.00	1.00	1.00	1.5	3.00	3.00

2.1.3 Vehicle Occupancy

The occupancy survey for vehicles was undertaken as part of the traffic studies. The purpose of this study is to determine the existing sectional ridership on the particular route during the study period. This would act as a major input towards model development and validation. The occupancy survey was also carried out along with TVC Survey. The location wise occupancy details are provided in the following table, wherein mode wise observed average occupancy values are listed.

Table 2.8: Occupancy Survey Summary

Location ID	Mid-Block	Mode-wise Average Occupancy Summary for all Vehicles (16 Hours)							
		Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus
MB1	Manpur	1.50	2.61	3.86	2.70	0.00	15.59	39.67	40.57
MB2	Sahara City	1.43	2.31	3.70	2.36	2.71	17.54	39.51	39.84
MB3	Beelwa	1.49	2.20	3.94	2.62	2.57	17.45	27.30	23.25
MB4	Laxmipura	1.36	1.83	2.23	2.34	2.01	22.02	26.80	29.59
MB5	Sitapura Industrial Area	1.46	2.31	3.70	2.36	2.92	17.54	39.51	39.84
MB6	Haldi Ghati Gate	1.37	1.86	2.30	2.46	1.89	22.35	27.92	29.15
MB7	Sanganer	1.49	2.45	3.78	2.53	3.03	16.24	39.44	40.51
MB8	Airport (Tonk Road)	1.40	2.32	3.63	2.32	3.36	16.72	30.97	38.53
MB9	Durgapura	1.38	1.81	2.27	2.37	2.98	22.61	26.78	28.81
MB10	Mahaveer Nagar	1.49	1.98	3.87	2.53	3.33	15.99	38.70	39.27
MB11	Gopalpura on Tonk road	1.54	1.87	2.66	2.82	2.70	23.65	35.18	46.38
MB12	Tonk Phatak	1.42	1.93	3.68	2.35	3.24	16.74	37.81	36.60
MB13	Gandhi Nagar Mode	1.40	1.83	2.35	2.34	2.57	22.63	36.05	33.42
MB14	Sawai Mansingh Stadium	1.50	2.06	3.68	2.58	3.28	15.60	40.47	38.79
MB15	SMS Hospital	1.39	1.85	2.36	2.38	2.50	22.37	27.61	27.08
MB16	Ashok Marg	1.51	2.43	3.80	2.52	3.12	17.34	40.42	40.33
MB17	Government	1.56	1.98	3.72	2.31	3.18	15.95	41.24	38.66

Location ID	Mid-Block	Mode-wise Average Occupancy Summary for all Vehicles (16 Hours)							
		Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus
	Hostel								
MB18	Ambabari	1.52	2.02	3.65	2.41	2.74	16.06	40.35	41.47
MB19	Madhyam Marg near Swarn Path	1.43	2.20	3.73	1.90	3.13	18.13	36.53	0.00
MB20	B2 Bypass near Mansarovar	1.48	2.25	4.18	2.57	3.18	17.12	35.49	36.00
MB21	Chandpole	1.40	1.83	2.37	2.44	2.51	21.92	34.71	32.33
MB22	Collectorate Circle	1.41	1.90	2.29	2.42	2.47	22.11	35.73	35.28
MB23	Pani Petch	1.57	1.90	3.57	2.31	3.10	16.00	41.40	41.80
MB24	Bandhu Nagar	1.40	1.85	2.30	2.44	2.50	22.76	27.00	26.81
MB25	Muralipura	1.48	2.11	5.13	2.33	3.28	17.91	40.12	41.40
MB26	Shekhawati Nagar	1.49	2.10	4.62	2.47	3.50	17.01	40.33	40.93
MB27	Badi Chaupad	1.49	2.04	5.11	2.34	3.65	17.58	37.52	0.00
MB28	Ramganj Chaupar	1.40	1.84	2.37	2.44	3.62	22.88	0.00	0.00
MB29	Anaj Mandi	1.52	2.73	4.56	2.62	3.69	16.37	38.49	32.25
MB30	Transport Nagar	1.60	2.50	4.82	2.52	2.95	18.10	37.80	32.29
MB31	Madhyam Marg near VT Road	1.42	2.06	3.78	2.26	3.19	18.25	40.81	0.00
MB32	New Sanganer Road near VT Road	1.47	2.23	4.10	2.57	3.20	16.31	39.40	40.42
MB33	New Sanganer Road near Vijay Path	1.48	2.26	3.71	2.84	3.20	14.76	37.58	36.61
MB34	New Sanganer Road near Sumer Nagar	1.49	2.38	3.58	2.84	3.12	15.00	35.20	33.93
MB35	JLN Marg near Jawahar Circle	1.50	2.17	3.64	2.84	3.19	14.89	34.18	27.50
MB36	JLN Marg near Mahesh	1.46	2.12	3.64	2.73	3.28	14.19	34.99	12.50

Location ID	Mid-Block	Mode-wise Average Occupancy Summary for all Vehicles (16 Hours)							
		Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus
	Nagar								
MB37	JLN Marg near SMS School	1.55	2.25	3.58	2.54	0.00	14.08	32.38	24.58
Average		**1.47**	**2.12**	**3.52**	**2.48**	**2.83**	**18.10**	**35.01**	**30.99**

The observed average occupancy values for all passenger modes were collated to obtain an accurate estimation of passenger movement. Occupancy values were used in conjunction with the traffic volumes to estimate the prevalent passenger movement at individual survey locations. The following table presents the location wise summary of the above-mentioned survey locations.

Table 2.9: Location-wise Traffic Summary (16 Hours)

Location ID	Location	ADT		Passenger Volume
		Vehicle	PCU	
MIDBLOCK				
MB1	Manpur	16,553	12,500	45,492
MB2	Sahara City	17,443	12,645	40,778
MB3	Beelwa	26,136	18,622	62,483
MB4	Laxmipura	24,895	19,890	73,566
MB5	Sitapura Industrial Area	30,245	22,434	77,797
MB6	Haldi Ghati Gate	50,042	36,923	129,084
MB7	Sanganer	61,106	45,987	170,439
MB8	Airport (Tonk Road)	109,681	76,202	236,143
MB9	Durgapura	94,084	67,351	203,761
MB10	Mahaveer Nagar	76,056	57,830	228,862
MB11	Gopalpura on Tonk road	84,503	65,008	222,120
MB12	Tonk Phatak	70,628	51,929	174,212
MB13	Gandhi Nagar Mode	77,288	58,813	208,436
MB14	Sawai Mansingh Stadium	63,555	50,768	221,585
MB15	SMS Hospital	47,078	37,430	148,333
MB16	Ashok Marg	42,769	30,781	100,858
MB17	Government Hostel	45,231	36,961	188,535
MB18	Ambabari	61,142	50,177	224,206
MB19	Madhyam Marg near Swarn Path	31,912	24,324	79,991
MB20	B2 Bypass near Mansarovar	59,574	41,335	121,346
MB21	Chandpole	45,263	36,809	157,301
MB22	Collectorate Circle	77,454	58,298	185,674
MB23	Pani Petch	56,108	48,548	231,869
MB24	Bandhu Nagar	45,974	37,585	148,655
MB25	Muralipura	46,305	35,040	126,749
MB26	Shekhawati Nagar	40,384	32,113	131,712

Location ID	Location	ADT		Passenger Volume
		Vehicle	PCU	
MB27	Badi Chaupad	55,194	43,112	140,181
MB28	Ramganj Chaupar	61,974	40,785	124,943
MB29	Anaj Mandi	60,532	48,681	200,685
MB30	Transport Nagar	51,336	41,903	178,151
MB31	Madhyam Marg near VT Road	25,576	19,544	68,234
MB32	New Sanganer Road near VT Road	45,402	32,420	95,164
MB33	New Sanganer Road near Vijay Path	47,869	33,867	114,443
MB34	New Sanganer Road near Sumer Nagar	39,933	30,316	103,399
MB35	JLN Marg near Jawahar Circle	63,515	45,944	144,909
MB36	JLN Marg near Mahesh Nagar	56,493	40,822	121,171
MB37	JLN Marg near SMS School	62,890	46,825	141,015
SCREEN LINE				
SL1	Ajmer Puliya	92,062	72,517	215,343
SL2	Tonk Phatak ROB	85,336	62,149	196,895
SL3	Sanganer Bridge	51,836	35,982	119,575
SL4	Shatabdi Nagar Bridge	59,716	44,271	165,177
SL5	Jhotwara Road (Near Triton Mall)	52,118	39,584	127,222
SL6	New Sanganer Road ROB	49,862	34,664	114,154
SL7	Bhawani Singh Road Bridge	27,205	21,109	82,942
SL8	Khatipura Road (near Army Golf Course)	42,551	30,915	88,056
SL9	Gopalpura ROB	43,624	34,046	97,879
SL10	Durgapura ROB	45,759	32,535	93,865
CORDON POINTS				
CP1	Ajmer Road (NH48) near Kanchan Kesari	40,977	30,370	101,651
CP2	Kalwad Road (SH2C)	33,899	24,588	91,132
CP3	Sikar Road (NH52)	44,714	35,873	162,329
CP4	NH48 near Laxminarayanpura	23,440	17,841	71,108
CP5	NH248 near Hathi Gaon	26,691	19,824	80,478
CP6	Alwar Road (SH55)	16,803	12,003	45,762
CP7	Tonk Road (NH52)	51,428	37,577	127,875
CP8	Diggi-Malpura Road (SH12)	46,923	34,254	115,402
CP9	Agra Road (NH21)	46,192	35,416	151,966
CP10	Khatipura Road	28,494	20,329	64,478

2.1.4 Vehicular Composition

Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area. The overall composition is expressed in the following chart.

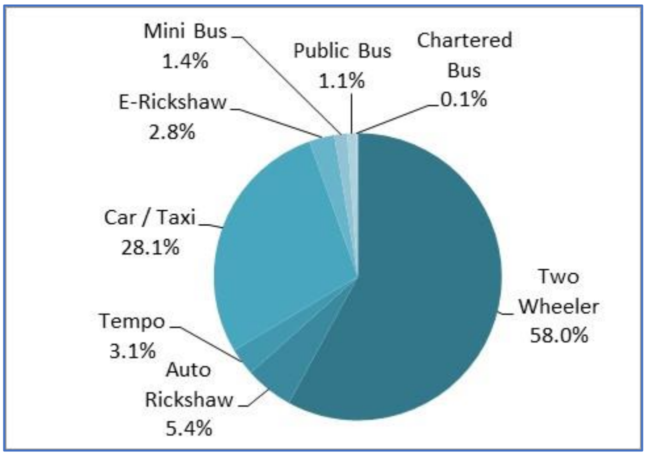


Figure 2.3: Vehicular Composition at Midblock Locations

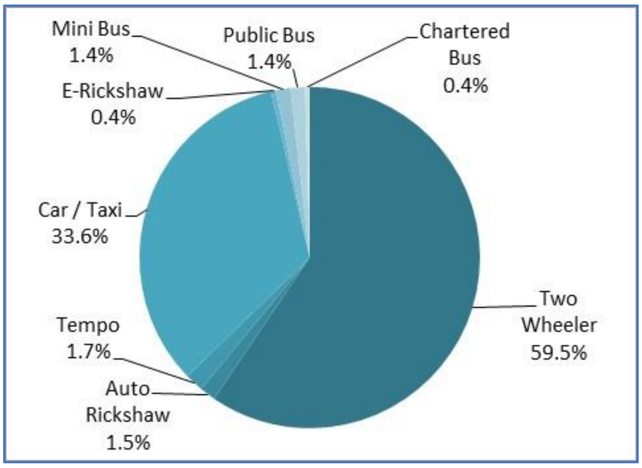


Figure 2.4: Vehicular Composition at Screen Line Locations

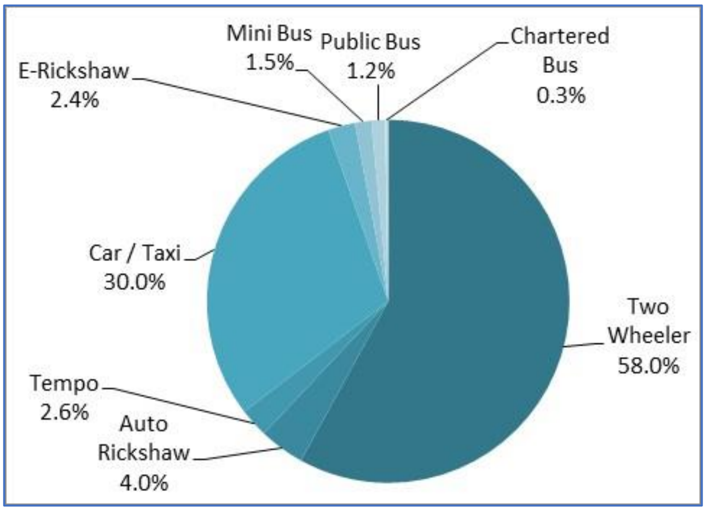


Figure 2.5: Vehicular Composition at Cordon Points

Average vehicular composition recorded during the traffic volume study shows that majority of the traffic comprises of two-wheelers (58%) and cars/taxi (30%). Mini bus recorded the share of less than 1.2% and chartered bus recorded a negligible share of 0.3%. Overall private vehicle accounted for 97% of total traffic at surveyed locations. The following table presents the vehicle composition of the surveyed locations.

Table 2.10: Vehicle Composition at Surveyed Locations

Location ID	Location	Vehicles	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus	Total Vehicles
MIDBLOCK											
MB1	Manpur	Vehicles	9,204	52	211	6,516	0	394	156	20	16,553
		%	**55.6%**	**0.3%**	**1.3%**	**39.4%**	**0.0%**	**2.4%**	**0.9%**	**0.1%**	**100%**
MB2	Sahara City	Vehicles	10,556	51	117	6,402	32	60	157	68	17,443
		%	**60.5%**	**0.3%**	**0.7%**	**36.7%**	**0.2%**	**0.3%**	**0.9%**	**0.4%**	**100%**
MB3	Beelwa	Vehicles	16,441	101	697	8,180	67	396	169	85	26,136
		%	**62.9%**	**0.4%**	**2.7%**	**31.3%**	**0.3%**	**1.5%**	**0.6%**	**0.3%**	**100%**
MB4	Laxmipura	Vehicles	13,268	671	289	9,298	82	630	616	41	24,895
		%	**53.3%**	**2.7%**	**1.2%**	**37.3%**	**0.3%**	**2.5%**	**2.5%**	**0.2%**	**100%**
MB5	Sitapura Industrial Area	Vehicles	17,472	204	617	10,917	50	697	219	69	30,245
		%	**57.8%**	**0.7%**	**2.0%**	**36.1%**	**0.2%**	**2.3%**	**0.7%**	**0.2%**	**100%**
MB6	Haldi Ghati Gate	Vehicles	43,713	2,282	863	13,763	452	809	447	518	50,042
		%	**87.4%**	**4.6%**	**1.7%**	**27.5%**	**0.9%**	**1.6%**	**0.9%**	**1.0%**	**100%**
MB7	Sanganer	Vehicles	34,988	2,020	1,604	19,624	710	1,297	746	117	61,106
		%	**57.3%**	**3.3%**	**2.6%**	**32.1%**	**1.2%**	**2.1%**	**1.2%**	**0.2%**	**100%**
MB8	Airport (Tonk Road)	Vehicles	72,115	5,554	1,792	27,704	540	916	845	215	109,681
		%	**65.7%**	**5.1%**	**1.6%**	**25.3%**	**0.5%**	**0.8%**	**0.8%**	**0.2%**	**100%**
MB9	Durgapura	Vehicles	57,922	4,632	1,682	26,216	1,855	884	812	81	94,084
		%	**61.6%**	**4.9%**	**1.8%**	**27.9%**	**2.0%**	**0.9%**	**0.9%**	**0.1%**	**100%**
MB10	Mahaveer Nagar	Vehicles	44,697	2,337	2,814	22,290	992	1,153	1,686	87	76,056
		%	**58.8%**	**3.1%**	**3.7%**	**29.3%**	**1.3%**	**1.5%**	**2.2%**	**0.1%**	**100%**
MB11	Gopalpura on Tonk road	Vehicles	42,973	3,672	1,090	34,232	1,011	706	728	91	84,503
		%	**50.9%**	**4.3%**	**1.3%**	**40.5%**	**1.2%**	**0.8%**	**0.9%**	**0.1%**	**100%**
MB12	Tonk Phatak	Vehicles	42,391	6,038	560	19,118	607	888	765	261	70,628
		%	**60.0%**	**8.5%**	**0.8%**	**27.1%**	**0.9%**	**1.3%**	**1.1%**	**0.4%**	**100%**
MB13	Gandhi Nagar Mode	Vehicles	43,713	6,097	982	22,593	1,256	1,275	1,148	224	77,288
		%	**56.6%**	**7.9%**	**1.3%**	**29.2%**	**1.6%**	**1.6%**	**1.5%**	**0.3%**	**100%**
MB14	Sawai Mansingh Stadium	Vehicles	34,592	2,043	2,993	18,570	1,739	1,818	1,644	156	63,555
		%	**54.4%**	**3.2%**	**4.7%**	**29.2%**	**2.7%**	**2.9%**	**2.6%**	**0.2%**	**100%**
MB15	SMS Hospital	Vehicles	26,169	4,05	2,84	7,486	3,677	1,509	1,290	51	47,078

Location ID	Location	Vehicles	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus	Total Vehicles
				2	4						
		%	55.6%	8.6%	6.0%	15.9%	7.8%	3.2%	2.7%	0.1%	100%
MB16	Ashok Marg	Vehicles	25,541	3,184	618	11,237	1,350	597	185	57	42,769
		%	59.7%	7.4%	1.4%	26.3%	3.2%	1.4%	0.4%	0.1%	100%
MB17	Government Hostel	Vehicles	26,872	4,799	271	7,430	2,527	999	1,744	589	45,231
		%	59.4%	10.6%	0.6%	16.4%	5.6%	2.2%	3.9%	1.3%	100%
MB18	Ambabari	Vehicles	31,986	2,338	2,066	18,983	1,951	1,739	1,642	437	61,142
		%	52.3%	3.8%	3.4%	31.0%	3.2%	2.8%	2.7%	0.7%	100%
MB19	Madhyam Marg near Swarn Path	Vehicles	16,937	1,127	1,378	9,958	1,316	1,008	188	0	31,912
		%	53.1%	3.5%	4.3%	31.2%	4.1%	3.2%	0.6%	0.0%	100%
MB20	B2 Bypass near Mansarovar	Vehicles	37,096	1,497	1,806	17,865	1,095	81	102	32	59,574
		%	62.3%	2.5%	3.0%	30.0%	1.8%	0.1%	0.2%	0.1%	100%
MB21	Chandpole	Vehicles	24,722	3,950	2,711	9,399	1,690	1,117	1,416	258	45,263
		%	54.6%	8.7%	6.0%	20.8%	3.7%	2.5%	3.1%	0.6%	100%
MB22	Collectorate Circle	Vehicles	43,382	3,636	510	28,110	400	198	630	588	77,454
		%	56.0%	4.7%	0.7%	36.3%	0.5%	0.3%	0.8%	0.8%	100%
MB23	Pani Petch	Vehicles	26,103	2,689	3,262	17,395	2,090	2,431	1,618	520	56,108
		%	46.5%	4.8%	5.8%	31.0%	3.7%	4.3%	2.9%	0.9%	100%
MB24	Bandhu Nagar	Vehicles	24,054	1,285	669	17,046	163	1,251	1,238	268	45,974
		%	52.3%	2.8%	1.5%	37.1%	0.4%	2.7%	2.7%	0.6%	100%
MB25	Muralipura	Vehicles	25,967	1,242	586	16,678	142	1,108	410	172	46,305
		%	56.1%	2.7%	1.3%	36.0%	0.3%	2.4%	0.9%	0.4%	100%
MB26	Shekhawati Nagar	Vehicles	21,855	264	243	16,169	150	500	985	218	40,384
		%	54.1%	0.7%	0.6%	40.0%	0.4%	1.2%	2.4%	0.5%	100%
MB27	Badi Chaupad	Vehicles	25,096	1,985	3,524	14,191	9,925	320	153	0	55,194
		%	45.5%	3.6%	6.4%	25.7%	18.0%	0.6%	0.3%	0.0%	100%
MB28	Ramganj Chaupar	Vehicles	42,600	3,054	656	2,281	13,161	222	0	0	61,974
		%	68.7%	4.9%	1.1%	3.7%	21.2%	0.4%	0.0%	0.0%	100%
MB29	Anaj Mandi	Vehicles	30,472	2,443	2,301	15,672	7,299	870	1,174	301	60,532

Location ID	Location	Vehicles	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus	Total Vehicles
		%	**50.3%**	**4.0%**	**3.8%**	**25.9%**	**12.1 %**	**1.4%**	**1.9%**	**0.5%**	**100%**
MB30	Transport Nagar	Vehicles	25,880	1,712	1,754	14,890	4,661	914	1,220	305	51,336
		%	**50.4%**	**3.3%**	**3.4%**	**29.0%**	**9.1%**	**1.8%**	**2.4%**	**0.6%**	**100%**
MB31	Madhyam Marg near VT Road	Vehicles	13,647	901	836	8,246	1,020	707	219	0	25,576
		%	**53.4%**	**3.5%**	**3.3%**	**32.2%**	**4.0%**	**2.8%**	**0.9%**	**0.0%**	**100%**
MB32	New Sanganer Road near VT Road	Vehicles	26,533	822	1,123	15,946	775	81	99	23	45,402
		%	**58.4%**	**1.8%**	**2.5%**	**35.1%**	**1.7%**	**0.2%**	**0.2%**	**0.1%**	**100%**
MB33	New Sanganer Road near Vijay Path	Vehicles	29,925	2,101	1,717	12,018	1,175	604	285	44	47,869
		%	**62.5%**	**4.4%**	**3.6%**	**25.1%**	**2.5%**	**1.3%**	**0.6%**	**0.1%**	**100%**
MB34	New Sanganer Road near Sumer Nagar	Vehicles	21,099	1,194	1,486	14,370	852	621	271	40	39,933
		%	**52.8%**	**3.0%**	**3.7%**	**36.0%**	**2.1%**	**1.6%**	**0.7%**	**0.1%**	**100%**
MB35	JLN Marg near Jawahar Circle	Vehicles	36,526	2,301	1,764	21,917	143	691	146	27	63,515
		%	**57.5%**	**3.6%**	**2.8%**	**34.5%**	**0.2%**	**1.1%**	**0.2%**	**0.0%**	**100%**
MB36	JLN Marg near Mahesh Nagar	Vehicles	32,067	1,103	1,367	21,340	155	373	85	3	56,493
		%	**56.8%**	**2.0%**	**2.4%**	**37.8%**	**0.3%**	**0.7%**	**0.2%**	**0.0%**	**100%**
MB37	JLN Marg near SMS School	Vehicles	33,550	2,186	1,656	24,585	0	744	158	11	62,890
		%	**53.3%**	**3.5%**	**2.6%**	**39.1%**	**0.0%**	**1.2%**	**0.3%**	**0.0%**	**100%**
SCREEN LINE											
SL1	Ajmer Puliya	Vehicles	44,880	5,177	4,559	31,675	3,575	998	1,067	131	92,062
		%	**48.7%**	**5.6%**	**5.0%**	**34.4%**	**3.9%**	**1.1%**	**1.2%**	**0.1%**	**100.0 %**
SL2	Tonk Phatak ROB	Vehicles	52,677	6,630	611	22,323	714	1,074	1,143	164	85,336
		%	**61.7%**	**7.8%**	**0.7%**	**26.2%**	**0.8%**	**1.3%**	**1.3%**	**0.2%**	**100%**
SL3	Sanganer Bridge	Vehicles	34,687	3,376	2,275	8,337	1,578	1,118	432	33	51,836
		%	**66.9%**	**6.5%**	**4.4%**	**16.1%**	**3.0%**	**2.2%**	**0.8%**	**0.1%**	**100%**
SL4	Shatabdi Nagar Bridge	Vehicles	37,741	1,587	682	16,315	629	1,399	1,294	69	59,716
		%	**63.2%**	**2.7%**	**1.1%**	**27.3%**	**1.1%**	**2.3%**	**2.2%**	**0.1%**	**100%**
SL5	Jhotwara Road (Near Triton Mall)	Vehicles	28,539	1,897	1,734	16,523	1,833	966	603	23	52,118

Location ID	Location	Vehicles	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus	Total Vehicles
		%	**54.8%**	**3.6%**	**3.3%**	**31.7%**	**3.5%**	**1.9%**	**1.2%**	**0.0%**	**100%**
SL6	New Sanganer Road ROB	Vehicles	33,248	3,315	2,245	8,032	1,511	1,064	415	32	49,862
		%	**66.7%**	**6.6%**	**4.5%**	**16.1%**	**3.0%**	**2.1%**	**0.8%**	**0.1%**	**100%**
SL7	Bhawani Singh Road Bridge	Vehicles	14,815	664	544	9,681	529	422	482	68	27,205
		%	**54.5%**	**2.4%**	**2.0%**	**35.6%**	**1.9%**	**1.6%**	**1.8%**	**0.2%**	**100%**
SL8	Khatipura Road (near Army Golf Course)	Vehicles	24,024	2,092	1,525	13,353	1,132	316	109	0	42,551
		%	**56.5%**	**4.9%**	**3.6%**	**31.4%**	**2.7%**	**0.7%**	**0.3%**	**0.0%**	**100%**
SL9	Gopalpura ROB	Vehicles	20,453	2,991	1,370	15,907	2,345	312	209	37	43,624
		%	**46.9%**	**6.9%**	**3.1%**	**36.5%**	**5.4%**	**0.7%**	**0.5%**	**0.1%**	**100%**
SL10	Durgapura ROB	Vehicles	27,732	1,962	1,459	12,410	1,731	192	267	6	45,759
		%	**60.6%**	**4.3%**	**3.2%**	**27.1%**	**3.8%**	**0.4%**	**0.6%**	**0.0%**	**100%**
CORDON POINTS											
CP1	Ajmer Road (NH48) near Kanchan Kesari	Vehicles	23,719	387	309	15,424	245	356	461	76	40,977
		%	**57.9%**	**0.9%**	**0.8%**	**37.6%**	**0.6%**	**0.9%**	**1.1%**	**0.2%**	**100%**
CP2	Kalwad Road (SH2C)	Vehicles	21,093	554	278	10,700	219	583	396	76	33,899
		%	**62.2%**	**1.6%**	**0.8%**	**31.6%**	**0.6%**	**1.7%**	**1.2%**	**0.2%**	**100%**
CP3	Sikar Road (NH52)	Vehicles	25,294	492	211	15,821	175	1,091	1,382	248	44,714
		%	**56.6%**	**1.1%**	**0.5%**	**35.4%**	**0.4%**	**2.4%**	**3.1%**	**0.6%**	**100.0%**
CP4	NH48 near Laxminarayanpura	Vehicles	13,857	85	456	8,327	0	67	531	117	23,440
		%	**59.1%**	**0.4%**	**1.9%**	**35.5%**	**0.0%**	**0.3%**	**2.3%**	**0.5%**	**100%**
CP5	NH248 near Hathi Gaon	Vehicles	16,601	54	32	8,882	49	475	321	277	26,691
		%	**62.2%**	**0.2%**	**0.1%**	**33.3%**	**0.2%**	**1.8%**	**1.2%**	**1.0%**	**100%**
CP6	Alwar Road (SH55)	Vehicles	10,952	227	193	4,781	130	243	230	47	16,803
		%	**65%**	**1%**	**1%**	**28%**	**1%**	**1%**	**1%**	**0%**	**100%**
CP7	Tonk Road (NH52)	Vehicles	30,518	432	1,552	17,500	230	656	343	197	51,428
		%	**59%**	**1%**	**3%**	**34%**	**0%**	**1%**	**1%**	**0%**	**100%**
CP8	Diggi-Malpura Road (SH12)	Vehicles	27,357	1,480	2,024	15,077	85	527	247	126	46,923
		%	**58%**	**3%**	**4%**	**32%**	**0%**	**1%**	**1%**	**0%**	**100%**
CP9	Agra Road	Vehicles	27,521	897	1,14	14,031	436	892	898	371	46,192

Location ID	Location	Vehicles	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus	Total Vehicles
	(NH21)				6						
		%	**59.6%**	**1.9%**	**2.5%**	**30.4%**	**0.9%**	**1.9%**	**1.9%**	**0.8%**	**100%**
CP10	Khatipura Road	Vehicles	16,999	884	91	10,193	0	213	90	24	28,494
		%	**59.7%**	**3.1%**	**0.3%**	**35.8%**	**0.0%**	**0.7%**	**0.3%**	**0.1%**	**100%**

2.1.5 Peak Hour Flows

Peak Hour and peak hour characteristics (Peak Hour PCU, Peak Period Factor) obtained during the 16 hours TVC survey are listed in the following table.

Table 2.11: Peak Hour, Peak Hour PCU and Peak Hour Factor Summary

Location	Peak Hour	Peak Hour PCU	Peak Hour Factor w.r.t. 16 Hour PCU
MIDBLOCK			
MB1	9:45-10:45	1,349	10.79%
MB2	17:45-18:45	1,344	10.63%
MB3	18:00-19:00	1,849	9.93%
MB5	17:45-18:45	2,238	9.98%
MB7	9:30-10:30	4,192	9.11%
MB8	17:30-18:30	6,710	8.80%
MB10	9:45-10:45	5,046	8.72%
MB12	9:45-10:45	4,393	8.46%
MB14	9:45-10:45	4,310	8.49%
MB16	17:45-18:45	2,936	9.54%
MB17	18:00-19:00	3,285	8.89%
MB18	9:45-10:45	4,445	8.86%
MB19	9:30-10:30	2,107	8.66%
MB20	18:00-19:00	4,050	9.80%
MB23	17:00-18:00	4,214	8.68%
MB25	9:45-10:45	3,493	9.97%
MB26	17:30-18:30	2,727	8.49%
MB27	9:15-10:15	3,982	9.24%
MB29	9:15-10:15	4,467	9.18%
MB30	17:30-18:30	3,901	9.31%
MB31	17:30-18:30	1,851	9.47%
MB32	18:00-19:00	3,070	9.47%
MB33	9:30-10:30	2,903	8.57%
MB34	18:00-19:00	2,603	8.58%
MB35	10:15-11:15	4,161	9.06%
MB36	12:00-13:00	3,687	9.03%
MB37	18:15-19:15	4,120	8.80%
SCREEN LINE			
SL1	18:30-19:30	8,076	10.41%

Location	Peak Hour	Peak Hour PCU	Peak Hour Factor w.r.t. 16 Hour PCU
SL2	18:30-19:30	5,130	7.59%
SL3	9:30-10:30	2,867	7.50%
SL4	9:45-10:45	3,731	8.13%
SL5	17:15-18:15	3,077	7.02%
SL6	12:30-13:30	2,811	7.61%
SL7	11:30-12:30	1,606	7.02%
SL8	16:15-17:15	2,567	7.92%
SL9	18:00-19:00	3,012	8.06%
SL10	19:00-20:00	2,944	8.23%
CORDON POINTS			
CP1	10:15-11:15	2,990	9.84%
CP2	18:00-19:00	2,258	9.18%
CP3	10:15-11:15	4,547	12.67%
CP4	9:30-10:30	1,963	11.00%
CP5	10:45-11:45	1,867	9.42%
CP6	9:30-10:30	1,304	10.86%
CP7	18:00-19:00	4,034	10.73%
CP8	17:45-18:45	3,224	9.41%
CP9	10:15-11:15	3,181	8.98%
CP10	11:30-12:30	1,558	7.66%

The average peak hour share across the survey locations is 9.1%. In addition to aggregate TVC estimates, other aspects of traffic were also covered through the survey viz. Hourly variation, intraday variation, peak hour traffic and peak hour characteristics, directional distribution of traffic etc.

2.1.6 Traffic Volumes at Videographic Survey Locations

In addition to the manual count, videograpghic volume count was also carried out at 10 locations along the study corridor. These were carried out for 24-hour period for 1 day. The obtained traffic volume from the above survey is provided in the following tables.

Table 2.12: Summary of Videographic TVC -24 Hours Vehicular Traffic

Location ID	Location	ADT (16 Hours)		ADT (24 Hours)	
		Vehicle	PCU	Vehicle	PCU
VD1	Beelwa	24,908	18,379	29,205	21,687
VD2	Haldi Ghat Gate	62,308	46,090	73,403	58,537
VD3	Airport (Tonk Road)	128,781	89,428	144,501	106,484
VD4	Mahaveer Nagar	97,876	70,642	106,300	77,365
VD5	Tonk Phatak	86,134	63,317	96,641	72,140
VD6	Gandhi Nagar Mod	70,948	54,004	79,794	61,386
VD7	Ramganj Chaupar	56,802	37,470	66,837	46,243

Location ID	Location	ADT (16 Hours)		ADT (24 Hours)	
		Vehicle	PCU	Vehicle	PCU
VD8	Ashok Marg	46,988	33,806	50,498	36,750
VD9	Government Hostel	51,637	42,140	63,631	53,792
VD10	Ambabari	62,097	53,133	68,313	58,843
VD11	Bandhu Nagar	55,019	41,649	62,767	49,366
VD12	Shekhawati Nagar	50,099	36,421	55,794	41,466
VD13	Anaj Mandi	64,093	49,616	68,274	53,111
VD14	SMS Hospital	43,628	34,282	50,053	39,432
VD15	Collectorate Circle	68,279	51,421	77,181	60,536

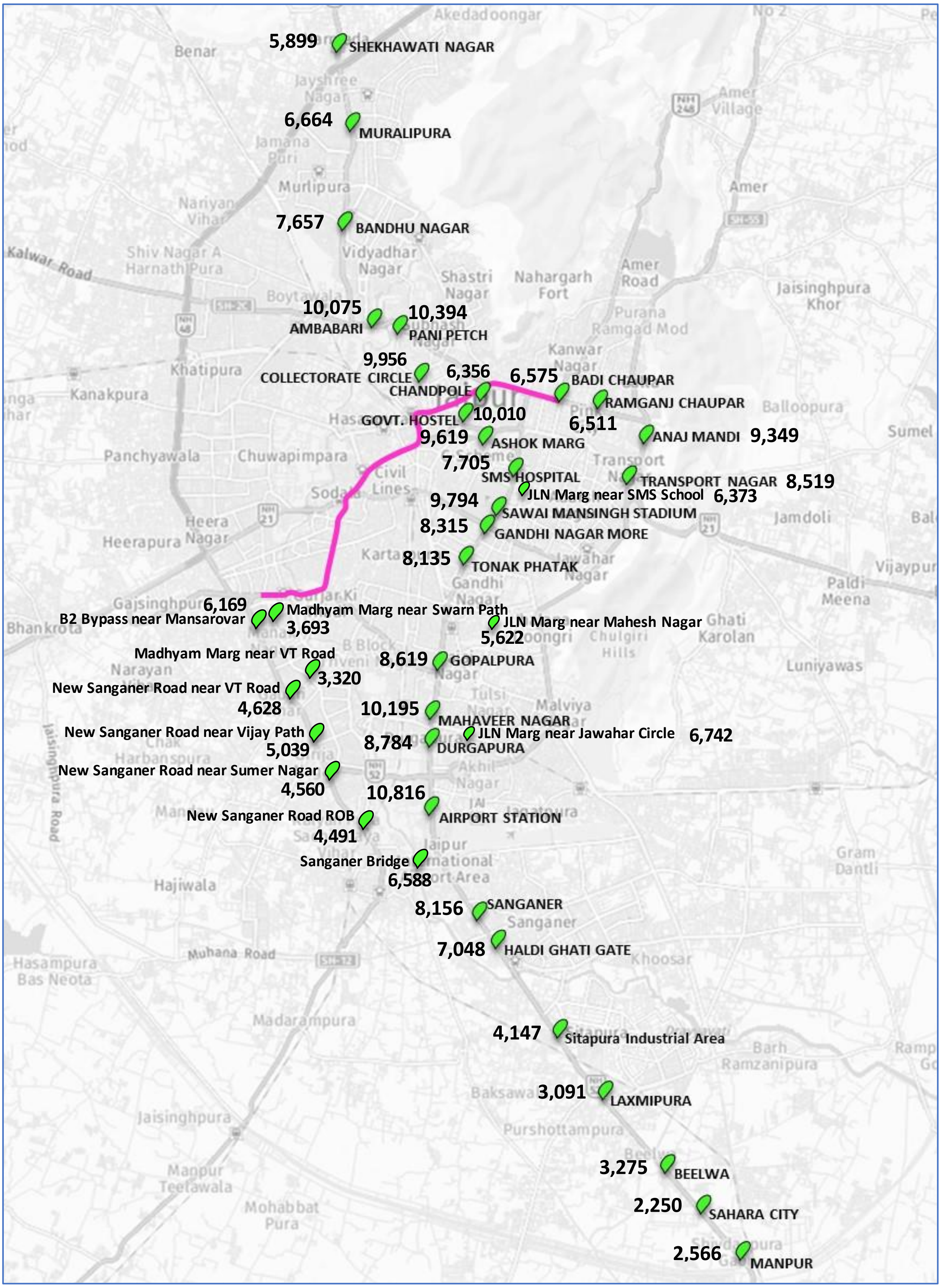


Figure 2.6: Observed Traffic Volumes on the Potential MRTS Corridors

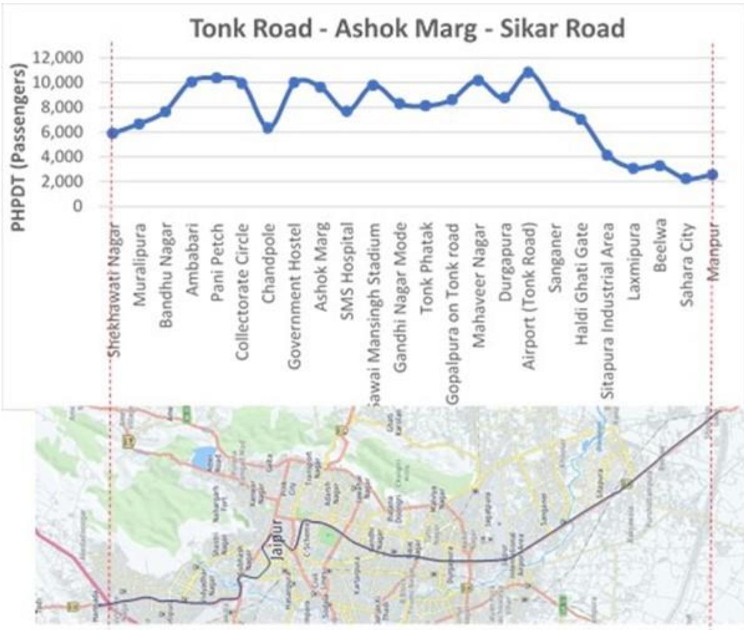
It has been observed that the variation in manual count and videography survey is in the acceptable range of 9% to 20% and the there is no major deviation in the traffic counts. The location wise percentage variation between manual and videographic count is presented below.

Table 2.13: Comparison of Manual Count and Videographic Count Results

Location ID	Mid-Block	Manual Survey Count		Videography Count		Percentage Difference	
		Total PCU (16hr)	Total Vehicles (16hr)	Total PCU (16hr)	Total Vehicles (16hr)	Total PCU	Total Vehicles
MB6	Haldi Ghati Gate	36,923	50,042	46,090	62,308	20%	20%
MB8	Airport (Tonk Road)	76,202	109,681	89,428	128,781	15%	15%
MB12	Tonk Phatak	51,929	70,628	63,317	86,134	18%	18%
MB13	Gandhi Nagar Mode	58,813	77,288	54,004	70,948	9%	9%
MB15	SMS Hospital	37,430	47,078	34,282	43,628	9%	8%
MB16	Ashok Marg	30,781	42,769	33,806	46,988	9%	9%
MB17	Government Hostel	36,961	45,231	42,140	51,637	12%	12%
MB22	Collectorate Circle	58,298	77,454	51,421	68,279	13%	13%
MB24	Bandhu Nagar	37,585	45,974	41,649	55,019	10%	16%
MB28	Ramganj Chaupar	40,785	61,974	37,470	56,802	9%	9%

2.1.7 Existing On-Road PHPDT for Potential MRTS Corridors

Based on the traffic volume count and occupancy surveys conducted at various locations the existing PHPDT on the proposed corridor is estimated and presented below.



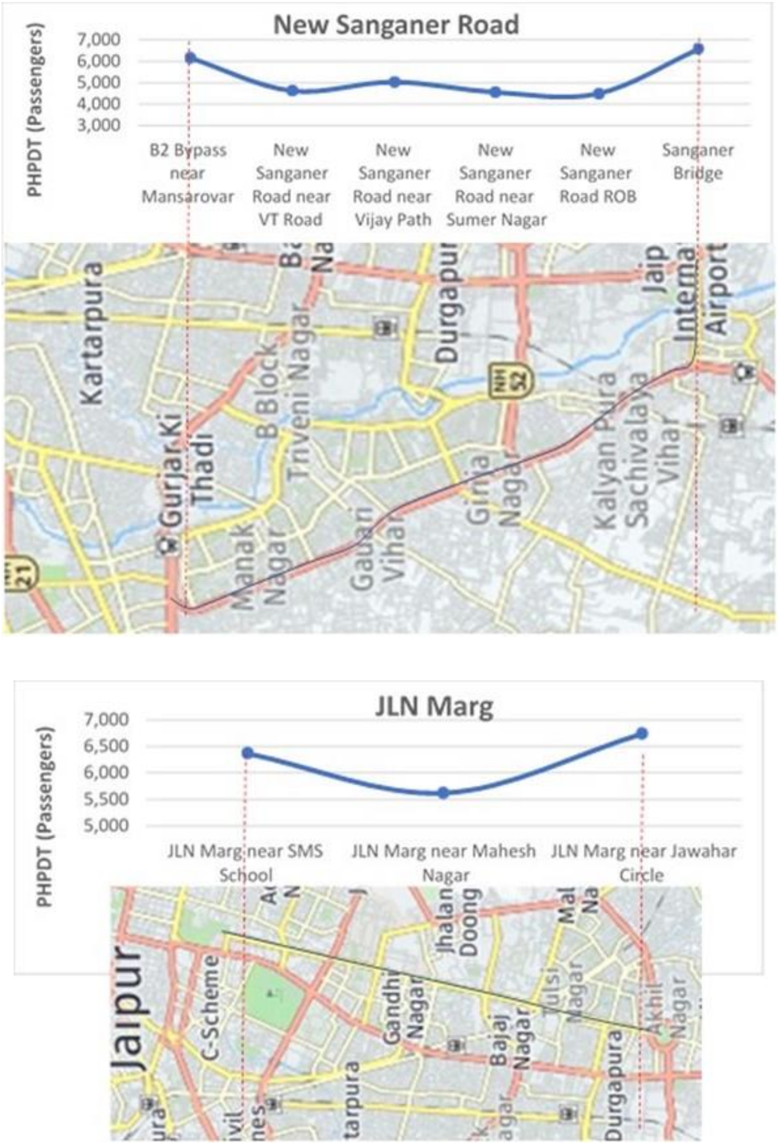


Figure 2.7: Observed on-Road PHPDT for Potential MRTS Corridors

It can be observed that passenger traffic is highest on Tonk road at 10,800 PHPDT followed by Ramganj Bazaar road and NH-248 at 9,300 PHPDT. JLN marg and Sanganer road has PHPDT of 6,700 & 6,500 respectively. Existing on-road PHPDT is helpful to have an idea about the potential PHPDT for MRTS corridors. With the help of analytical model, understanding of the travel pattern in the study area and response towards passenger's willingness to shift towards MRTS, the potential PHPDT on the proposed MRTS corridors to be estimated further.

2.1.8 Origin – Destination Survey

The Origin-Destination (OD) survey was conducted to understand the existing travel pattern of the region. Origin Destination survey of passengers was undertaken at 12 locations identified for conducting the Classified Traffic Volume Surveys. The aforesaid locations are depicted in the Figure below. The survey was conducted for 1 day (16 hours duration), on stratified random sampling basis. To capture the travel patterns, trained enumerators were organized into multiple shifts with sufficient enumerators for each direction of flow. Passengers were surveyed for their trip origin, destination, trip purpose, occupancy, frequency etc.

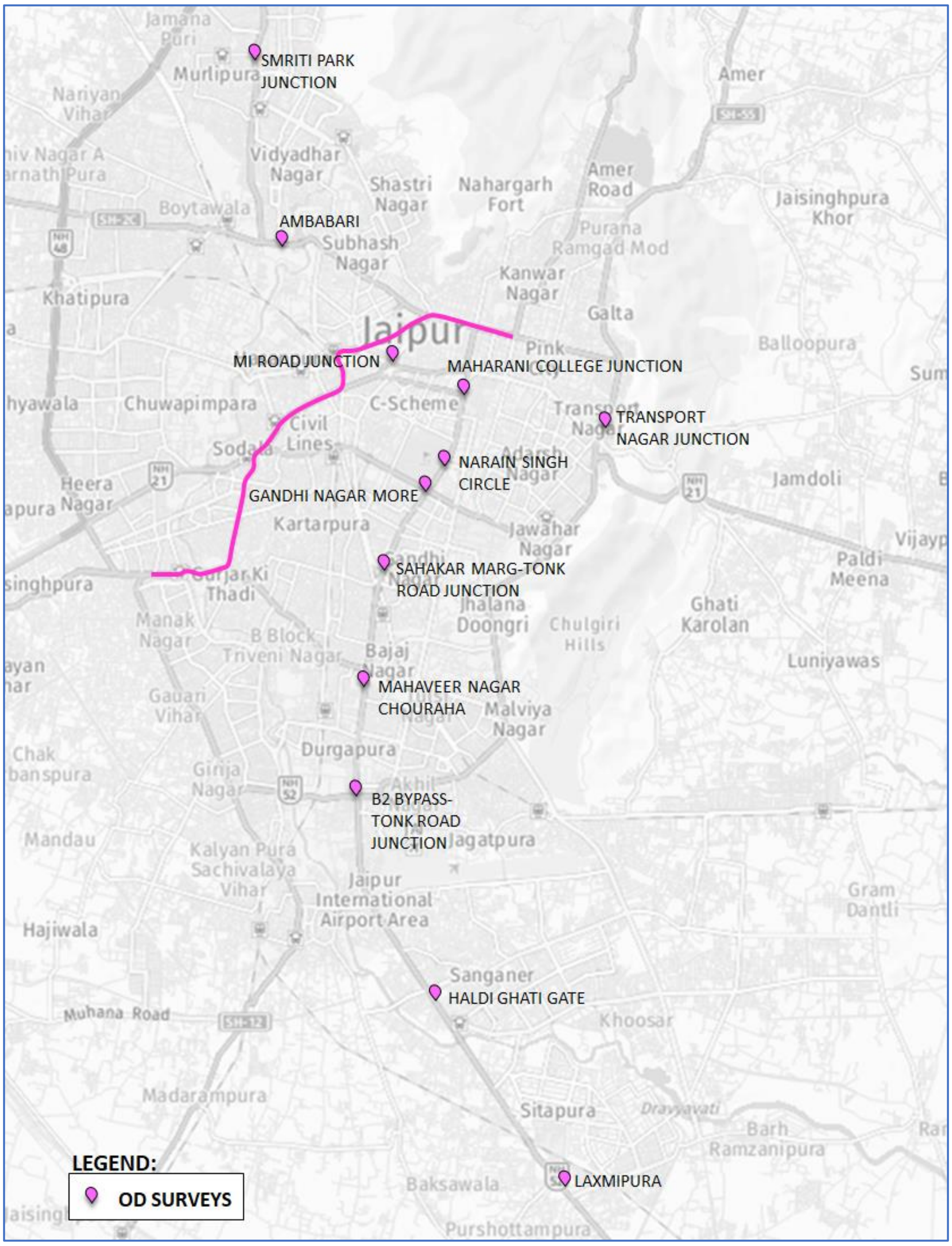


Figure 2.8: OD Survey Location Map

2.1.9 Travel Pattern

Further the trip patterns were assessed with respect to the study area zoning to understand the predominant travel patterns on the corridor and the major origin-attraction zones. For the study purpose, a comprehensive zoning system was adopted consisting of 167 zones out of which 143 zones are within the JMC area, 14 are from the rest of JDA region and 10 are external zones. The zoning system was developed in lieu of the administrative boundaries and road networks. The municipal zones along the high demand corridors were further segregated. The zone map is depicted in the Figure below.

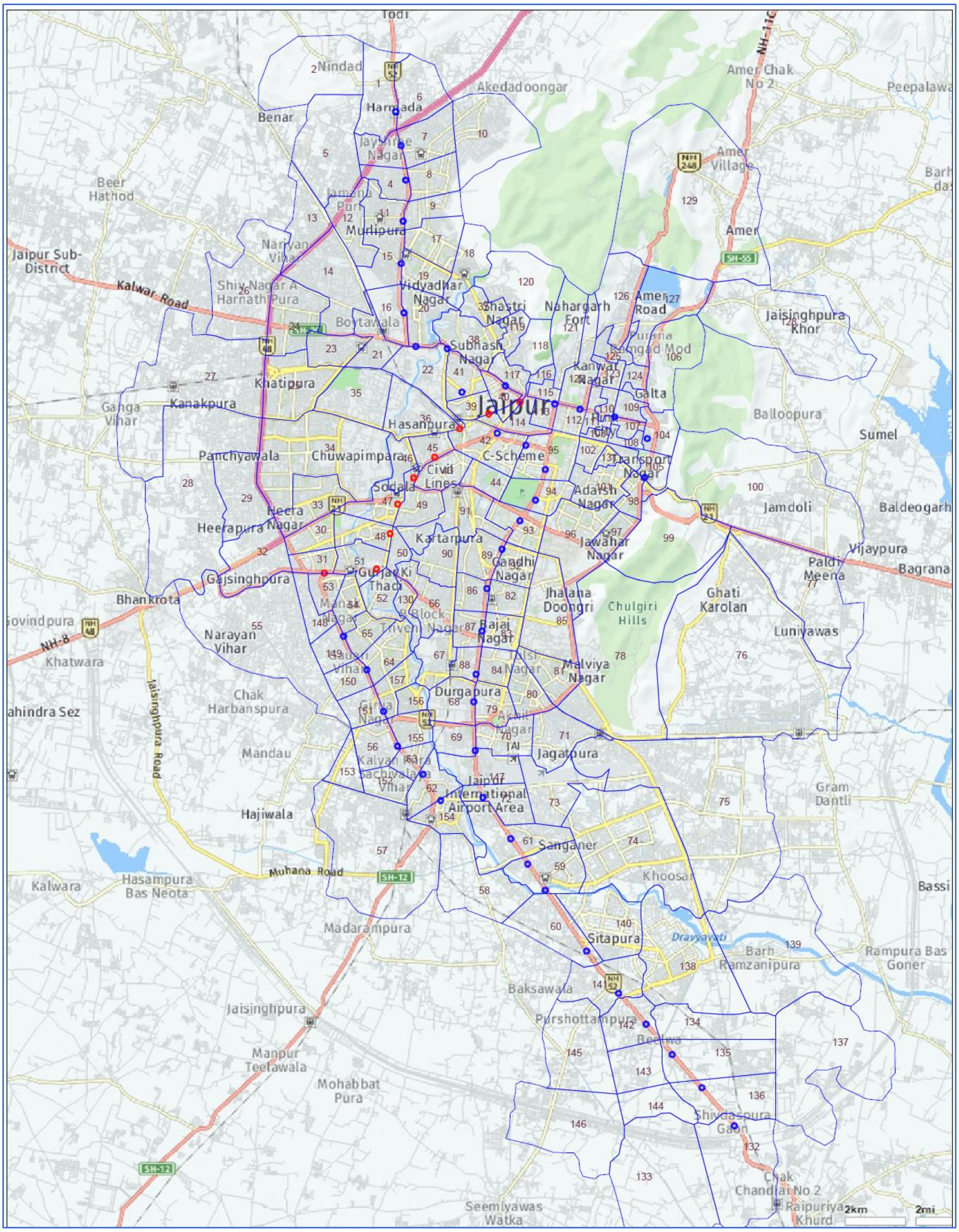


Figure 2.9: Traffic Analysis Zones

To capture the travel patterns, trained enumerators were organized into multiple shifts with sufficient enumerators for each direction of flow. Passengers were surveyed for their trip origin, destination, trip purpose, occupancy, frequency, willingness to shift etc.

The collated OD data was coded to the respective Origin Destination zones and was thus assessed to understand the prominent travel patterns. Mode wise origin destination matrices were developed which was later combined to provide the overall passenger matrices.

For the purpose of estimation of potential trips for the MRTS corridors in Jaipur, trips taking place within the immediate influence zone of the proposed MRTS corridor was analysed. For this, the immediate zones within 1km radius of the proposed MRTS corridor were identified and the associated trips were extracted. Trips originating or destining within the identified zones were considered under the same, as these will have higher impact and will be the potential trips for the proposed corridor. It is observed that the trips originating/ destining within the buffer area of potential corridor contribute to around 64% of the total trips. The major originating/ destining zones within the buffer area are Tonk Phatak, Ajmeri Gate, Maharani Colony, Rambagh, Chandpole, Surajpole Sanganer Thana, Collectorate Circle, Sindhi Camp, Jyothi Nagar, Sudershanpura Industrial Area, Gandhinagar, Panch Batti, Ashok Nagar, Durgapur and Transport Nagar. The trips both originating and destining within the buffer area of potential corridor contribute to 35% of total trips and the major zonal interaction is between Tonk Phatak-Ajmeri Gate, Sindhi Camp-SMS Hospital, Chandpole – Tonk Phatak, Collectorate Circle-Ajmeri Gate, Jaipur Junction-Sanganeri Gate, Hasanpura-Sanganeri Gate.
The mode wise percentage of trips either originating or destining within the influence zones is provided in the following table.

Table 2.14: Interaction within Influence are of Proposed Corridor

Two Wheeler	Car/Jeep/Van	Auto Rickshaw (3 Seater)	Tempo (More than 3 Seater)	Bus	Total
67%	61%	63%	66%	63%	64%

2.1.10 Willingness to Pay/Shift

The respondents were questioned regarding their willingness to shift to the MRTS system and the deciding factor of cost/ time for the same. The result of survey shows that majority of respondents i.e. 94% showed willingness to shift to the proposed MRTS.

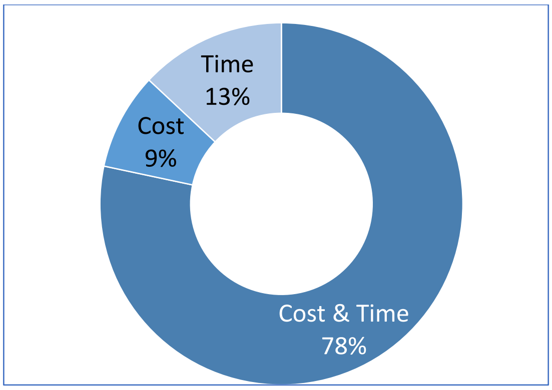


Figure 2.10: Distribution of Influence Service Parameters

It has also been observed that 78% of respondents consider both cost and time as the influence service parameter for their shift to the MRTS system. Therefore, both cost and time need to be considered for generalized cost estimation in the travel demand model development.

2.1.11 Trip Purpose

The respondents were questioned their purpose of the trip so as to have wider perspective of their reason for travel. Trip purpose information was categorized into four broad categories: work/ business trips, education trips, social/ recreational/ religious trips and others.

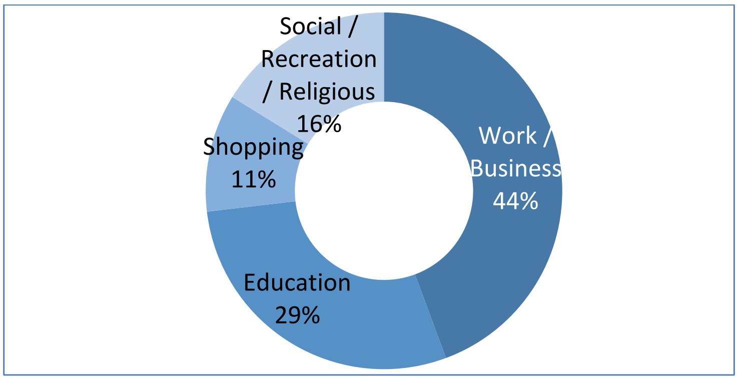


Figure 2.11: Trip Purpose Distribution

Looking at the trip purposes observed across the survey locations, it can be seen that 44% of the respondents were travelling for work/ business activities, while 29% was travelling for Education related purposes and remaining 27% trips were made for social/ religious/ shopping/ recreational and other reasons. As work, business, shopping and education trips are the daily trips for the same path, these would be potential trips for the proposed MRTS. Therefore, above 80% trips are potential from the trip purpose perspective for proposed MRTS.

2.1.12 Trip Frequency

To understand the frequency characteristics prevalent travel along the corridor. The respondents were asked about the frequency of their journey. The trip frequency was recorded as daily, weekly, monthly and yearly/ occasionally.

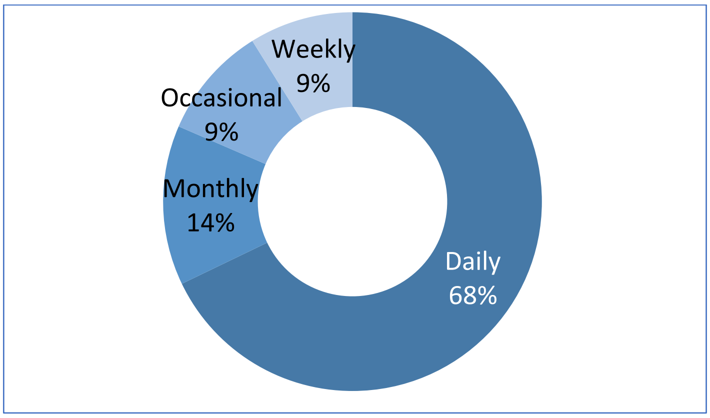


Figure 2.12: Trip Frequency Distribution

It was observed that about 68% of the respondents were making that particular trip daily, whereas 9% of the respondents were making trips weekly. Daily trips being the regular user would be the certain component of the proposed MRTS.

2.1.13 Speed and Delay Survey

Speed and Delay Survey was carried out to assess the network characteristics of the study corridor. Moving car method was adopted wherein the observed speed and delay was recorded while travelling through the network in a car. The principle objective of the study is to find out the journey speed, running speed and delay of traffic flow of a road or entire road network system. Road sections along the proposed corridor were considered for conduct of journey speed and delay surveys. The findings of the same are provided in the following table.

Table 2.15: Speed and Delay Observations at Peak Period

Link	Distance	Morning Peak Period		Evening Peak Period		Off-Peak Period	
	(km)	Average Journey Speed (kmph)	Average Running Speed (kmph)	Average Journey Speed (kmph)	Average Running Speed (kmph)	Journey Speed (kmph)	Running Speed (kmph)
Harmada – Manpur	**39.63**	20.5	24.2	18.2	20.4	30.8	*33.2*
Mansarovar – Transport Nagar	**13.92**	25.8	28.6	23.2	26.5	32.4	*35.3*
Mansarovar – Sanganer Thana	**7**	28.4	31.2	26.1	28.7	35.5	*36.2*
JLN Marg	**12**	12.4	14.3	11.5	13.2	26.5	*28.6*

The average speed during peak hour on the Harmada – Manpur corridor was observed to be 18.2 kmph. During peak period the speed on the network reduces and on an average, it is in the range of 12 to 26kmph.This assessment would be further used as an input for assessing the network characteristics.

2.2 PLANNING PERIOD

As the study was initiated in 2019, the same has been considered as base year and demand forecasting on the network was undertaken till 2051. In order to estimate the demand on the identified MRTS corridors, all relevant data has been collated from primary and secondary sources available. The horizon years for demand assessment have been set as 2021, 2031, 2041 and 2051.

2.3 SCENARIO BUILDING

Scenario building is a process of analysing possible future events by considering alternative possible outcomes. Thus, scenario analysis, a method of projections, does not try to show one exact picture of the future. Instead, it presents several alternative future developments. Consequently, a scope of possible future outcomes is observable. Not only are the outcomes observable, but also the development paths leading to the outcomes. The development programs are taken from the Comprehensive Traffic and Transportation Study (CTTS) for Jaipur Region – 2018, Jaipur Master Plan – 2025 and other relevant studies. Two scenarios that have been evaluated for the present study as mentioned below:

- **Moderate Scenario –** with realistic Population Growth Trend where future growth rates for the horizon years have been moderated as compare to predicted growth rates in different development plans including CTTS – 2018.
- **Optimistic Scenario –** with Population Growth Trend as per the predicted growth rates in Jaipur Master Plan – 2025.

2.4 MODEL DEVELOPMENT

2.4.1 Analytical Framework for Model Development

The figure below discusses the analytical framework towards the model built up. Worldwide accepted CUBE Voyager software has been utilized to develop the ridership estimation model. A complete three-fold analytical approach consisting of network development, matrix development and trip assignment was adopted. The assignment technique adopted helped to ascertain the ridership at proposed metro corridors.

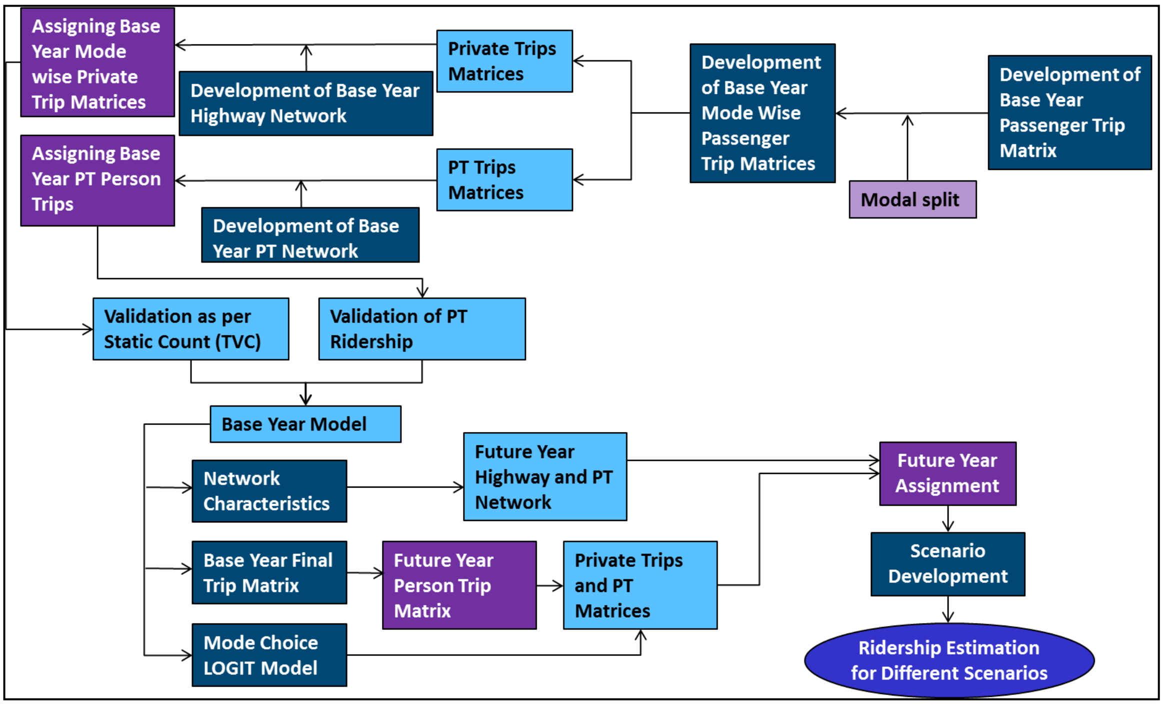


Figure 2.13: Methodology for Development of Ridership Model

2.4.2 Network Development

The network development stage involves both the highway and transit network throughout the entire study area. Base year network is the existing road network. Once the base year mode-wise matrices are developed and assigned to the base year network, the network characteristics have been calibrated and validated with respect to the ground conditions. Further future year proposed MRTS routes have been incorporated with the base year validated network for future forecasting.

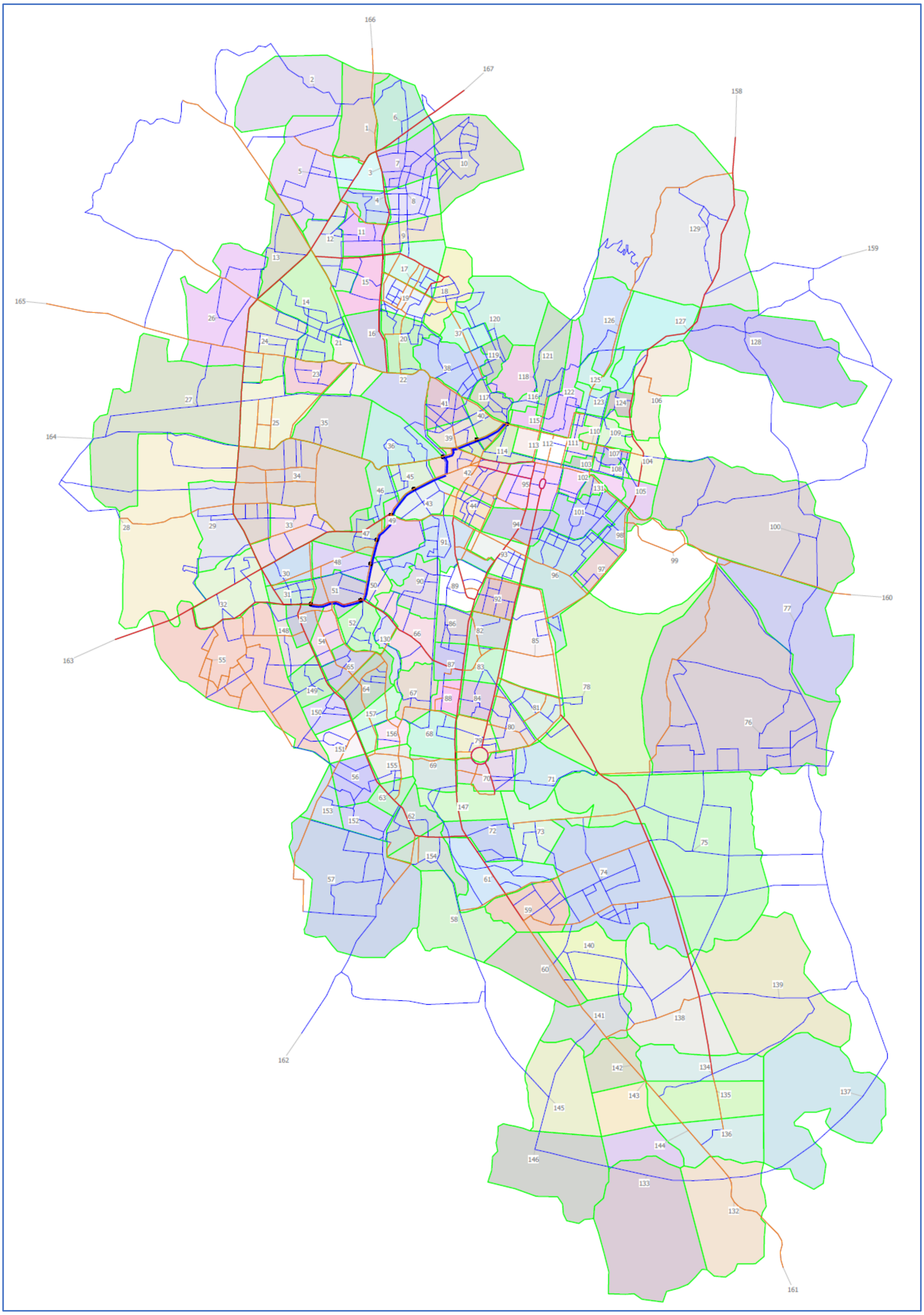


Figure 2.14: Base Year Network Developed in CUBE Voyager

2.4.3 Matrix Development

Development of Base Year Matrices

Road-side interview data from OD survey, constituted only a sample of the total trip interaction of the study region, has been collated in order to reflect the overall travel pattern along the selected MRTS corridors of study area. Vehicular matrices from road-side OD data were multiplied with the respective location wise occupancy values to obtain the passenger matrices. Further, the matrices were appropriately used in conjunction with one another to obtain the total Survey OD matrix. The obtained matrix from the base year OD Survey was used along with the furnished CMP Matrix to arrive at the base year trip matrix. This was obtained by replacing the significant zone-to-zone interaction with the obtained Survey OD Matrix and further balancing the overall matrix to match with the total base year person trips obtained from the trip-end data.

Trip Generation

Trip generation forms the initial stage of the four-stage modelling process, wherein the respective zone wise trip production and attraction are evaluated. Trip production and attraction of each individual zone needs to be ascertained on the basis of observed relationships of population and employment with various trip generation parameters. For the present study, different horizon year population and employment for individual zone have been estimated (as presented in the table below) based on the available development plans/ master plans for proposed urban areas and census data for villages.

Table 2.16: Zone-wise Horizon Year Population-Employment for Study Area (Moderate Scenario)

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
1	11,414	1,305	12,030	1,348	16,548	1,963	20,712	2,654	23,825	3,160
2	26,632	3,045	28,069	3,145	35,170	3,611	41,357	3,633	41,624	3,673
3	9,157	1,015	9,651	1,121	13,276	1,632	16,617	2,206	19,114	2,626
4	9,157	1,015	9,651	1,121	13,276	1,632	16,617	2,206	19,114	2,626
5	18,314	2,030	19,302	2,241	24,185	3,192	30,008	4,349	56,159	8,274
6	7,919	6,930	8,148	7,652	11,208	11,143	14,028	15,063	16,136	17,934
7	7,919	6,930	8,148	7,652	11,208	11,143	14,028	15,063	16,136	17,934
8	7,919	6,930	8,148	7,652	11,208	11,143	14,028	15,063	16,136	17,934
9	7,919	6,930	8,148	7,652	11,208	11,143	14,028	15,063	16,136	17,934
10	7,919	6,930	8,148	7,652	8,841	10,899	8,859	14,851	8,912	28,254
11	35,436	5,085	36,988	5,615	49,709	7,997	61,492	10,297	65,088	12,021
12	34,076	2,811	35,914	2,965	44,999	3,586	51,518	3,633	51,828	3,673
13	40,792	5,181	42,251	5,183	46,608	5,188	46,701	5,219	46,982	5,277
14	48,002	21,770	48,012	21,779	48,424	22,374	48,521	22,509	48,813	22,758
15	19,128	5,209	19,777	5,752	27,126	8,328	33,919	10,923	36,333	12,840

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
16	19,128	5,209	20,896	5,589	28,660	8,092	35,837	10,614	38,388	12,477
17	28,396	6,389	29,928	7,055	41,048	10,214	51,327	13,397	54,981	15,748
18	18,930	4,259	19,951	4,703	24,010	6,698	24,772	9,126	24,921	11,065
19	22,601	11,163	22,606	11,538	30,381	16,433	37,583	21,159	39,781	24,701
20	27,623	13,643	30,073	14,626	40,416	20,832	49,996	26,823	52,920	31,314
21	20,126	4,228	21,987	4,536	30,157	6,567	37,709	8,614	40,393	10,126
22	24,599	5,168	26,873	5,545	36,858	8,028	46,088	10,530	49,369	12,378
23	37,432	6,978	39,043	6,981	43,833	7,321	43,921	7,365	44,185	7,446
24	54,870	8,849	57,830	9,020	72,459	10,016	85,436	10,076	86,218	10,187
25	44,185	5,115	46,569	5,309	58,350	6,165	72,399	6,202	1,35,493	6,271
26	41,093	4,773	43,155	4,775	49,281	4,866	49,380	4,895	49,677	4,949
27	44,634	4,979	47,042	5,221	58,942	6,221	73,133	6,258	78,301	6,327
28	44,900	6,558	47,322	6,745	59,293	7,660	68,302	7,706	68,713	7,791
29	39,644	5,951	41,783	6,115	50,074	6,929	51,450	6,971	51,760	7,048
30	9,297	1,701	10,156	1,825	13,930	2,642	17,418	3,465	18,658	4,073
31	9,297	1,701	10,156	1,825	13,930	2,642	17,418	3,465	18,658	4,073
32	27,890	5,102	29,020	5,634	32,381	8,024	32,446	10,933	32,641	20,800
33	49,111	13,994	51,760	14,000	64,854	14,712	71,460	14,801	71,890	14,965
34	46,175	16,691	48,666	16,698	60,977	17,342	65,885	17,446	66,281	17,639
35	23,017	7,346	23,890	7,349	26,494	7,685	26,547	7,731	26,707	7,816
36	23,017	7,346	25,145	7,881	34,488	11,410	43,125	14,966	46,195	17,592
37	41,096	13,938	41,104	13,944	41,186	13,952	41,268	14,036	41,516	14,191
38	41,792	15,552	45,498	16,673	61,146	23,747	75,640	30,577	80,064	35,696
39	12,260	10,790	13,347	11,567	17,937	16,475	22,189	21,213	23,487	24,764
40	12,260	10,790	13,347	11,567	17,937	16,475	22,189	21,213	23,487	24,764
41	16,347	14,386	17,797	15,423	23,918	21,967	29,588	28,285	31,318	33,020
42	21,028	26,202	22,972	28,112	31,508	40,701	39,398	53,386	42,202	62,755
43	10,514	13,101	11,486	14,056	15,754	20,351	19,699	26,693	21,101	31,377
44	10,514	13,101	10,901	14,466	12,054	20,598	12,078	24,568	12,151	24,840
45	36,215	6,100	39,283	6,538	52,742	8,787	64,671	10,722	67,843	11,383
46	33,851	6,597	36,719	7,071	49,299	9,503	60,450	11,595	63,415	12,310
47	21,553	3,334	23,464	3,574	31,534	5,090	39,009	6,554	41,290	7,651
48	21,553	3,334	23,464	3,574	31,534	5,090	39,009	6,554	41,290	7,651
49	27,838	5,564	30,307	5,965	40,730	8,496	50,385	10,939	53,332	12,770
50	11,930	2,385	12,988	2,557	17,455	3,642	21,593	4,689	22,856	5,474
51	20,436	4,755	22,248	5,098	29,899	7,261	36,986	9,349	39,149	10,914
52	20,436	4,755	22,248	5,098	29,899	7,261	36,986	9,349	39,149	10,914
53	7,976	1,695	8,683	1,817	11,669	2,588	14,435	3,332	15,279	3,890
54	31,904	6,782	34,733	7,271	46,678	10,356	57,743	13,334	61,120	15,566
55	40,572	3,520	42,761	3,703	53,578	4,448	66,478	4,476	1,24,412	4,525
56	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
57	52,968	36,098	53,861	36,112	56,742	36,565	56,856	36,785	57,198	37,192
58	52,073	7,409	54,882	7,577	68,766	8,484	85,322	8,535	91,376	8,629
59	26,184	7,045	28,605	7,558	39,234	10,943	49,059	14,353	52,551	16,872
60	26,184	7,045	28,605	7,558	39,234	10,943	49,059	14,353	52,551	16,872
61	36,612	5,787	39,997	6,209	54,859	8,990	68,597	11,792	73,480	13,861
62	22,667	4,127	22,672	4,177	22,722	4,558	28,108	5,869	29,752	6,852
63	14,954	5,591	15,089	5,593	15,591	5,798	19,287	7,465	20,415	8,715
64	19,887	5,748	20,960	5,750	26,262	6,050	32,487	7,790	34,387	9,094
65	21,879	9,585	23,059	9,589	27,056	9,635	33,469	12,406	35,426	14,483
66	39,148	24,325	39,156	24,335	39,234	24,491	39,313	24,638	39,550	24,910
67	11,628	2,931	12,255	3,236	15,355	4,609	19,052	5,587	35,655	5,649
68	13,566	3,419	14,820	3,668	20,327	5,311	25,417	6,966	27,226	8,188
69	13,566	3,419	14,820	3,668	20,327	5,311	25,417	6,966	27,226	8,188
70	22,198	2,177	24,250	2,336	33,261	3,382	41,590	4,436	44,550	5,214
71	22,198	2,177	23,396	2,404	29,315	3,424	36,373	4,665	68,071	8,875
72	9,935	1,339	10,939	1,463	15,047	2,130	18,834	2,879	21,665	3,428
73	19,870	2,677	20,942	2,956	26,240	4,210	32,558	5,736	37,459	10,913
74	34,028	3,845	35,864	3,994	44,937	4,650	55,756	4,678	1,04,346	4,730
75	38,262	13,099	40,326	13,104	50,527	13,649	62,692	13,731	1,17,326	13,883
76	40,063	9,703	41,586	9,728	46,125	10,361	46,217	10,423	46,495	10,538
77	46,945	5,170	49,478	5,377	61,995	6,278	74,962	6,316	77,579	6,386
78	47,156	16,599	47,165	16,606	47,270	16,623	47,365	16,723	47,650	16,908
79	20,251	14,466	22,047	15,508	29,629	22,088	36,652	28,440	38,796	33,201
80	20,251	14,466	21,344	15,973	25,030	22,750	25,164	30,998	25,315	36,433
81	36,502	5,778	38,471	5,780	48,203	6,096	59,808	6,133	1,11,929	6,201
82	6,405	5,145	7,052	5,622	9,700	8,187	12,141	11,067	13,966	13,177
83	6,405	5,145	7,052	5,622	9,700	8,187	12,141	11,067	13,966	13,177
84	6,405	5,145	7,052	5,622	9,700	8,187	12,141	11,067	13,966	13,177
85	23,483	18,865	24,750	20,830	30,143	29,668	31,474	40,424	31,663	76,906
86	14,852	4,191	16,169	4,493	21,730	6,399	26,881	8,239	28,453	9,618
87	14,852	4,191	16,169	4,493	21,730	6,399	26,881	8,239	28,453	9,618
88	12,730	3,592	13,859	3,851	18,625	5,485	23,040	7,062	24,387	8,244
89	42,052	13,153	45,781	14,101	61,526	20,084	76,110	25,860	80,561	30,189
90	46,213	7,703	48,706	7,706	61,027	8,148	68,399	8,197	68,811	8,288
91	44,690	30,228	44,699	30,240	44,788	31,963	44,878	32,155	45,148	32,510
92	9,164	32,572	10,090	35,590	13,879	51,827	17,372	70,058	19,983	83,412
93	9,164	32,572	10,090	35,590	13,879	51,827	17,372	70,058	19,983	83,412
94	9,164	32,572	10,090	35,590	13,879	51,827	17,372	70,058	19,983	83,412
95	9,164	32,572	10,090	35,590	13,879	51,827	17,372	70,058	19,983	83,412
96	41,269	15,681	41,277	15,687	41,360	16,142	41,443	16,239	41,692	16,419
97	22,249	6,807	22,253	6,810	22,298	6,817	22,343	6,858	22,477	6,934

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
98	22,249	6,807	24,222	7,297	32,552	10,393	40,268	13,382	42,623	15,622
99	40,880	3,459	40,888	3,460	40,970	3,563	41,052	3,584	41,299	3,624
100	39,835	7,090	41,984	7,386	52,605	8,658	65,270	8,710	1,22,151	8,806
101	41,563	9,740	41,571	9,744	41,654	10,282	41,737	10,344	41,988	10,458
102	35,728	36,405	35,735	36,420	35,807	37,789	35,879	38,016	36,095	38,436
103	14,223	8,435	15,428	9,041	20,714	12,150	25,399	14,825	26,645	15,739
104	19,870	5,876	21,632	6,299	29,072	8,972	35,963	11,552	38,066	13,486
105	19,870	5,876	21,632	6,299	29,072	8,972	35,963	11,552	38,066	13,486
106	45,382	3,831	45,391	3,944	45,482	4,489	45,573	4,516	45,847	4,566
107	35,344	4,212	38,338	4,515	51,473	6,068	63,115	7,404	66,211	7,860
108	37,550	4,136	40,731	4,433	54,686	5,958	67,055	7,270	70,344	7,718
109	35,702	5,799	38,727	6,216	51,995	8,354	63,755	10,193	66,882	10,821
110	31,336	12,787	33,991	13,706	45,637	18,420	55,959	22,476	58,704	23,862
111	32,163	25,737	34,888	27,586	46,841	37,073	57,436	45,236	60,253	48,025
112	31,272	22,206	33,921	23,801	45,543	31,987	55,844	39,030	58,583	41,436
113	30,956	29,960	33,579	32,113	45,084	43,157	55,281	52,660	57,993	55,906
114	37,848	20,846	41,055	22,344	55,121	30,028	67,588	36,640	70,903	38,899
115	31,512	10,640	34,182	11,404	45,893	15,326	56,273	18,701	59,033	19,854
116	31,963	3,155	34,671	3,382	46,550	4,545	57,079	5,546	59,879	5,888
117	40,150	8,845	43,552	9,480	58,473	12,740	71,699	15,545	75,216	16,503
118	44,186	5,893	44,195	5,895	44,283	5,901	44,372	5,937	44,639	6,003
119	51,939	4,545	51,949	4,547	52,053	4,802	52,157	4,831	52,471	4,884
120	54,199	5,855	54,210	5,857	54,319	5,863	54,428	5,898	54,755	5,963
121	35,831	9,613	35,838	9,617	35,910	9,677	35,982	9,735	36,198	9,843
122	26,919	18,820	29,306	20,176	39,385	28,736	48,721	37,000	51,570	43,195
123	33,099	7,745	33,280	7,840	34,088	8,556	34,156	8,607	34,361	8,702
124	30,629	3,305	30,635	3,306	30,696	3,413	30,757	3,434	30,942	3,472
125	34,632	4,413	34,974	4,518	36,217	5,073	36,289	5,104	36,507	5,160
126	34,119	5,495	34,126	5,807	34,194	7,056	34,262	7,183	34,468	7,262
127	40,466	7,662	40,474	7,665	40,555	7,730	40,636	7,777	40,880	7,863
128	36,249	6,795	36,256	6,798	36,329	7,203	36,402	7,246	36,621	7,326
129	62,282	15,080	65,642	15,451	76,735	17,377	76,905	17,482	77,368	17,675
130	14,585	2,846	15,933	3,053	21,853	4,420	27,326	5,797	29,271	6,814
131	21,137	3,905	21,754	3,907	23,620	3,911	23,667	3,935	23,809	3,978
132	3,570	2,322	3,571	2,442	5,037	3,753	6,769	5,577	8,284	6,765
133	5,354	3,482	5,356	3,662	5,416	4,398	5,427	4,424	5,460	4,473
134	1,891	1,973	1,891	2,059	2,667	3,164	3,584	4,702	4,386	5,704
135	1,891	1,973	1,891	2,059	2,667	3,164	3,584	4,702	4,386	5,704
136	1,891	1,973	1,891	2,059	2,667	3,164	3,584	4,702	4,386	5,704
137	3,782	3,945	3,783	4,118	3,814	4,850	3,822	4,879	3,845	4,933
138	2,470	10,547	2,470	11,315	2,482	14,279	2,487	15,093	2,502	15,260

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
139	3,704	15,820	3,705	16,973	3,723	21,418	3,730	22,640	3,752	22,890
140	1,914	3,903	2,111	4,295	2,978	6,600	4,002	9,807	4,898	11,896
141	1,914	3,903	2,111	4,295	2,978	6,600	4,002	9,807	4,898	11,896
142	3,592	1,402	3,599	1,532	5,077	2,354	6,823	3,498	8,350	4,243
143	3,592	1,402	3,599	1,532	5,077	2,354	6,823	3,498	8,350	4,243
144	3,592	1,402	3,599	1,532	5,077	2,354	6,823	3,498	8,350	4,243
145	3,592	1,402	3,599	1,532	3,657	2,021	3,664	2,233	3,686	2,258
146	3,592	1,402	3,599	1,532	3,657	2,021	3,664	2,233	3,686	2,258
147	9,935	1,339	10,939	1,463	15,047	2,130	18,834	2,879	21,665	3,428
148	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501
149	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501
150	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501
151	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501
152	6,128	804	6,459	825	8,093	933	10,130	1,261	11,652	1,501
153	4,086	536	4,306	550	5,395	622	6,107	626	6,144	633
154	27,705	5,044	27,711	5,105	27,773	5,570	34,356	7,172	36,365	8,373
155	14,954	5,591	15,089	5,593	15,591	5,798	19,287	7,465	20,415	8,715
156	7,477	2,795	7,544	2,796	7,795	2,899	9,643	3,733	10,207	4,358
157	19,887	5,748	20,960	5,750	26,262	6,050	32,487	7,790	34,387	9,094

Table 2.17: Zone-wise Horizon Year Population-Employment for Study Area: Optimistic Scenario

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
1	11,414	1,305	12,596	1,391	17,076	2,156	21,373	3,149	25,926	4,195
2	26,632	3,045	29,391	3,246	48,244	4,892	79,299	7,912	1,18,063	14,457
3	9,157	1,015	10,106	1,082	13,701	1,677	17,149	2,449	20,802	3,263
4	9,157	1,015	10,106	1,082	13,701	1,677	17,149	2,449	20,802	3,263
5	18,314	2,030	20,211	2,164	33,175	3,261	54,530	5,988	81,186	10,942
6	7,919	6,930	8,739	7,388	11,848	11,451	14,830	16,723	17,989	22,279
7	7,919	6,930	8,739	7,388	11,848	11,451	14,830	16,723	17,989	22,279
8	7,919	6,930	8,739	7,388	11,848	11,451	14,830	16,723	17,989	22,279
9	7,919	6,930	8,739	7,388	11,848	11,451	14,830	16,723	17,989	22,279
10	7,919	6,930	8,739	7,388	11,265	10,878	13,404	13,919	14,755	15,083
11	35,436	5,085	39,107	5,421	50,403	8,275	59,952	11,741	69,371	15,460
12	34,076	2,811	37,606	2,997	61,729	4,516	77,117	7,111	89,118	12,994
13	40,792	5,181	45,018	5,524	73,895	8,268	1,21,461	10,756	1,80,835	11,849
14	48,002	21,770	52,975	23,210	86,956	31,763	1,08,633	37,778	1,25,537	38,050
15	19,128	5,209	21,110	5,554	28,563	8,584	35,681	12,333	41,328	16,255

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
16	19,128	5,209	24,533	7,385	33,195	11,414	41,467	16,399	48,029	21,615
17	28,396	6,389	31,338	6,812	42,403	10,528	52,970	15,126	61,353	19,937
18	18,930	4,259	20,891	4,541	26,929	6,843	32,045	9,711	35,273	11,670
19	22,601	11,163	24,942	11,901	32,147	18,166	38,237	25,774	44,245	33,938
20	27,623	13,643	35,284	19,333	45,476	29,510	54,091	41,869	62,590	55,132
21	20,126	4,228	25,813	5,994	34,927	9,264	43,631	13,310	50,536	17,543
22	24,599	5,168	31,550	7,327	42,690	11,324	53,328	16,269	61,767	21,443
23	37,432	6,978	41,310	7,440	67,809	11,212	1,11,458	14,844	1,41,869	16,642
24	54,870	8,849	60,554	9,434	99,397	14,217	1,63,379	23,057	2,07,956	42,131
25	44,185	5,115	48,762	5,453	80,041	8,218	1,31,563	15,089	1,75,685	27,571
26	41,093	4,773	45,350	5,089	74,440	7,669	1,22,357	10,328	1,82,169	11,777
27	44,634	4,979	49,258	5,308	80,855	7,999	1,32,901	13,764	1,97,868	25,150
28	44,900	6,558	49,551	6,992	81,336	10,537	1,33,692	16,696	1,99,045	30,508
29	39,644	5,951	43,751	6,345	71,815	9,562	1,18,042	13,514	1,75,745	16,174
30	9,297	1,701	11,924	2,412	16,134	3,728	20,155	5,356	23,345	7,059
31	9,297	1,701	11,924	2,412	16,134	3,728	20,155	5,356	23,345	7,059
32	27,890	5,102	30,779	5,439	50,522	8,197	83,043	10,786	1,23,637	12,019
33	49,111	13,994	54,199	14,920	88,965	22,485	1,46,232	34,078	2,17,715	62,269
34	46,175	16,691	50,958	17,795	83,645	26,817	1,37,487	39,855	2,04,695	72,825
35	23,017	7,346	25,401	7,832	41,695	11,786	68,534	15,413	83,128	17,069
36	23,017	7,346	29,521	10,415	39,944	16,097	49,898	23,127	57,795	30,482
37	41,096	13,938	45,353	14,860	74,445	18,981	93,004	21,070	1,07,477	21,091
38	41,792	15,552	53,383	22,038	68,803	33,639	81,837	47,727	94,695	62,845
39	12,260	10,790	15,660	15,290	20,183	23,339	24,007	33,113	27,779	43,602
40	12,260	10,790	15,660	15,290	20,183	23,339	24,007	33,113	27,779	43,602
41	16,347	14,386	20,881	20,386	26,913	31,118	32,012	44,150	37,042	58,135
42	21,028	26,202	26,970	37,148	36,493	57,414	45,587	82,487	52,801	1,08,722
43	10,514	13,101	13,485	18,574	18,246	28,707	22,793	41,244	26,400	54,362
44	10,514	13,101	11,603	13,967	19,046	20,957	31,306	27,329	37,974	30,180
45	36,215	6,100	45,388	8,618	55,709	13,130	63,140	18,557	72,988	24,222
46	33,851	6,597	42,425	9,320	52,072	14,199	59,018	20,068	68,223	26,194
47	21,553	3,334	27,531	4,724	35,483	7,211	42,205	10,231	48,836	13,472
48	21,553	3,334	27,531	4,724	35,483	7,211	42,205	10,231	48,836	13,472
49	27,838	5,564	35,559	7,884	45,830	12,034	54,512	17,074	63,077	22,482
50	11,930	2,385	15,239	3,380	19,641	5,159	23,362	7,320	27,033	9,639
51	20,436	4,755	26,104	6,738	33,644	10,285	40,018	14,592	46,305	19,214
52	20,436	4,755	26,104	6,738	33,644	10,285	40,018	14,592	46,305	19,214
53	7,976	1,695	10,188	2,402	13,131	3,666	15,619	5,201	18,073	6,849
54	31,904	6,782	40,753	9,610	52,525	14,669	62,476	20,812	72,292	27,405
55	40,572	3,520	44,775	3,753	73,496	5,656	1,20,805	10,385	1,79,859	18,976
56	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
57	52,968	36,098	58,455	38,485	95,951	55,014	1,57,715	68,346	2,34,812	71,904
58	52,073	7,409	57,467	7,899	94,330	11,904	1,55,050	20,488	2,30,844	37,437
59	26,184	7,045	33,582	9,988	45,439	15,437	56,763	22,178	65,746	29,232

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
60	26,184	7,045	33,582	9,988	45,439	15,437	56,763	22,178	65,746	29,232
61	36,612	5,787	46,957	8,205	63,536	12,681	79,369	18,219	91,930	24,014
62	22,667	4,127	25,015	4,400	41,061	5,984	48,840	8,490	56,514	11,179
63	14,954	5,591	16,503	5,961	27,089	8,357	32,221	11,857	37,283	15,613
64	19,887	5,748	21,947	6,128	36,025	9,235	42,850	13,103	49,582	17,254
65	21,879	9,585	24,145	10,219	39,633	15,400	47,141	21,849	54,548	28,770
66	39,148	24,325	43,203	25,934	70,916	26,283	1,16,565	28,070	1,41,387	28,098
67	11,628	2,931	12,833	3,125	21,065	4,709	26,317	8,646	30,412	15,798
68	13,566	3,419	17,399	4,847	23,542	7,491	29,409	10,762	34,063	14,185
69	13,566	3,419	17,399	4,847	23,542	7,491	29,409	10,762	34,063	14,185
70	22,198	2,177	28,470	3,086	38,522	4,770	48,122	6,853	55,738	9,033
71	22,198	2,177	24,498	2,321	40,212	3,498	50,236	6,423	58,053	11,736
72	9,935	1,339	12,930	1,908	17,529	2,957	21,940	4,319	26,614	5,754
73	19,870	2,677	21,928	2,854	28,266	4,301	33,635	7,897	37,023	14,430
74	34,028	3,845	37,553	4,099	61,642	6,177	1,01,321	11,342	1,50,850	20,725
75	38,262	13,099	42,226	13,965	69,312	21,045	1,13,928	38,641	1,69,620	70,607
76	40,063	9,703	44,213	10,345	72,574	15,568	1,19,290	20,363	1,77,603	22,555
77	46,945	5,170	51,808	5,512	85,041	8,307	1,39,782	13,816	2,08,112	25,245
78	47,156	16,599	49,111	17,697	50,705	24,066	52,091	28,444	54,592	28,468
79	20,251	14,466	25,868	20,499	33,340	31,290	39,656	44,394	45,887	58,457
80	20,251	14,466	22,349	15,423	36,685	23,243	45,831	32,142	52,963	37,640
81	36,502	5,778	40,283	6,160	51,926	9,283	61,790	17,045	68,014	31,145
82	6,405	5,145	8,336	7,330	11,301	11,361	14,145	16,592	17,158	22,104
83	6,405	5,145	8,336	7,330	11,301	11,361	14,145	16,592	17,158	22,104
84	6,405	5,145	8,336	7,330	11,301	11,361	14,145	16,592	17,158	22,104
85	23,483	18,865	25,916	20,113	33,406	30,310	39,752	43,533	43,757	52,947
86	14,852	4,191	18,971	5,939	24,451	9,065	29,083	12,861	33,652	16,935
87	14,852	4,191	18,971	5,939	24,451	9,065	29,083	12,861	33,652	16,935
88	12,730	3,592	16,261	5,090	20,958	7,770	24,928	11,024	28,845	14,516
89	42,052	13,153	53,715	18,638	69,231	28,450	82,346	40,365	95,284	53,151
90	46,213	7,703	50,574	8,212	59,103	12,376	63,762	19,080	66,823	34,864
91	44,690	30,228	49,320	32,227	60,540	36,495	68,601	38,976	71,908	39,015
92	9,164	32,572	11,926	46,405	16,168	71,928	20,237	1,05,046	24,548	1,39,944
93	9,164	32,572	11,926	46,405	16,168	71,928	20,237	1,05,046	24,548	1,39,944
94	9,164	32,572	11,926	46,405	16,168	71,928	20,237	1,05,046	24,548	1,39,944
95	9,164	32,572	11,926	46,405	16,168	71,928	20,237	1,05,046	24,548	1,39,944
96	41,269	15,681	45,544	16,718	55,915	21,313	63,370	23,614	66,435	23,638
97	22,249	6,807	24,335	7,257	28,449	7,689	30,702	8,212	32,176	8,220
98	22,249	6,807	28,420	9,646	36,629	14,724	43,568	20,890	50,413	27,507
99	40,880	3,459	43,000	3,688	45,515	4,119	46,759	4,399	49,004	4,403
100	39,835	7,090	43,962	7,559	72,162	11,391	1,18,613	20,915	1,76,595	38,217
101	41,563	9,740	45,486	10,384	53,156	13,185	57,346	14,548	60,099	14,563
102	35,728	36,405	39,100	38,813	45,693	49,105	49,295	53,991	51,661	54,045
103	14,223	8,435	17,825	11,917	21,878	18,156	24,796	25,660	28,664	33,494

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
104	19,870	5,876	25,381	8,327	32,712	12,711	38,909	18,034	45,022	23,747
105	19,870	5,876	25,381	8,327	32,712	12,711	38,909	18,034	45,022	23,747
106	45,382	3,831	47,736	4,084	50,528	4,567	51,909	4,878	54,401	4,883
107	35,344	4,212	44,296	5,951	54,368	9,066	61,620	12,813	71,231	16,725
108	37,550	4,136	47,061	5,843	57,762	8,902	65,467	12,581	75,678	16,422
109	35,702	5,799	44,745	8,193	54,919	12,482	62,245	17,641	71,954	23,026
110	31,336	12,787	39,273	18,065	48,203	27,522	54,633	38,898	63,154	50,773
111	32,163	25,737	40,309	36,360	49,475	55,395	56,074	78,291	64,820	1,02,192
112	31,272	22,206	39,193	31,372	48,105	47,795	54,522	67,550	63,026	88,172
113	30,956	29,960	38,797	42,327	47,619	64,485	53,971	91,138	62,389	1,18,961
114	37,848	20,846	47,434	29,451	58,220	44,869	65,986	63,415	76,278	82,774
115	31,512	10,640	39,493	15,032	48,473	22,901	54,939	32,367	63,508	42,248
116	31,963	3,155	40,059	4,457	49,168	6,790	55,727	9,596	64,419	12,525
117	40,150	8,845	50,319	12,496	61,761	19,038	69,999	26,907	80,917	35,121
118	44,186	5,893	45,651	6,283	46,200	6,469	47,463	6,909	49,742	6,916
119	51,939	4,545	53,661	4,846	54,307	6,140	55,791	6,761	58,469	6,768
120	54,199	5,855	58,153	6,242	64,686	6,486	66,422	6,927	69,611	6,934
121	35,831	9,613	37,020	10,249	37,465	11,004	38,489	11,752	40,337	11,764
122	26,919	18,820	34,385	26,669	44,317	40,708	52,713	57,756	60,995	76,051
123	33,099	7,745	33,107	8,257	33,505	11,477	34,421	13,862	36,073	14,179
124	30,629	3,305	30,642	3,524	31,010	4,475	31,858	4,938	33,387	4,943
125	34,632	4,413	37,158	4,705	41,332	6,611	42,442	8,073	44,479	8,349
126	34,119	5,495	35,251	5,858	35,674	7,197	36,649	7,684	38,408	7,692
127	40,466	7,662	41,808	8,169	42,311	8,684	43,467	9,274	45,554	9,283
128	36,249	6,795	40,004	7,244	65,665	9,658	1,07,934	11,189	1,44,130	11,200
129	62,282	15,080	68,734	16,077	88,599	24,228	1,05,429	33,399	1,16,049	38,989
130	14,585	2,846	18,706	4,035	25,311	6,236	31,619	8,959	36,623	11,808
131	21,137	3,905	23,327	4,163	30,069	6,134	35,780	7,854	39,383	8,516
132	3,570	2,322	3,940	2,476	5,595	3,849	7,339	5,670	9,340	7,561
133	5,354	3,482	5,909	3,712	9,699	5,093	12,140	6,073	14,056	6,132
134	1,891	1,973	2,087	2,103	2,964	3,269	3,888	4,816	4,948	6,422
135	1,891	1,973	2,087	2,103	2,964	3,269	3,888	4,816	4,948	6,422
136	1,891	1,973	2,087	2,103	2,964	3,269	3,888	4,816	4,948	6,422
137	3,782	3,945	4,174	4,206	6,851	5,754	8,574	6,842	9,928	6,889
138	2,470	10,547	2,726	11,245	4,475	15,333	5,601	18,169	6,485	18,233
139	3,704	15,820	4,088	16,866	6,710	22,997	8,399	27,252	9,725	27,348
140	1,914	3,903	2,491	5,562	3,538	8,646	4,641	12,737	5,906	16,985
141	1,914	3,903	2,491	5,562	3,538	8,646	4,641	12,737	5,906	16,985
142	3,592	1,402	3,964	1,495	5,630	2,324	7,385	3,424	9,398	4,566
143	3,592	1,402	3,964	1,495	5,630	2,324	7,385	3,424	9,398	4,566
144	3,592	1,402	3,964	1,495	5,630	2,324	7,385	3,424	9,398	4,566
145	3,592	1,402	3,964	1,495	6,507	2,061	8,144	2,469	9,429	2,506
146	3,592	1,402	3,964	1,495	6,507	2,061	8,144	2,469	9,429	2,506
147	9,935	1,339	12,930	1,908	17,529	2,957	21,940	4,319	26,614	5,754

Zone No.	Population (2019)	Employment (2019)	Population (2021)	Employment (2021)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
148	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
149	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
150	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
151	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
152	6,128	804	6,763	857	11,101	1,292	13,895	1,887	16,855	2,514
153	4,086	536	4,509	571	7,401	860	12,165	1,339	18,112	2,447
154	27,705	5,044	30,575	5,378	50,188	7,314	59,696	10,377	69,075	13,664
155	14,954	5,591	16,503	5,961	27,089	8,357	32,221	11,857	37,283	15,613
156	7,477	2,795	8,252	2,980	13,545	4,178	16,111	5,928	18,642	7,806
157	19,887	5,748	21,947	6,128	36,025	9,235	42,850	13,103	49,582	17,254

To estimate the zone-wise trip production and attraction, trip-end models have been built by regressing the generations/ attractions of the base year trips with planning variables such as population and employment. The trip end model built for Walled city, JMC and rest of study area from JDA are presented below.

Trip generation model for

- Walled City: Trip Production = (0.044 x Population) + (0.153 x Employment) - 1406
- JMC: Trip Production = (0.022 x Population) + (0.136 x Employment) + 294.6
- Rest of Study Area from JDA: Trip Production = (0.03 x Population) + 32.85

Trip attraction model for

- Walled City: Trip Production = (0.26 x Employment) - 808
- JMC: Trip Production = (0.228 x Employment) + 37.60
- Rest of Study Area from JDA: Trip Production = (0.06 x Employment) - 18.63

Based on above mentioned trip-end model, estimated trip ends for both the moderate and optimistic scenario are presented below.

Table 2.18: Horizon Year Trip Ends of Different Zones for Moderate Scenario

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
1	7,700	3,568	7,906	3,673	9,855	5,166	11,831	6,843	13,293	8,071
2	13,784	7,792	14,265	8,035	16,603	9,166	18,084	9,219	18,205	9,317
3	6,751	2,864	7,020	3,122	8,609	4,362	10,223	5,755	11,416	6,775
4	6,751	2,864	7,020	3,122	8,609	4,362	10,223	5,755	11,416	6,775
5	10,366	5,328	10,903	5,840	13,424	8,149	16,463	10,958	28,272	20,486
6	15,026	17,223	16,125	18,976	21,897	27,450	28,234	36,966	32,884	43,935
7	15,026	17,223	16,125	18,976	21,897	27,450	28,234	36,966	32,884	43,935
8	15,026	17,223	16,125	18,976	21,897	27,450	28,234	36,966	32,884	43,935

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
9	15,026	17,223	16,125	18,976	21,897	27,450	28,234	36,966	32,884	43,935
10	15,026	17,223	16,125	18,976	20,989	26,858	26,716	36,451	46,136	68,987
11	18,800	12,744	19,931	14,031	26,360	19,813	32,450	25,396	35,789	29,581
12	15,189	7,224	15,842	7,598	18,869	9,105	20,464	9,219	20,595	9,317
13	20,194	12,977	20,538	12,982	21,566	12,994	21,633	13,070	21,782	13,210
14	45,903	53,247	45,918	53,269	46,877	54,714	47,095	55,041	47,524	55,646
15	15,160	13,045	16,098	14,363	21,549	20,617	26,898	26,916	30,239	31,570
16	15,160	13,045	16,124	13,968	21,567	20,044	26,900	26,166	30,195	30,688
17	19,039	15,910	20,362	17,526	27,541	25,195	34,558	32,922	38,818	38,629
18	13,738	10,739	14,620	11,817	18,459	16,660	22,153	22,554	24,996	27,261
19	24,594	27,499	25,139	28,409	34,048	40,292	42,578	51,764	48,222	60,362
20	29,362	33,519	31,359	35,905	42,768	50,970	53,687	65,514	60,875	76,416
21	13,973	10,664	14,855	11,412	19,709	16,342	24,442	21,311	27,260	24,981
22	16,382	12,946	17,460	13,861	23,394	19,888	29,179	25,962	32,624	30,448
23	22,009	17,340	22,390	17,347	24,005	18,172	24,089	18,279	24,268	18,476
24	28,802	21,881	29,743	22,297	34,612	24,714	37,739	24,860	38,082	25,129
25	20,893	12,817	21,732	13,288	25,731	15,366	29,075	15,456	43,954	15,623
26	19,673	11,987	20,159	11,992	21,726	12,213	21,791	12,283	21,939	12,414
27	20,801	12,487	21,715	13,074	25,951	15,502	29,328	15,592	30,639	15,759
28	23,150	16,320	23,988	16,774	28,117	18,995	30,293	19,107	30,513	19,313
29	21,040	14,846	21,778	15,245	24,899	17,221	25,282	17,323	25,466	17,509
30	7,777	4,530	8,158	4,831	10,225	6,814	12,234	8,812	13,405	10,288
31	7,777	4,530	8,158	4,831	10,225	6,814	12,234	8,812	13,405	10,288
32	17,057	12,786	18,092	14,077	22,340	19,879	26,567	26,940	40,900	50,893
33	34,903	34,371	35,532	34,386	39,630	36,114	41,307	36,330	41,645	36,728
34	38,121	40,918	38,714	40,935	42,531	42,498	43,831	42,751	44,203	43,219
35	19,165	18,233	19,374	18,240	20,470	19,056	20,549	19,167	20,710	19,374
36	19,165	18,233	20,438	19,532	27,736	28,098	34,909	36,731	39,430	43,105
37	32,945	34,235	32,955	34,250	32,986	34,269	33,127	34,473	33,410	34,849
38	35,445	38,153	37,936	40,874	51,845	58,047	65,129	74,626	73,578	87,053
39	21,632	26,593	23,012	28,479	31,194	40,394	39,050	51,895	44,496	60,515
40	21,632	26,593	23,012	28,479	31,194	40,394	39,050	51,895	44,496	60,515
41	27,796	35,323	29,638	37,840	40,547	53,726	51,024	69,063	58,285	80,557
42	46,002	64,006	49,223	68,643	69,452	99,203	89,667	1,29,996	1,03,890	1,52,739
43	24,569	32,203	26,180	34,521	36,295	49,803	46,402	65,198	53,513	76,568
44	24,569	32,203	26,637	35,517	35,786	50,402	41,540	60,040	41,951	60,700
45	20,452	15,208	21,805	16,271	28,214	21,731	33,810	26,428	35,510	28,033
46	20,618	16,415	21,976	17,565	28,444	23,469	34,086	28,547	35,815	30,283
47	13,013	8,494	13,808	9,076	17,893	12,756	21,764	16,310	23,887	18,973
48	13,013	8,494	13,808	9,076	17,893	12,756	21,764	16,310	23,887	18,973
49	17,714	13,907	18,873	14,880	24,979	21,025	30,778	26,955	34,120	31,400
50	9,384	6,190	9,881	6,607	12,499	9,241	14,984	11,783	16,417	13,689
51	14,809	11,943	15,730	12,776	20,654	18,027	25,337	23,095	28,110	26,894
52	14,809	11,943	15,730	12,776	20,654	18,027	25,337	23,095	28,110	26,894

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
53	7,459	4,515	7,801	4,811	9,617	6,683	11,342	8,489	12,348	9,843
54	20,430	16,864	21,801	18,051	29,066	25,540	35,970	32,769	39,992	38,187
55	17,737	8,945	18,515	9,389	22,127	11,198	25,189	11,266	38,830	11,385
56	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
57	67,813	88,029	68,043	88,063	69,373	89,162	69,719	89,697	70,388	90,685
58	26,062	18,386	26,963	18,794	31,529	20,995	35,481	21,119	37,035	21,347
59	19,471	17,502	20,781	18,747	28,172	26,965	35,411	35,242	39,876	41,357
60	19,471	17,502	20,781	18,747	28,172	26,965	35,411	35,242	39,876	41,357
61	20,092	14,448	21,496	15,473	29,004	22,224	36,279	29,026	40,419	34,048
62	14,422	10,419	14,495	10,540	15,059	11,465	18,219	14,647	20,027	17,034
63	14,735	13,973	14,770	13,977	15,184	14,475	18,464	18,522	20,538	21,556
64	16,118	14,354	16,372	14,359	18,048	15,087	22,026	19,311	24,359	22,476
65	22,140	23,668	22,423	23,678	23,425	23,789	28,940	30,516	32,406	35,558
66	47,529	59,450	47,545	59,474	47,789	59,853	48,021	60,209	48,470	60,870
67	10,104	7,515	10,693	8,256	13,407	11,589	15,689	13,963	19,668	14,113
68	11,265	8,700	11,919	9,304	15,588	13,293	19,177	17,310	21,370	20,277
69	11,265	8,700	11,919	9,304	15,588	13,293	19,177	17,310	21,370	20,277
70	11,488	5,685	12,199	6,071	15,825	8,610	19,302	11,169	21,122	13,057
71	11,488	5,685	12,098	6,236	14,961	8,712	18,411	11,725	31,932	21,945
72	7,403	3,651	7,817	3,952	9,745	5,571	11,717	7,389	13,175	8,722
73	11,667	6,899	12,322	7,576	15,379	10,620	19,068	14,325	27,713	26,892
74	16,675	9,734	17,320	10,096	20,396	11,688	22,970	11,756	34,427	11,882
75	31,066	32,198	31,557	32,210	34,735	33,533	37,704	33,733	50,721	34,102
76	26,571	23,955	26,964	24,015	28,943	25,552	29,055	25,702	29,286	25,981
77	21,619	12,951	22,512	13,453	26,748	15,640	29,841	15,733	30,555	15,902
78	38,217	40,695	38,230	40,712	38,279	40,753	38,446	40,996	38,781	41,445
79	28,827	35,517	30,756	38,046	42,060	54,019	52,903	69,439	60,299	80,996
80	28,827	35,517	31,265	39,175	41,941	55,626	53,916	75,648	61,821	88,842
81	20,053	14,427	20,517	14,431	23,254	15,198	26,026	15,288	38,333	15,453
82	12,087	12,890	12,929	14,048	17,263	20,274	22,005	27,266	25,488	32,388
83	12,087	12,890	12,929	14,048	17,263	20,274	22,005	27,266	25,488	32,388
84	12,087	12,890	12,929	14,048	17,263	20,274	22,005	27,266	25,488	32,388
85	35,953	46,195	39,096	50,965	53,156	72,420	69,043	98,530	1,21,912	1,87,091
86	12,684	10,574	13,430	11,307	17,492	15,934	21,363	20,401	23,728	23,748
87	12,684	10,574	13,430	11,307	17,492	15,934	21,363	20,401	23,728	23,748
88	11,320	9,120	11,959	9,749	15,441	13,715	18,759	17,543	20,786	20,413
89	32,032	32,329	34,278	34,631	46,630	49,155	58,409	63,176	65,720	73,685
90	25,115	19,099	25,703	19,107	29,229	20,180	31,027	20,299	31,255	20,520
91	57,374	73,779	57,394	73,808	59,910	77,991	60,209	78,457	60,786	79,319
92	52,447	79,469	57,034	86,796	81,433	1,26,211	1,08,649	1,70,467	1,28,597	2,02,884
93	52,447	79,469	57,034	86,796	81,433	1,26,211	1,08,649	1,70,467	1,28,597	2,02,884
94	52,447	79,469	57,034	86,796	81,433	1,26,211	1,08,649	1,70,467	1,28,597	2,02,884
95	52,447	79,469	57,034	86,796	81,433	1,26,211	1,08,649	1,70,467	1,28,597	2,02,884
96	35,509	38,466	35,520	38,481	36,198	39,585	36,358	39,821	36,677	40,258

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
97	18,205	16,924	18,210	16,932	18,231	16,949	18,300	17,048	18,442	17,233
98	18,205	16,924	19,376	18,114	25,810	25,630	31,946	32,885	35,741	38,323
99	17,721	8,797	17,724	8,800	17,892	9,050	17,942	9,101	18,058	9,198
100	22,734	17,611	23,666	18,330	27,995	21,418	31,037	21,544	44,500	21,777
101	26,976	24,044	26,983	24,054	27,782	25,360	27,891	25,511	28,115	25,787
102	64,219	88,774	64,243	88,810	66,242	92,134	66,588	92,685	67,246	93,704
103	5,434	14,747	6,986	16,425	14,526	25,031	21,079	32,436	23,151	34,966
104	16,299	14,664	17,324	15,691	22,938	22,180	28,288	28,443	31,581	33,138
105	16,299	14,664	17,324	15,691	22,938	22,180	28,288	28,443	31,581	33,138
106	19,314	9,700	19,480	9,974	20,290	11,297	20,350	11,363	20,487	11,484
107	8,449	3,057	10,345	3,896	19,028	8,195	26,659	11,893	28,852	13,155
108	9,359	2,847	11,333	3,669	20,354	7,890	28,286	11,522	30,557	12,762
109	19,896	14,477	21,209	15,490	27,412	20,680	32,830	25,144	34,471	26,668
110	20,540	26,794	23,281	29,338	36,416	42,388	47,859	53,616	51,402	57,452
111	42,023	62,643	46,312	67,761	67,365	94,023	85,626	1,16,620	91,489	1,24,341
112	35,854	52,868	39,693	57,284	58,472	79,944	74,771	99,441	79,973	1,06,101
113	48,337	74,333	53,073	80,293	76,453	1,10,865	96,710	1,37,172	1,03,269	1,46,157
114	42,187	51,004	45,107	54,641	59,528	73,294	72,022	89,345	76,070	94,828
115	17,125	20,851	19,621	22,966	31,496	33,823	41,856	43,166	45,027	46,357
116	5,143	131	6,782	759	14,241	3,979	20,804	6,750	22,673	7,697
117	25,349	21,872	27,065	23,413	35,280	31,327	42,440	38,136	44,651	40,462
118	22,019	14,706	22,024	14,711	22,054	14,725	22,127	14,812	22,285	14,973
119	21,884	11,433	21,889	11,438	22,282	12,057	22,349	12,128	22,499	12,256
120	24,310	14,613	24,315	14,618	24,350	14,633	24,426	14,718	24,596	14,876
121	25,449	23,736	25,456	23,746	25,560	23,891	25,661	24,032	25,868	24,294
122	28,299	43,495	31,626	47,249	50,292	70,945	68,127	93,821	79,553	1,10,970
123	13,153	12,837	13,392	13,100	14,937	15,082	15,052	15,223	15,303	15,486
124	15,097	8,423	15,099	8,426	15,269	8,685	15,313	8,736	15,412	8,829
125	17,639	11,113	17,871	11,368	18,966	12,715	19,027	12,790	19,159	12,926
126	19,085	13,740	19,539	14,497	21,363	17,529	21,563	17,837	21,726	18,029
127	23,710	19,000	23,716	19,007	23,829	19,165	23,916	19,279	24,098	19,488
128	21,466	16,895	21,472	16,903	22,076	17,886	22,155	17,990	22,322	18,184
129	39,561	37,007	40,885	37,908	46,272	42,583	46,464	42,838	46,852	43,307
130	10,674	7,309	11,289	7,812	14,655	11,130	17,931	14,473	19,859	16,941
131	13,742	9,880	13,889	9,885	14,332	9,894	14,378	9,953	14,474	10,057
132	1,490	1,285	1,490	1,362	1,959	2,199	2,512	3,364	2,996	4,123
133	2,060	2,026	2,061	2,141	2,080	2,611	2,083	2,628	2,094	2,659
134	954	1,062	954	1,117	1,202	1,823	1,495	2,805	1,751	3,445
135	954	1,062	954	1,117	1,202	1,823	1,495	2,805	1,751	3,445
136	954	1,062	954	1,117	1,202	1,823	1,495	2,805	1,751	3,445
137	1,558	2,322	1,558	2,432	1,568	2,900	1,571	2,918	1,578	2,953
138	1,139	6,539	1,139	7,030	1,143	8,923	1,144	9,443	1,149	9,550
139	1,533	9,908	1,533	10,644	1,539	13,484	1,541	14,265	1,548	14,424
140	961	2,295	1,024	2,545	1,301	4,018	1,628	6,067	1,914	7,401

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
141	961	2,295	1,024	2,545	1,301	4,018	1,628	6,067	1,914	7,401
142	1,497	697	1,499	780	1,971	1,305	2,529	2,036	3,017	2,512
143	1,497	697	1,499	780	1,971	1,305	2,529	2,036	3,017	2,512
144	1,497	697	1,499	780	1,971	1,305	2,529	2,036	3,017	2,512
145	1,497	697	1,499	780	1,518	1,093	1,520	1,228	1,527	1,244
146	1,497	697	1,499	780	1,518	1,093	1,520	1,228	1,527	1,244
147	7,403	3,651	7,817	3,952	9,745	5,571	11,717	7,389	13,175	8,722
148	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
149	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
150	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
151	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
152	5,736	2,352	5,844	2,403	6,383	2,665	7,335	3,461	8,039	4,044
153	4,870	1,701	4,942	1,735	5,301	1,910	5,474	1,920	5,492	1,937
154	16,930	12,645	17,019	12,793	17,707	13,922	21,569	17,810	23,779	20,726
155	14,735	13,973	14,770	13,977	15,184	14,475	18,464	18,522	20,538	21,556
156	8,935	7,185	8,952	7,188	9,160	7,438	10,801	9,462	11,838	10,979
157	16,118	14,354	16,372	14,359	18,048	15,087	22,026	19,311	24,359	22,476

Table 2.19: Horizon Year Trip Ends of Different Zones for Optimistic Scenario

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
1	7,700	3,568	8,101	3,693	10,258	5,461	12,703	7,755	15,284	10,171
2	13,784	7,792	14,721	7,979	21,521	11,782	33,168	18,759	51,725	33,881
3	6,751	2,864	7,071	2,979	8,774	4,354	10,700	6,137	12,734	8,018
4	6,751	2,864	7,071	2,979	8,774	4,354	10,700	6,137	12,734	8,018
5	10,366	5,328	11,004	5,479	15,629	8,014	24,580	14,314	37,997	25,760
6	15,026	17,223	15,881	17,549	22,493	26,936	30,825	39,116	39,610	51,953
7	15,026	17,223	15,881	17,549	22,493	26,936	30,825	39,116	39,610	51,953
8	15,026	17,223	15,881	17,549	22,493	26,936	30,825	39,116	39,610	51,953
9	15,026	17,223	15,881	17,549	22,493	26,936	30,825	39,116	39,610	51,953
10	15,026	17,223	15,881	17,549	21,527	25,612	26,431	32,638	28,433	35,327
11	18,800	12,744	20,146	13,004	26,925	19,598	34,180	27,606	41,772	36,198
12	15,189	7,224	16,285	7,404	24,135	10,913	31,497	16,909	42,826	30,501
13	20,194	12,977	21,680	13,242	32,417	19,582	47,162	25,330	62,652	27,855
14	45,903	53,247	49,153	54,104	69,497	73,865	83,284	87,762	87,638	88,390
15	15,160	13,045	16,123	13,311	22,257	20,312	29,352	28,973	36,354	38,035
16	15,160	13,045	19,576	17,542	27,439	26,850	36,595	38,368	45,685	50,419
17	19,039	15,910	20,341	16,218	28,313	24,803	37,446	35,426	46,376	46,542
18	13,738	10,739	14,605	10,971	19,353	16,289	24,704	22,916	28,297	27,442
19	24,594	27,499	26,211	27,975	36,971	42,450	49,414	60,028	62,642	78,890
20	29,362	33,519	39,395	45,146	56,519	68,659	76,433	97,213	97,628	1,27,856

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
21	13,973	10,664	17,862	14,328	24,732	21,883	32,629	31,231	40,376	41,011
22	16,382	12,946	21,136	17,408	29,533	26,642	39,185	38,067	48,654	50,021
23	22,009	17,340	23,586	17,669	35,255	26,384	50,738	34,775	60,465	38,929
24	28,802	21,881	30,981	22,276	47,005	33,326	74,792	53,750	1,12,852	97,819
25	20,893	12,817	22,454	13,078	33,785	19,466	55,802	35,341	84,211	64,179
26	19,673	11,987	21,128	12,237	31,678	18,198	46,752	24,341	62,860	27,689
27	20,801	12,487	22,360	12,743	33,658	18,960	54,197	32,280	85,901	58,586
28	23,150	16,320	24,867	16,634	37,446	24,824	58,627	39,054	93,935	70,965
29	21,040	14,846	22,572	15,139	33,804	22,571	50,354	31,702	67,722	37,848
30	7,777	4,530	9,422	6,052	12,314	9,092	15,613	12,854	18,826	16,788
31	7,777	4,530	9,422	6,052	12,314	9,092	15,613	12,854	18,826	16,788
32	17,057	12,786	18,222	13,046	26,840	19,418	38,206	25,399	49,500	28,248
33	34,903	34,371	37,436	34,950	56,533	52,429	86,734	79,213	1,44,298	1,44,346
34	38,121	40,918	40,840	41,593	61,560	62,437	93,050	92,560	1,56,533	1,68,734
35	19,165	18,233	20,427	18,574	29,969	27,710	41,507	36,090	47,324	39,916
36	19,165	18,233	25,132	24,542	35,801	37,670	48,312	53,912	60,812	70,905
37	32,945	34,235	35,277	34,812	48,058	44,333	55,430	49,159	58,851	49,208
38	35,445	38,153	47,552	51,396	67,962	78,199	91,414	1,10,748	1,16,316	1,45,676
39	21,632	26,593	28,945	35,805	41,659	54,402	56,707	76,984	72,779	1,01,217
40	21,632	26,593	28,945	35,805	41,659	54,402	56,707	76,984	72,779	1,01,217
41	27,796	35,323	37,546	47,579	54,499	72,374	74,564	1,02,483	95,992	1,34,794
42	46,002	64,006	63,244	86,306	94,820	1,33,129	1,33,255	1,91,057	1,72,933	2,51,671
43	24,569	32,203	33,190	43,393	48,978	66,804	68,196	95,769	88,036	1,26,077
44	24,569	32,203	26,079	32,749	37,943	48,898	50,042	63,620	55,732	70,207
45	20,452	15,208	26,247	20,390	35,198	30,815	44,797	43,353	55,306	56,442
46	20,618	16,415	26,569	22,012	35,894	33,285	46,019	46,844	57,045	60,998
47	13,013	8,494	16,426	11,394	21,889	17,140	27,837	24,117	34,083	31,605
48	13,013	8,494	16,426	11,394	21,889	17,140	27,837	24,117	34,083	31,605
49	17,714	13,907	22,882	18,695	31,297	28,283	40,628	39,927	50,465	52,422
50	9,384	6,190	11,600	8,288	15,207	12,399	19,208	17,391	23,426	22,749
51	14,809	11,943	19,008	16,047	25,910	24,242	33,639	34,193	41,805	44,871
52	14,809	11,943	19,008	16,047	25,910	24,242	33,639	34,193	41,805	44,871
53	7,459	4,515	9,001	6,029	11,521	8,949	14,326	12,496	17,287	16,303
54	20,430	16,864	26,598	22,682	36,680	34,371	47,906	48,563	59,752	63,796
55	17,737	8,945	19,059	9,150	28,542	13,547	46,471	24,473	72,743	44,321
56	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
57	67,813	88,029	72,555	89,395	1,05,271	1,27,584	1,39,043	1,58,386	1,62,254	1,66,606
58	26,062	18,386	28,035	18,729	42,469	27,982	69,121	47,815	1,11,417	86,974
59	19,471	17,502	25,465	23,556	36,133	36,145	48,546	51,719	60,864	68,017
60	19,471	17,502	25,465	23,556	36,133	36,145	48,546	51,719	60,864	68,017
61	20,092	14,448	26,016	19,436	36,381	29,777	48,108	42,572	59,442	55,961
62	14,422	10,419	15,367	10,645	21,419	14,305	26,870	20,095	32,561	26,307
63	14,735	13,973	15,634	14,252	21,583	19,787	27,853	27,874	34,477	36,552
64	16,118	14,354	17,151	14,637	24,947	21,816	32,147	30,752	39,734	40,343
65	22,140	23,668	23,589	24,089	34,719	36,059	45,816	50,959	57,572	66,950

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
66	47,529	59,450	50,808	60,397	57,805	61,204	71,085	65,332	76,940	65,397
67	10,104	7,515	10,668	7,699	14,889	11,359	21,820	20,455	33,136	36,979
68	11,265	8,700	14,230	11,678	19,498	17,787	25,608	25,344	31,655	33,252
69	11,265	8,700	14,230	11,678	19,498	17,787	25,608	25,344	31,655	33,252
70	11,488	5,685	14,274	7,609	19,067	11,500	24,332	16,312	29,272	21,349
71	11,488	5,685	12,236	5,842	17,621	8,561	24,204	15,319	33,728	27,594
72	7,403	3,651	8,928	4,888	11,524	7,311	14,530	10,458	17,702	13,773
73	11,667	6,899	12,405	7,073	15,985	10,416	22,450	18,725	32,703	33,818
74	16,675	9,734	17,868	9,950	26,520	14,751	43,293	26,684	68,480	48,362
75	31,066	32,198	33,249	32,744	49,845	49,102	85,774	89,755	1,45,106	1,63,610
76	26,571	23,955	28,472	24,380	42,678	36,448	60,564	47,526	77,397	52,590
77	21,619	12,951	23,253	13,214	35,085	19,672	55,884	32,400	88,438	58,805
78	38,217	40,695	40,265	41,366	49,861	56,081	56,525	66,196	57,145	66,252
79	28,827	35,517	38,878	47,840	56,254	72,772	76,708	1,03,047	98,530	1,35,538
80	28,827	35,517	30,704	36,113	45,385	54,180	60,413	74,740	70,045	87,443
81	20,053	14,427	21,492	14,711	28,741	21,927	42,291	39,860	64,166	72,437
82	12,087	12,890	15,703	17,415	22,234	26,728	30,475	38,813	39,162	51,548
83	12,087	12,890	15,703	17,415	22,234	26,728	30,475	38,813	39,162	51,548
84	12,087	12,890	15,703	17,415	22,234	26,728	30,475	38,813	39,162	51,548
85	35,953	46,195	38,330	46,948	54,850	70,508	75,483	1,01,058	90,053	1,22,808
86	12,684	10,574	16,180	14,201	21,990	21,423	28,571	30,193	35,541	39,606
87	12,684	10,574	16,180	14,201	21,990	21,423	28,571	30,193	35,541	39,606
88	11,320	9,120	14,316	12,239	19,297	18,431	24,938	25,949	30,912	34,017
89	32,032	32,329	42,706	43,541	60,548	66,210	80,873	93,739	1,02,418	1,23,279
90	25,115	19,099	26,874	19,452	34,901	29,073	45,700	44,562	69,272	81,029
91	57,374	73,779	61,353	74,937	70,162	84,797	75,642	90,529	76,473	90,620
92	52,447	79,469	73,124	1,07,693	1,11,075	1,66,662	1,59,983	2,43,178	2,11,524	3,23,806
93	52,447	79,469	73,124	1,07,693	1,11,075	1,66,662	1,59,983	2,43,178	2,11,524	3,23,806
94	52,447	79,469	73,124	1,07,693	1,11,075	1,66,662	1,59,983	2,43,178	2,11,524	3,23,806
95	52,447	79,469	73,124	1,07,693	1,11,075	1,66,662	1,59,983	2,43,178	2,11,524	3,23,806
96	35,509	38,466	38,012	39,105	47,095	49,721	52,173	55,037	52,926	55,093
97	18,205	16,924	19,345	17,246	20,934	18,244	22,219	19,452	22,576	19,471
98	18,205	16,924	23,761	22,765	33,037	34,498	43,590	48,744	54,775	64,031
99	17,721	8,797	18,549	9,000	19,762	9,996	20,459	10,643	20,991	10,652
100	22,734	17,611	24,379	17,944	36,533	26,797	61,205	48,801	99,839	88,776
101	26,976	24,044	28,827	24,471	34,679	30,942	37,634	34,091	38,301	34,126
102	64,219	88,774	68,496	90,153	84,943	1,13,931	92,862	1,25,220	93,494	1,25,345
103	5,434	14,747	12,793	24,386	24,855	41,657	38,446	62,430	53,020	84,116
104	16,299	14,664	21,139	19,718	29,204	29,847	38,364	42,145	48,068	55,344
105	16,299	14,664	21,139	19,718	29,204	29,847	38,364	42,145	48,068	55,344
106	19,314	9,700	20,232	9,915	21,585	11,031	22,359	11,749	22,950	11,761
107	8,449	3,057	15,476	7,871	25,268	16,494	34,770	26,866	45,645	37,696
108	9,359	2,847	16,595	7,572	26,591	16,040	36,194	26,224	47,234	36,857
109	19,896	14,477	25,481	19,408	34,074	29,318	43,261	41,237	53,332	53,679
110	20,540	26,794	32,856	41,405	52,445	67,584	73,989	99,075	97,325	1,31,948

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
111	42,023	62,643	63,144	92,050	98,446	1,44,743	1,38,835	2,08,124	1,81,866	2,74,287
112	35,854	52,868	54,496	78,242	85,424	1,23,704	1,20,610	1,78,390	1,58,187	2,35,477
113	48,337	74,333	72,156	1,08,568	1,12,384	1,69,906	1,58,777	2,43,687	2,08,044	3,20,707
114	42,187	51,004	56,892	68,523	81,744	1,04,145	1,10,417	1,46,993	1,40,860	1,91,720
115	17,125	20,851	28,019	33,009	45,044	54,792	63,493	80,996	83,603	1,08,349
116	5,143	131	11,057	3,735	19,125	10,193	26,768	17,961	35,612	26,069
117	25,349	21,872	33,017	29,350	45,170	44,465	58,494	62,645	72,945	81,623
118	22,019	14,706	22,927	14,996	23,325	15,425	24,258	16,442	24,802	16,458
119	21,884	11,433	22,723	11,676	24,748	14,665	25,995	16,100	26,632	16,116
120	24,310	14,613	25,796	14,901	27,680	15,465	28,725	16,483	29,482	16,500
121	25,449	23,736	26,648	24,159	27,846	25,903	29,169	27,631	29,619	27,659
122	28,299	43,495	44,582	65,223	72,104	1,04,086	1,03,809	1,51,279	1,37,491	2,01,923
123	13,153	12,837	13,990	14,254	19,422	23,168	23,737	29,770	25,027	30,648
124	15,097	8,423	15,417	8,621	16,880	10,818	17,749	11,888	18,114	11,900
125	17,639	11,113	18,653	11,350	22,391	15,753	24,768	19,131	25,644	19,769
126	19,085	13,740	19,876	14,014	21,914	17,107	22,847	18,232	23,271	18,251
127	23,710	19,000	24,758	19,353	25,622	20,543	26,747	21,906	27,249	21,927
128	21,466	16,895	22,996	17,216	32,502	22,793	44,620	26,330	53,114	26,356
129	39,561	37,007	42,516	37,624	58,971	56,456	76,193	77,644	86,775	90,559
130	10,674	7,309	13,361	9,802	18,095	14,887	23,515	21,178	28,813	27,761
131	13,742	9,880	14,629	10,098	19,062	14,651	22,890	18,625	24,693	20,155
132	1,490	1,285	1,608	1,383	2,890	2,260	3,880	3,424	4,953	4,632
133	2,060	2,026	2,237	2,173	4,248	3,055	5,133	3,681	5,601	3,719
134	954	1,062	1,016	1,145	2,088	1,890	2,799	2,878	3,560	3,904
135	954	1,062	1,016	1,145	2,088	1,890	2,799	2,878	3,560	3,904
136	954	1,062	1,016	1,145	2,088	1,890	2,799	2,878	3,560	3,904
137	1,558	2,322	1,683	2,489	3,792	3,477	4,543	4,172	4,876	4,202
138	1,139	6,539	1,220	6,985	6,295	9,597	7,465	11,408	7,693	11,449
139	1,533	9,908	1,656	10,576	9,267	14,493	11,022	17,211	11,363	17,272
140	961	2,295	1,145	3,355	3,940	5,325	5,505	7,938	7,158	10,652
141	961	2,295	1,145	3,355	3,940	5,325	5,505	7,938	7,158	10,652
142	1,497	697	1,616	757	2,411	1,286	3,173	1,989	4,010	2,718
143	1,497	697	1,616	757	2,411	1,286	3,173	1,989	4,010	2,718
144	1,497	697	1,616	757	2,411	1,286	3,173	1,989	4,010	2,718
145	1,497	697	1,616	757	2,532	1,118	3,046	1,379	3,359	1,403
146	1,497	697	1,616	757	2,532	1,118	3,046	1,379	3,359	1,403
147	7,403	3,651	8,928	4,888	11,524	7,311	14,530	10,458	17,702	13,773
148	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
149	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
150	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
151	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
152	5,736	2,352	5,962	2,459	7,608	3,464	9,124	4,839	10,725	6,288
153	4,870	1,701	5,020	1,799	6,115	2,466	7,925	3,573	10,922	6,133
154	16,930	12,645	18,086	12,905	25,483	17,378	32,145	24,454	39,102	32,049
155	14,735	13,973	15,634	14,252	21,583	19,787	27,853	27,874	34,477	36,552

Zone No.	Production (2019)	Attraction (2019)	Production (2021)	Attraction (2021)	Production (2031)	Attraction (2031)	Production (2041)	Attraction (2041)	Production (2051)	Attraction (2051)
156	8,935	7,185	9,385	7,364	12,359	10,132	15,494	14,175	18,806	18,514
157	16,118	14,354	17,151	14,637	24,947	21,816	32,147	30,752	39,734	40,343

Table 2.20: Population-Employment Summary for Moderate Scenario

Horizon Year	Population	Employment	Population Growth (CAGR)	WFPR	Motorised Person Trips	PCTR
2011	30,46,163	9,85,494	2.75%	32.4%		
2019	37,11,454	12,24,780	2.50%	33.0%	30,14,657	0.81
2021	38,99,346	12,86,784	2.50%	33.0%	31,56,488	0.81
2031	47,53,281	16,39,882	2.00%	34.5%	39,07,409	0.82
2041	55,16,377	19,85,896	1.50%	36.0%	46,22,947	0.84
2051	61,54,113	22,77,022	1.10%	37.0%	52,07,116	0.85

Table 2.21: Population-Employment Summary for Optimistic Scenario

Horizon Year	Population	Employment	Population Growth (CAGR)	WFPR	Motorised Person Trips	PCTR
2011	30,46,163	9,85,494	2.75%	32.4%		
2019	37,11,454	12,24,780	2.50%	33.0%	30,14,657	0.81
2021	42,80,336	15,12,958	3.46%	35.3%	35,95,649	0.84
2031	58,87,865	22,22,380	3.24%	37.7%	50,70,774	0.86
2041	77,22,824	31,04,729	2.75%	40.2%	68,30,860	0.88
2051	96,47,378	40,92,181	2.25%	42.4%	87,66,315	0.91

Trip Distribution

The second stage of the process involves distributing the estimated zonal trip ends within the zones, thereby yielding the zone wise production-attraction matrix. The obtained trip ends (as per the established relationship with relevant zonal parameters) were distributed as per the conventional doubly constrained gravity model and further calibrated and validated as per the observed movement pattern from the primary Origin-Destination Survey. The general form of gravity model used is of the form:

$$T_{ij} = r_i G_i s_j A_j f(c_{ij})$$

where,

T = number of inter zonal trips between zone I and j and by particular mode

G = total generated trip ends by zone

A = total attracted trip ends by zone

i = generation zone

j = attraction zone

r, s = balancing factors (constants)

f(cij)= Deterrence function of travel impedance between zone i and j

Mode Choice

The mode choice model is based on the utility of a particular choice of mode i.e. degree of satisfaction people derives from their mode choices. The parameters of generalized cost have been associated with each mode to develop the model. The model has been developed using a set of discrete choice models. The mathematical framework of logit model is based on the theory of utility which assumes the following form:

$$\mathbf{Pmi} = \frac{\exp(\mathrm{Umi})}{\sum_{mi=1}^{n} \exp(\mathrm{Umi})}$$

where,

Pmi – is the probability of selecting mode m by an individual i from the choice set

Umi – is the utility of mode m for individual I

n – number of available modal alternatives

m – is the set of all available travelling modes

The utility function defined using a logit model is defined as:

$$\mathbf{Ui = K + \alpha\, X1 + \beta\, X2}$$

where,

K – Mode Specific Constant

α – Coefficients for the vehicle operating cost

β – Coefficients for the journey time

X1 – Vehicle operating cost attribute

X2 – Journey time attribute

The mode-wise calibrated parameters of the above mentioned utility function are presented below:

Table 2.22: Calibrated Co-efficient for Mode-wise Utility Functions

Mode	K	α	β
Two Wheeler	-0.01	-0.019	-0.015
Car	-0.42	-0.015	-0.025
Auto Rickshaw	-1.90	-0.029	-0.010
Public Transport	-2.82	-0.044	-0.001

The modal split obtained from the mode choice model and from the observed data is presented below:

Table 2.23: Observed and Calibrated Modal Split for the Base Year (2019)

Mode	Total Daily Trips	Observed Modal Split	Calibrated Modal Split
Two Wheeler	15,68,691	52.18%	52.31%
Car	6,95,792	23.14%	23.05%
Auto Rickshaw	3,10,083	10.31%	10.17%
Public Transport	4,31,684	14.36%	14.47%
Total	**30,06,250**	**100.00%**	**100.00%**

Trip Assignment

In order to assess the corridor-wise MRTS demand, the generated mode wise trip matrices have been assigned on the developed network as per the generalised costs of travel.

Generalized Cost = (Distance Travelled) x (Vehicle Operating Cost/km) + (Travel Time) x (Value of Time/minute)

MRTS demand were assessed using the CUBE Voyager software. Vehicle operating cost depends on vehicle cost, fuel cost, maintenance cost, cost of repairs, parking charges, comfort (driving/ safety etc.) cost, fare, transfer (from one mode to another) cost, type and surface of road, incremental congestion on road etc. Travel time is the combination of journey time depending on speed, delay time, waiting time for vehicle availability, transfer time etc. Value of time is the average income (earning) per minute depending on monthly income of different type of vehicle owners or public transport travelers.

2.5 OPTION EVALUATION

For assessment of alternative MRTS corridor demand, different combinations of MRTS corridors have been considered along the selected demand corridors. These combinations of MRTS corridors are mentioned as alternative options. Mass rapid transit demand for each alternative option has been evaluated for the selection of suitable MRTS corridors in Jaipur. These alternative options are mentioned below:

1. Option-1:
   Corridor 1: Sitapura Industrial Area to Mansarovar
   Corridor 2 : Mansarovar to Transport Nagar
2. Option-2:
   Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road)
   Corridor 2 : Mansarovar to Transport Nagar
3. Option-3:
   Corridor 1: Sitapura Industrial Area to Ambabari (on JNL Marg)
   Corridor 2: Mansarovar to Transport Nagar
4. Option-2A:
   Corridor 1: Manpur(Ring Road) to Harmada (on Tonk Road)
   Corridor 2: Mansarovar to Transport Nagar
5. Option-3A:
   Corridor 1: Manpur(Ring Road) to Harmada (on JNL Marg)
   Corridor 2: Mansarovar to Transport Nagar
6. Option-4:
   Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road)
   Corridor 2: Mansarovar to Badi Chaupar
7. Option-5:
   Corridor 1: Sitapura Industrial Area to Ambabari (on JLN Marg)
   Corridor 2: Mansarovar – Badi Chaupar
8. Option-6:

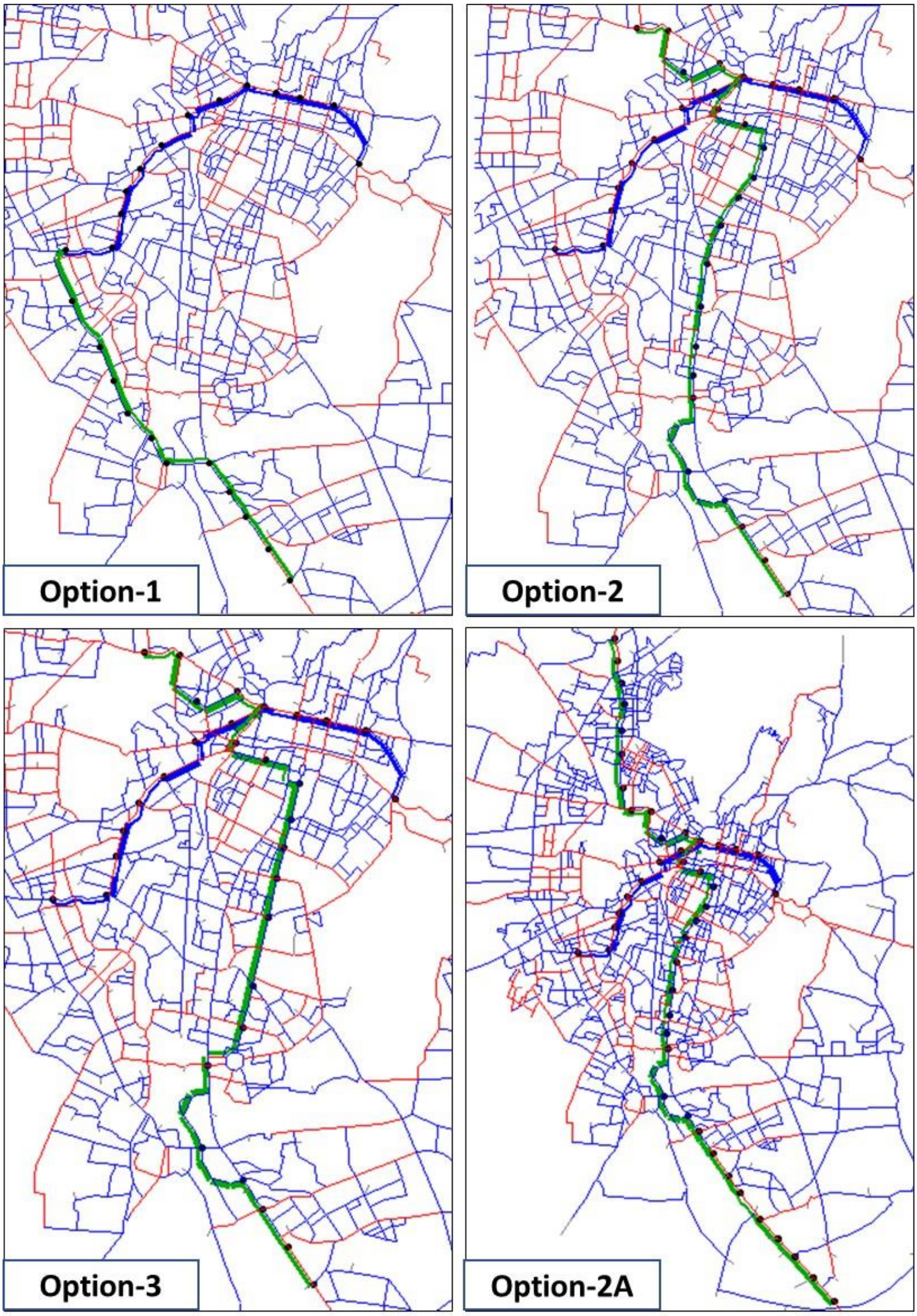
Corridor 1: Ambabari – Sitapura Industrial Area to Ambabari (on Tonk Road) without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle
Corridor 2: Mansarovar – Transport Nagar

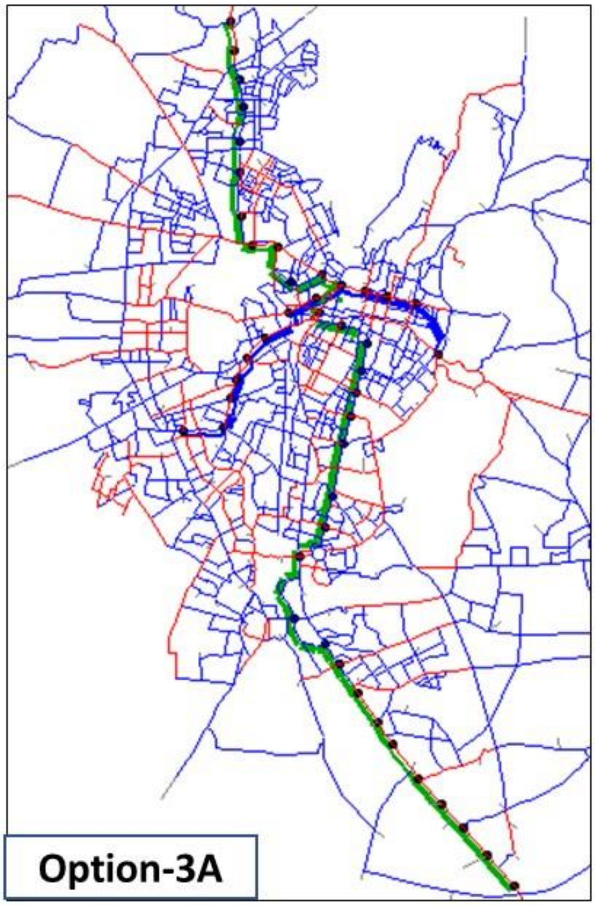
9. Option-7:
   Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) within air funnel zone on Tonk Road
   Corridor 2: Mansarovar – Transport Nagar
10. Option-7A:
   Corridor 1: Manpur (Ring Road) to Harmada (on Tonk Road) within air funnel zone on Tonk Road
   Corridor 2: Mansarovar – Transport Nagar
11. Option-8:
   Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) within air funnel zone
   Corridor 2: Mansarovar to Transport Nagar
   Corridor 3: Sanganer Thana to Mansarovar
12. Option-8A:
   Corridor 1: Manpur (Ring Road) to Harmada (on Tonk Road) within air funnel zone
   Corridor 2: Mansarovar to Transport Nagar
   Corridor 3: Sanganer Thana to Mansarovar
13. Option-9:
   Corridor 1: Sitapura Industrial Area to Ambabari (partly on JLN Marg and partly on Tonk Road)
   Corridor 2: Mansarovar to Transport Nagar
14. Option-9A:
   Corridor 1: Manpur (ring Road) to Harmada (partly on JLN Marg and partly on Tonk Road)
   Corridor 2: Mansarovar to Transport Nagar
15. Option-10:
   Corridor 1: Sitapura Industrial Area to Ambabari (partly on JLN Marg and partly on Tonk Road)
   Corridor 2: Mansarovar – Transport Nagar
   Corridor 3: Mansarovar – Sanganer Thana
16. Option-10A:
   Corridor 1: Manpur (Ring Road) to Harmada (partly on JLN Marg and partly on Tonk Road)
   Corridor 2: Mansarovar – Transport Nagar
   Corridor 3: Mansarovar – Sanganer Thana
17. Option-11: Mansarovar – Badi Chaupar

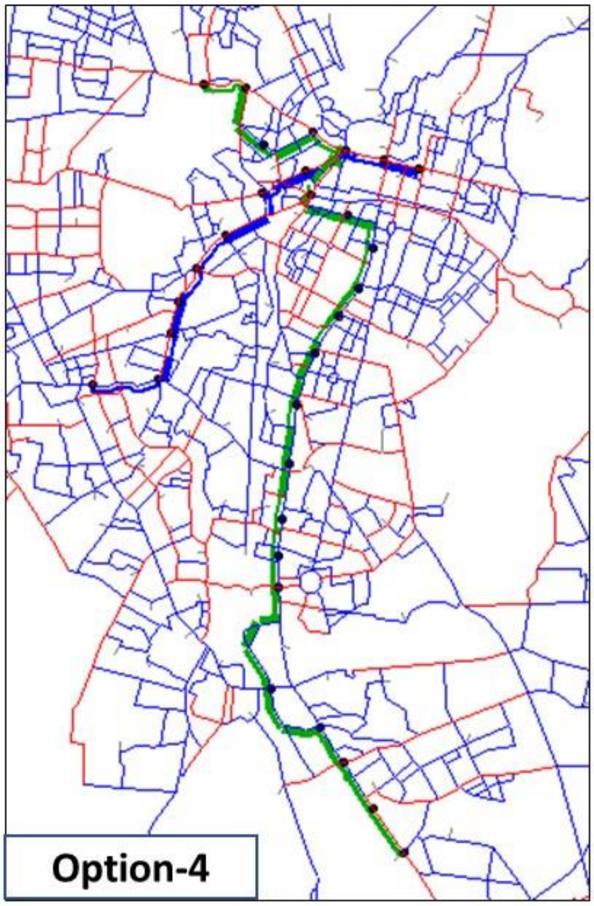
Among the above mentioned 17 options, the last option (Option-11) is a do-nothing option in terms of future MRTS development in Jaipur. Therefore, this option is not for option evaluation and system selection for future proposed MRTS in Jaipur.

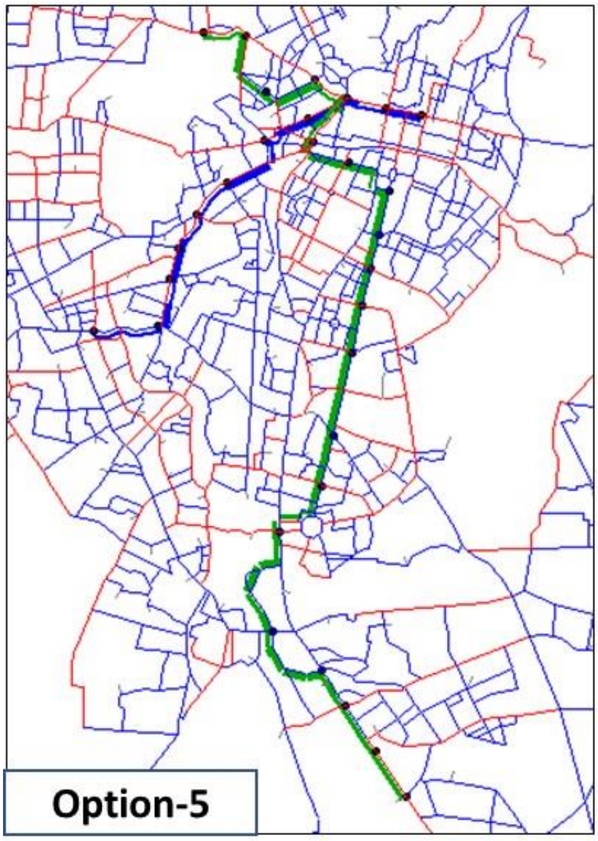
From rest of the 16 options Option-7, Option-7A, Option-8 and Option-8A have the highest demand for respective configuration. However, all these four options are with MRTS alignment within air funnel zone on the Tonk Road. Due to limited ROW available on the Tonk Road, proposed MRTS should be elevated or underground on Tonk Road. Underground corridor is difficult to execute for construction limitations and elevated option is not feasible due to restriction of air funnel zone. Therefore, these four options are not considered as feasible options.

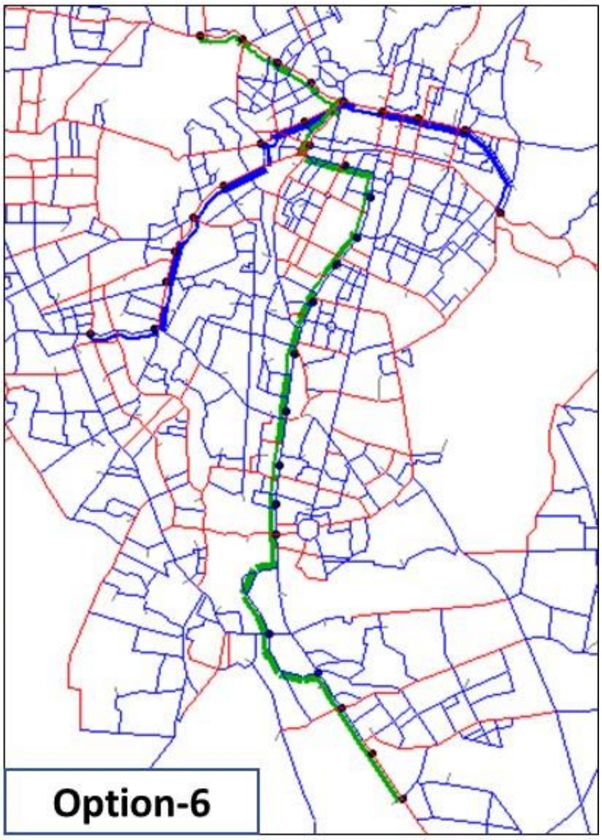
Estimated demands for Option-1, Option-4 and Option-5 are very low and therefore these three options are not viable for proposed MRTS corridors in Jaipur.

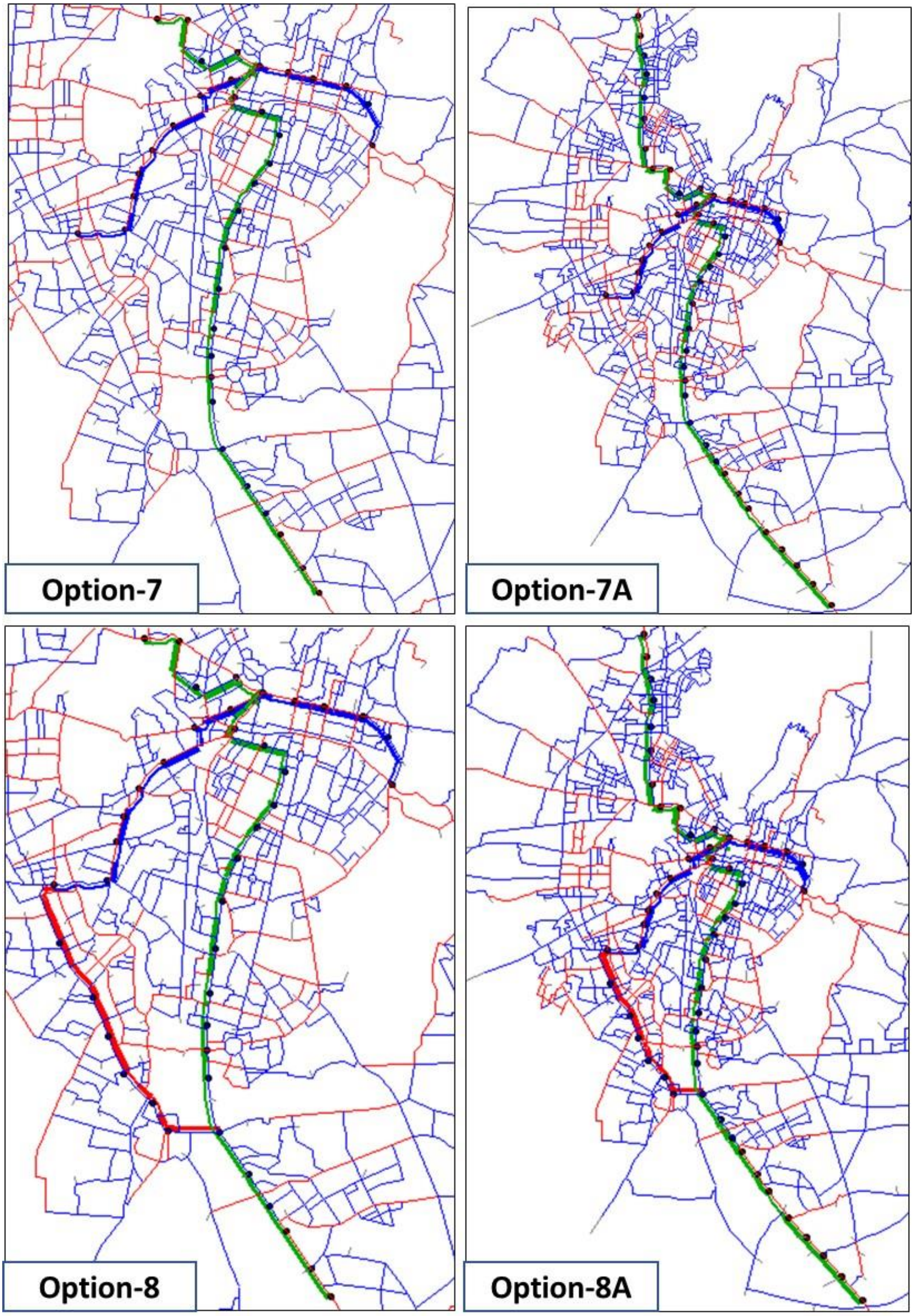

Option-1
Option-2
Option-3
Option-2A


Option-3A


Option-4


Option-5


Option-6


Option-7
Option-7A
Option-8
Option-8A

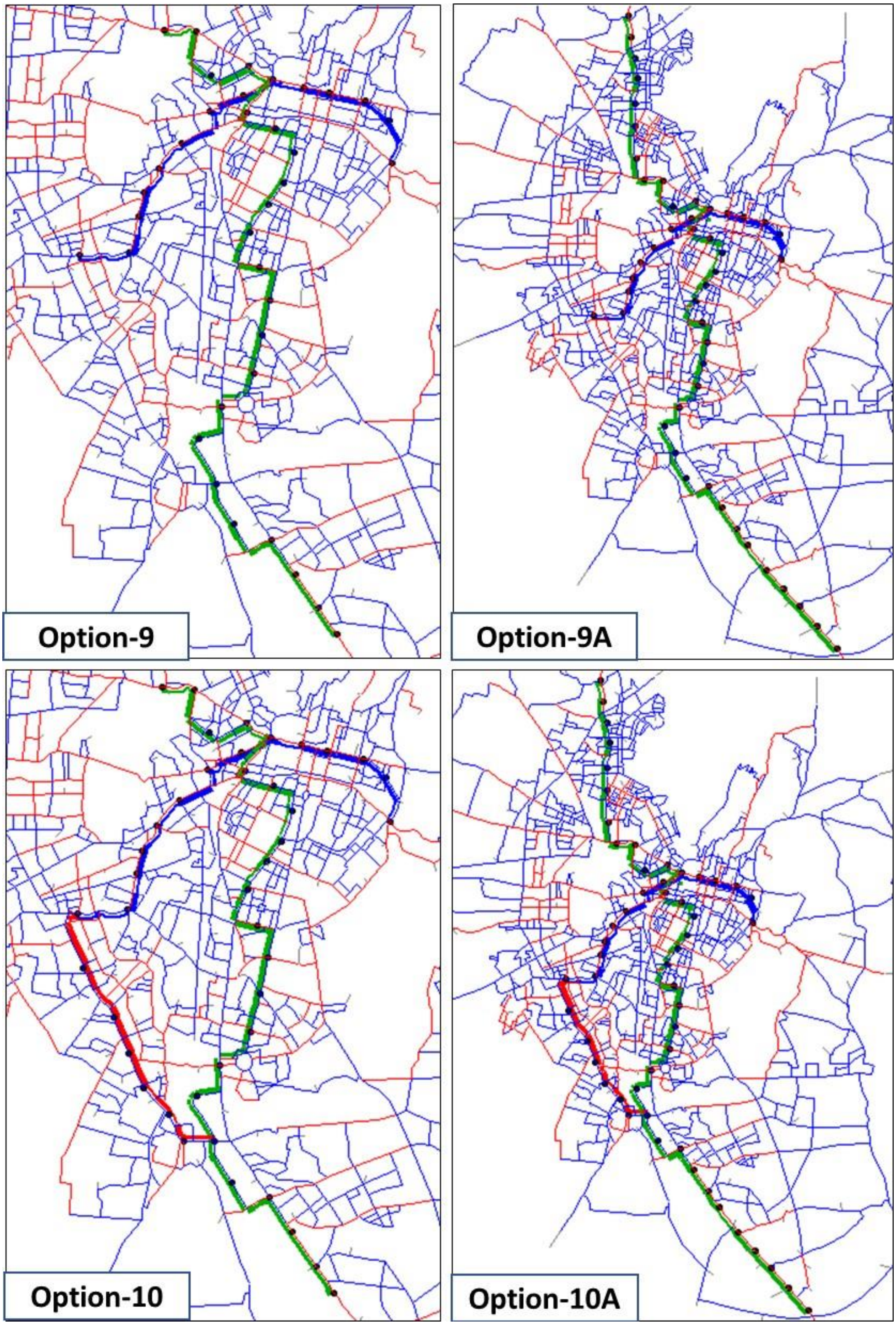


Figure 2.15: Maps Showing Different Options or Combinations Developed for Evaluation

Table 2.24: Estimated MRTS Demand for Different Options

Sl. No.	Option	Moderate Scenario					Optimistic Scenario					Remarks
		2021	2023	2031	2041	2051	2021	2023	2031	2041	2051	
1	Option-1	54,557	65,771	1,10,628	1,97,334	3,51,179	71,865	91,516	1,70,121	3,10,950	6,38,830	Low demand
2	Option-2	1,06,185	1,25,725	2,03,886	3,62,039	5,87,942	1,66,254	2,01,858	3,44,277	5,75,888	9,96,526	Viable for MRTS
3	Option-3	1,04,052	1,23,790	2,02,738	3,56,629	5,81,029	1,61,435	1,96,771	3,38,115	5,68,005	9,90,799	Viable for MRTS
4	Option-2A	1,37,501	1,66,473	2,82,364	5,13,669	8,47,868	2,00,019	2,48,135	4,40,598	7,18,340	13,27,243	Viable for MRTS
5	Option-3A	1,36,660	1,65,403	2,80,374	5,07,079	8,45,217	1,98,356	2,45,976	4,36,454	7,02,916	13,02,357	Viable for MRTS
6	Option-4	92,344	1,09,335	1,77,297	3,19,676	5,35,884	1,45,820	1,77,162	3,02,531	5,07,913	8,81,336	Low demand
7	Option-5	90,869	1,07,469	1,73,870	3,14,308	5,13,844	1,42,349	1,73,339	2,97,302	4,82,068	8,17,426	Low demand
8	Option-6	1,06,835	1,10,796	2,05,869	3,65,845	5,90,832	1,67,106	2,03,161	3,47,385	5,87,592	9,97,216	Viable for MRTS (revised alignment of Option-2)
9	Option-7	1,07,420	1,28,114	2,10,886	3,72,937	6,00,452	1,67,588	2,04,548	3,52,388	6,03,378	10,34,097	Difficult to construct
10	Option-7A	1,39,565	1,69,383	2,88,657	5,25,636	8,58,520	2,02,762	2,51,499	4,46,448	7,15,258	13,55,589	Difficult to construct
11	Option-8	1,19,330	1,41,277	2,29,064	4,05,114	6,51,162	1,84,429	2,23,556	3,80,065	6,46,378	11,35,951	Difficult to construct
12	Option-8A	1,53,423	1,84,735	3,09,982	5,64,372	9,21,457	2,23,066	2,76,170	4,88,586	7,78,358	14,59,456	Difficult to construct
13	Option-9	1,06,384	1,25,867	2,03,797	3,62,123	5,91,052	1,65,567	2,02,349	3,49,476	6,00,090	10,30,675	Lower demand per km
14	Option-9A	1,38,213	1,67,163	2,82,962	5,10,912	8,50,848	2,01,682	2,49,698	4,41,764	7,11,518	13,46,844	Lower demand per km
15	Option-10	1,17,808	1,39,202	2,24,778	3,97,875	6,43,214	1,82,589	2,21,427	3,76,778	6,37,385	11,26,503	Lower demand per km
16	Option-10A	1,51,637	1,82,345	3,05,176	5,54,812	9,11,782	2,20,843	2,73,349	4,83,376	7,73,321	14,50,689	Lower demand per km
17	Option-11	31,258	37,589	62,914	1,13,618	1,99,842	35,414	44,437	80,529	1,40,812	2,69,566	Do-nothing

Option-2 and Option-2A are the revised configurations of Option-9 and Option-9A. Option-9 and Option-9A have higher demand than Option-2 and Option-2A. However, Option-9 and Option-9A have higher corridor length and therefore, have lower demand per km. Therefore, Option-9 and Option-9A are not viable option for proposed MRTS in Jaipur.

Option-10 and Option-10A are the longer configurations (extended network) of Option-9 and Option-9A with additional corridor from Mansarovar to Sanganer Thana connecting the existing phase-1 corridor and proposed corridor on Tonk Road. Therefore, due to similar reason of lower demand per km, Option-10 and Option-10A are also not viable for proposed standalone MRTS configuration in Jaipur. However, the corridor from Mansarovar to Sanganer Thana can be considered as separate corridor along with other viable configuration.

After a detailed evaluation mentioned above, it is concluded that Option-2, Option-3, Option-2A, Option-3A and Option-6 are the viable options for proposed MRTS in Jaipur. Option-2A and Option-3A are the longer configurations (extended network) of Option-2 and Option-3. Therefore, Option-2A and Option-3A are not considered as separate options from Option-2 and Option-3. Further, Option-6 is the improved alignment of Option-2 with ease of construction avoiding some limited ROW section. Therefore, Option-6 is the more viable option in comparison of Option-2.

2.6 ESTIMATED RIDERSHIP FOR PROPOSED METRO

2.6.1 Suitable Option for Proposed Metro

From the option evaluation section it is clear that Option-2A and Option-3A are the extended network of Option-6 and Option-3. Analysing the detailed ridership of Option-2A and Option-3A, it is suggested to develop the extended part (which are same for both of these options) as metro system beyond 2041 due to insufficient ridership for metro system for these extended parts till the time.

Further, Option-6 has better ridership than Option-3 and the corridor from Mansarovar to Sanganer Thana is not viable for metro like system from demand perspective. Therefore, Option-6 has been selected for immediate development as suitable option for metro like system.

This section covers the estimated ridership details for proposed metro for Option-6 as this option is evaluated for operation of metro as a suitable mass rapid transit system in Jaipur. Each corridor-wise and scenario-wise ridership including all station loadings for Option-6 in different horizon years are presented in this section.

2.6.2 Corridor Brief for Option-6

Option-6 is detailed out as combination of two metro corridors – one is the extension of existing phase-1 corridor which is considered as east-west corridor and the other is the new north-south corridor. East-west corridor is called as Mansarovar-Transport Nagar corridor with total 13 stations. Within these 13 stations, 11 stations are for phase-1 (Mansarovar-Badi Chaupar) corridor. North-south corridor is called as

Ambabari – Sitapura Industrial Area corridor with 21 stations. These two corridors intersect each other at Chandpole station. North-south corridor is planned on Tonk Road without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle. Station details for both the corridors are presented below:

Table 2.25: List of Stations for Different Corridors in Option-6

Sl. No.	Mansarovar – Transport Nagar Corridor	Ambabari – Sitapura Industrial Area Corridor
1	Mansarovar	Ambabari
2	New Aatish Market	Pani Petch
3	Vivek Vihar	Subhash Nagar
4	Shyam Nagar	Collectorate
5	Ram Nagar	Chandpole
6	Civil Lines	Government Hostel
7	Jaipur Railway Station	Ashok Marg
8	Sindhi Camp	SMS Hospital
9	Chandpole	Narayan Singh Circle
10	Choti Chaupar	Ram Bagh Circle
11	Badi Chaupar	Tonk Phatak
12	Ramganj Chaupar	Gandhi Nagar Railway Station
13	Transport Nagar	Dev Nagar
14		Mahaveer Nagar
15		Durgapura
16		B2 Bypass
17		Sanganer Sethu
18		Pinjarapole Gaushala
19		Haldi Ghati Gate
20		Kumbha Marg
21		India Gate (SIA)

2.6.3 Ridership Details for Moderate Scenario in Option-6

Estimation of Line-wise Ridership for Moderate Scenario

Corridor (line)-wise ridership summary estimated for realistic (moderate) scenario at an aggregated network level including daily ridership, peak hour peak direction traffic (PHPDT), daily passenger-km and average trip length is given below:

Table 2.26: Proposed Jaipur Metro Phase-2 Ridership Summary (Line Wise) for Realistic (Moderate) Scenario

Target Year	Corridor	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger Kilometres (km)	Average Trip Length/ Passenger Lead (km)
2021	Mansarovar - Transport Nagar	44,563	1,265	1,96,786	4.42
2021	Ambabari - India Gate (SIA)	62,271	1,936	4,98,310	8.00
2023	Mansarovar - Transport Nagar	52,439	1,493	2,33,776	4.46
2023	Ambabari - India Gate (SIA)	74,203	2,335	6,09,725	8.22
2031	Mansarovar - Transport Nagar	83,939	2,407	3,81,735	4.55
2031	Ambabari - India Gate (SIA)	1,21,931	3,942	10,55,385	8.66
2041	Mansarovar - Transport Nagar	1,44,119	4,209	6,62,342	4.60
2041	Ambabari - India Gate (SIA)	2,21,726	7,409	20,34,357	9.18
2051	Mansarovar - Transport Nagar	2,19,243	6,594	9,78,168	4.46
2051	Ambabari - India Gate (SIA)	3,71,590	12,743	35,23,035	9.48

Station-wise Boarding and Alighting for Moderate Scenario

The route wise stop to stop passengers obtained from the public transport assignment model have been extracted for different horizon years for moderate scenario and presented below. Applying 10% as peak hour factor, peak hour boarding and alighting was also estimated, which helps in identification of the line PHPDT.

Table 2.27: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Moderate Scenario - Horizon Year 2021										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	2,601	0	0		13	Transport Nagar	2,701	0	0
2	New Aatish Market	1,427	24	2,601		12	Ramganj Chaupar	3,267	54	2,701
3	Vivek Vihar	1,058	51	4,004		11	Badi Chaupar	3,107	162	5,914
4	Shyam Nagar	1,933	105	5,011		10	Choti Chaupar	3,101	352	8,859
5	Ram Nagar	3,584	445	6,838		9	Chandpole	7,641	6,818	11,607
6	Civil Lines	1,679	395	9,977		8	Sindhi Camp	604	949	12,431
7	Jaipur Railway Stn.	1,760	653	11,262		7	Jaipur Railway Stn.	741	3,441	12,086
8	Sindhi Camp	901	627	12,368		6	Civil Lines	377	1,689	9,386
9	Chandpole	7,077	7,836	12,642		5	Ram Nagar	307	2,000	8,074
10	Choti Chaupar	322	3,418	11,883		4	Shyam Nagar	101	1,866	6,380
11	Badi Chaupar	147	3,271	8,786		3	Vivek Vihar	51	968	4,616
12	Ramganj Chaupar	53	3,136	5,662		2	New Aatish Market	24	1,335	3,699
13	Transport Nagar	0	2,580	2,580		1	Mansarovar	0	2,388	2,388
	Total	**22,541**	**22,541**				**Total**	**22,022**	**22,022**	

Table 2.28: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2021										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	5,252	0	0		21	India Gate (SIA)	499	0	0
2	Pani Petch	1,646	46	5,252		20	Kumbha Marg	1,210	1	499
3	Subhash Nagar	1,259	60	6,852		19	Haldi Ghati Gate	1,380	5	1,708
4	Collectorate	2,544	156	8,051		18	Pinjarapole Gaushala	2,335	21	3,083
5	Chandpole	11,323	3,755	10,439		17	Sanganer Sethu	2,706	57	5,397
6	Government Hostel	1,688	622	18,007		16	B2 Bypass	2,231	101	8,046
7	Ashok Marg	1,049	1,240	19,072		15	Durgapura	1,962	158	10,176
8	SMS Hospital	1,539	1,471	18,881		14	Mahaveer Nagar	1,337	127	11,980
9	Narayan Singh Circle	1,253	1,756	18,948		13	Dev Nagar	2,599	419	13,190
10	Ram Bagh Circle	1,365	2,518	18,445		12	Gandhi Nagar Rly. Stn.	749	161	15,371
11	Tonk Phatak	956	3,158	17,292		11	Tonk Phatak	3,128	1,005	15,959
12	Gandhi Nagar Rly. Stn.	159	711	15,090		10	Ram Bagh Circle	2,438	1,465	18,082
13	Dev Nagar	397	2,581	14,539		9	Narayan Singh Circle	1,642	1,337	19,054
14	Mahaveer Nagar	128	1,255	12,354		8	SMS Hospital	1,406	1,604	19,360
15	Durgapura	155	1,934	11,226		7	Ashok Marg	1,114	1,119	19,161
16	B2 Bypass	103	2,063	9,447		6	Government Hostel	620	1,825	19,156
17	Sanganer Sethu	62	2,402	7,487		5	Chandpole	3,745	11,332	17,951
18	Pinjarapole Gaushala	23	2,105	5,147		4	Collectorate	160	2,474	10,364
19	Haldi Ghati Gate	6	1,306	3,065		3	Subhash Nagar	56	1,317	8,051
20	Kumbha Marg	2	1,145	1,765		2	Pani Petch	44	1,677	6,790
21	India Gate (SIA)	0	622	622		1	Ambabari	0	5,157	5,157
	Total	**30,909**	**30,909**				**Total**	**31,362**	**31,362**	

Table 2.29: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Moderate Scenario - Horizon Year 2023										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	3,151	0	0		13	Transport Nagar	3,091	0	0
2	New Aatish Market	1,710	28	3,151		12	Ramganj Chaupar	4,061	60	3,091
3	Vivek Vihar	1,229	57	4,833		11	Badi Chaupar	3,693	184	7,093
4	Shyam Nagar	2,246	117	6,005		10	Choti Chaupar	3,764	412	10,602
5	Ram Nagar	3,539	496	8,134		9	Chandpole	8,757	8,048	13,954
6	Civil Lines	2,578	456	11,178		8	Sindhi Camp	714	1,108	14,663
7	Jaipur Railway Stn.	2,079	755	13,299		7	Jaipur Railway Stn.	815	3,430	14,269
8	Sindhi Camp	1,049	744	14,623		6	Civil Lines	433	2,586	11,654
9	Chandpole	8,351	9,013	14,928		5	Ram Nagar	377	2,261	9,502
10	Choti Chaupar	377	4,148	14,266		4	Shyam Nagar	113	2,163	7,618
11	Badi Chaupar	168	3,880	10,495		3	Vivek Vihar	57	1,128	5,567
12	Ramganj Chaupar	60	3,890	6,783		2	New Aatish Market	27	1,608	4,497
13	Transport Nagar	0	2,953	2,953		1	Mansarovar	0	2,916	2,916
	Total	**26,535**	**26,535**				**Total**	**25,904**	**25,904**	

Table 2.30: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2023										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	6,552	0	0		21	India Gate (SIA)	653	0	0
2	Pani Petch	2,023	51	6,552		20	Kumbha Marg	1,575	1	653
3	Subhash Nagar	1,527	70	8,524		19	Haldi Ghati Gate	1,829	6	2,227
4	Collectorate	2,978	176	9,982		18	Pinjarapole Gaushala	2,878	24	4,049
5	Chandpole	13,141	4,429	12,784		17	Sanganer Sethu	3,272	65	6,904
6	Government Hostel	2,066	728	21,496		16	B2 Bypass	2,633	116	10,110
7	Ashok Marg	1,266	1,454	22,834		15	Durgapura	2,353	187	12,628
8	SMS Hospital	1,759	1,589	22,645		14	Mahaveer Nagar	1,636	151	14,794
9	Narayan Singh Circle	1,532	2,072	22,815		13	Dev Nagar	2,947	472	16,279
10	Ram Bagh Circle	1,595	2,918	22,275		12	Gandhi Nagar Rly. Stn.	881	191	18,754
11	Tonk Phatak	1,152	3,746	20,952		11	Tonk Phatak	3,724	1,209	19,443
12	Gandhi Nagar Rly. Stn.	189	835	18,357		10	Ram Bagh Circle	2,818	1,710	21,959
13	Dev Nagar	449	2,920	17,711		9	Narayan Singh Circle	1,943	1,638	23,067
14	Mahaveer Nagar	151	1,536	15,240		8	SMS Hospital	1,527	1,835	23,373
15	Durgapura	185	2,320	13,855		7	Ashok Marg	1,304	1,354	23,064
16	B2 Bypass	119	2,427	11,720		6	Government Hostel	713	2,255	23,014
17	Sanganer Sethu	72	2,904	9,412		5	Chandpole	4,433	13,145	21,472
18	Pinjarapole Gaushala	27	2,580	6,579		4	Collectorate	180	2,915	12,759
19	Haldi Ghati Gate	7	1,728	4,026		3	Subhash Nagar	66	1,603	10,024
20	Kumbha Marg	2	1,488	2,305		2	Pani Petch	50	2,071	8,487
21	India Gate (SIA)	0	819	819		1	Ambabari	0	6,465	6,465
	Total	**36,790**	**36,790**				**Total**	**37,413**	**37,413**	

Table 2.31: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Moderate Scenario - Horizon Year 2031										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	5,349	0	0		13	Transport Nagar	4,654	0	0
2	New Aatish Market	2,841	41	5,349		12	Ramganj Chaupar	7,237	84	4,654
3	Vivek Vihar	1,910	79	8,149		11	Badi Chaupar	6,040	272	11,808
4	Shyam Nagar	3,501	163	9,980		10	Choti Chaupar	6,417	649	17,575
5	Ram Nagar	3,362	699	13,318		9	Chandpole	13,220	12,970	23,343
6	Civil Lines	6,170	702	15,981		8	Sindhi Camp	1,151	1,744	23,593
7	Jaipur Railway Stn.	3,354	1,161	21,449		7	Jaipur Railway Stn.	1,114	3,387	23,000
8	Sindhi Camp	1,640	1,209	23,643		6	Civil Lines	659	6,176	20,728
9	Chandpole	13,448	13,723	24,074		5	Ram Nagar	658	3,302	15,211
10	Choti Chaupar	596	7,066	23,799		4	Shyam Nagar	159	3,354	12,566
11	Badi Chaupar	250	6,314	17,329		3	Vivek Vihar	81	1,767	9,372
12	Ramganj Chaupar	84	6,905	11,264		2	New Aatish Market	41	2,698	7,686
13	Transport Nagar	0	4,444	4,444		1	Mansarovar	0	5,029	5,029
	Total	**42,507**	**42,507**				**Total**	**41,432**	**41,432**	

Table 2.32: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2031										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	11,754	0	0		21	India Gate (SIA)	1,270	0	0
2	Pani Petch	3,531	74	11,754		20	Kumbha Marg	3,033	2	1,270
3	Subhash Nagar	2,603	108	15,211		19	Haldi Ghati Gate	3,624	10	4,301
4	Collectorate	4,715	254	17,705		18	Pinjarapole Gaushala	5,049	36	7,915
5	Chandpole	20,410	7,125	22,166		17	Sanganer Sethu	5,535	98	12,929
6	Government Hostel	3,577	1,149	35,452		16	B2 Bypass	4,243	174	18,367
7	Ashok Marg	2,134	2,310	37,879		15	Durgapura	3,914	302	22,436
8	SMS Hospital	2,640	2,061	37,703		14	Mahaveer Nagar	2,829	244	26,049
9	Narayan Singh Circle	2,647	3,334	38,282		13	Dev Nagar	4,338	687	28,634
10	Ram Bagh Circle	2,513	4,519	37,595		12	Gandhi Nagar Rly. Stn.	1,408	312	32,285
11	Tonk Phatak	1,935	6,100	35,589		11	Tonk Phatak	6,109	2,023	33,381
12	Gandhi Nagar Rly. Stn.	308	1,331	31,423		10	Ram Bagh Circle	4,341	2,687	37,467
13	Dev Nagar	657	4,272	30,400		9	Narayan Singh Circle	3,144	2,840	39,121
14	Mahaveer Nagar	245	2,659	26,785		8	SMS Hospital	2,011	2,760	39,425
15	Durgapura	303	3,864	24,372		7	Ashok Marg	2,064	2,295	38,676
16	B2 Bypass	180	3,881	20,811		6	Government Hostel	1,085	3,978	38,445
17	Sanganer Sethu	109	4,909	17,110		5	Chandpole	7,184	20,397	35,552
18	Pinjarapole Gaushala	41	4,482	12,310		4	Collectorate	259	4,679	22,338
19	Haldi Ghati Gate	11	3,419	7,869		3	Subhash Nagar	102	2,749	17,918
20	Kumbha Marg	3	2,858	4,461		2	Pani Petch	71	3,646	15,271
21	India Gate (SIA)	0	1,606	1,606		1	Ambabari	0	11,697	11,697
	Total	**60,316**	**60,316**				**Total**	**61,615**	**61,615**	

Table 2.33: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Moderate Scenario - Horizon Year 2041										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	9,843	0	0		13	Transport Nagar	7,521	0	0
2	New Aatish Market	5,009	65	9,843		12	Ramganj Chaupar	13,449	113	7,521
3	Vivek Vihar	3,071	114	14,787		11	Badi Chaupar	10,332	393	20,857
4	Shyam Nagar	5,665	231	17,743		10	Choti Chaupar	11,621	996	30,796
5	Ram Nagar	5,265	1,004	23,176		9	Chandpole	22,172	22,968	41,421
6	Civil Lines	10,199	1,147	27,437		8	Sindhi Camp	1,879	2,993	40,625
7	Jaipur Railway Stn.	5,773	1,885	36,488		7	Jaipur Railway Stn.	1,809	5,867	39,511
8	Sindhi Camp	2,789	1,974	40,376		6	Civil Lines	1,076	10,232	35,454
9	Chandpole	23,882	22,981	41,190		5	Ram Nagar	955	5,188	26,298
10	Choti Chaupar	917	12,866	42,091		4	Shyam Nagar	229	5,400	22,065
11	Badi Chaupar	363	10,706	30,142		3	Vivek Vihar	120	2,866	16,894
12	Ramganj Chaupar	116	12,734	19,798		2	New Aatish Market	65	4,799	14,148
13	Transport Nagar	0	7,181	7,181		1	Mansarovar	0	9,414	9,414
	Total	**72,889**	**72,889**				**Total**	**71,230**	**71,230**	

Table 2.34: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2041										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	22,549	0	0		21	India Gate (SIA)	2,569	0	0
2	Pani Petch	6,654	109	22,549		20	Kumbha Marg	6,284	3	2,569
3	Subhash Nagar	4,820	165	29,095		19	Haldi Ghati Gate	7,609	16	8,850
4	Collectorate	8,028	372	33,750		18	Pinjarapole Gaushala	9,475	54	16,443
5	Chandpole	35,437	12,166	41,406		17	Sanganer Sethu	11,011	172	25,864
6	Government Hostel	6,728	1,924	64,677		16	B2 Bypass	10,153	416	36,702
7	Ashok Marg	4,166	3,927	69,481		15	Durgapura	7,118	562	46,439
8	SMS Hospital	4,178	2,746	69,720		14	Mahaveer Nagar	5,159	449	52,996
9	Narayan Singh Circle	5,054	5,600	71,152		13	Dev Nagar	6,779	1,152	57,706
10	Ram Bagh Circle	4,432	7,326	70,605		12	Gandhi Nagar Rly. Stn.	2,373	593	63,333
11	Tonk Phatak	3,752	10,447	67,712		11	Tonk Phatak	10,549	3,941	65,113
12	Gandhi Nagar Rly. Stn.	581	2,231	61,017		10	Ram Bagh Circle	7,095	4,738	71,721
13	Dev Nagar	1,105	6,623	59,367		9	Narayan Singh Circle	5,324	5,439	74,079
14	Mahaveer Nagar	450	4,836	53,848		8	SMS Hospital	2,717	4,370	73,964
15	Durgapura	566	7,033	49,462		7	Ashok Marg	3,486	4,499	72,311
16	B2 Bypass	435	9,207	42,995		6	Government Hostel	1,830	7,623	71,298
17	Sanganer Sethu	191	9,836	34,223		5	Chandpole	12,341	35,700	65,505
18	Pinjarapole Gaushala	64	8,279	24,579		4	Collectorate	379	8,084	42,146
19	Haldi Ghati Gate	18	7,203	16,365		3	Subhash Nagar	155	5,109	34,441
20	Kumbha Marg	4	5,921	9,180		2	Pani Petch	105	6,937	29,487
21	India Gate (SIA)	0	3,263	3,263		1	Ambabari	0	22,655	22,655
	Total	**1,09,214**	**1,09,214**				**Total**	**1,12,512**	**1,12,512**	

Table 2.35: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Moderate Scenario - Horizon Year 2051										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	11,271	0	0		13	Transport Nagar	11,658	0	0
2	New Aatish Market	8,303	49	11,271		12	Ramganj Chaupar	21,293	135	11,658
3	Vivek Vihar	4,721	111	19,525		11	Badi Chaupar	15,331	459	32,816
4	Shyam Nagar	9,000	304	24,135		10	Choti Chaupar	18,430	1,274	47,688
5	Ram Nagar	7,848	1,220	32,831		9	Chandpole	33,346	36,851	64,844
6	Civil Lines	15,901	1,450	39,459		8	Sindhi Camp	2,649	4,682	61,339
7	Jaipur Railway Stn.	9,293	2,756	53,910		7	Jaipur Railway Stn.	2,650	9,469	59,306
8	Sindhi Camp	4,340	2,797	60,446		6	Civil Lines	1,358	15,946	52,487
9	Chandpole	38,492	34,527	61,989		5	Ram Nagar	1,161	7,764	37,899
10	Choti Chaupar	1,169	20,588	65,954		4	Shyam Nagar	301	8,576	31,297
11	Badi Chaupar	427	15,826	46,534		3	Vivek Vihar	116	4,455	23,022
12	Ramganj Chaupar	139	20,129	31,135		2	New Aatish Market	48	8,024	18,683
13	Transport Nagar	0	11,145	11,145		1	Mansarovar	0	10,707	10,707
	Total	**1,10,902**	**1,10,902**				**Total**	**1,08,341**	**1,08,341**	

Table 2.36: Corridor-wise Daily Ridership

Moderate Scenario (Option-6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2051										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	38,579	0	0		21	India Gate (SIA)	4,235	0	0
2	Pani Petch	11,272	147	38,579		20	Kumbha Marg	10,884	4	4,235
3	Subhash Nagar	7,851	221	49,704		19	Haldi Ghati Gate	13,080	23	15,115
4	Collectorate	12,723	498	57,334		18	Pinjarapole Gaushala	15,776	79	28,172
5	Chandpole	55,849	18,656	69,559		17	Sanganer Sethu	21,431	309	43,869
6	Government Hostel	11,756	2,961	1,06,751		16	B2 Bypass	20,514	885	64,991
7	Ashok Marg	7,657	5,838	1,15,547		15	Durgapura	12,274	1,009	84,621
8	SMS Hospital	6,706	3,661	1,17,365		14	Mahaveer Nagar	9,001	808	95,886
9	Narayan Singh Circle	9,042	8,371	1,20,411		13	Dev Nagar	10,713	2,009	1,04,079
10	Ram Bagh Circle	7,836	11,109	1,21,082		12	Gandhi Nagar Rly. Stn.	3,785	1,092	1,12,782
11	Tonk Phatak	7,050	16,556	1,17,809		11	Tonk Phatak	16,861	7,419	1,15,475
12	Gandhi Nagar Rly. Stn.	1,067	3,523	1,08,302		10	Ram Bagh Circle	10,868	8,354	1,24,918
13	Dev Nagar	1,939	10,392	1,05,847		9	Narayan Singh Circle	8,052	9,714	1,27,432
14	Mahaveer Nagar	823	8,289	97,394		8	SMS Hospital	3,670	6,993	1,25,770
15	Durgapura	1,027	12,124	89,928		7	Ashok Marg	5,184	8,267	1,22,447
16	B2 Bypass	932	18,633	78,832		6	Government Hostel	2,832	13,401	1,19,364
17	Sanganer Sethu	340	19,627	61,130		5	Chandpole	18,998	56,672	1,08,795
18	Pinjarapole Gaushala	94	13,774	41,843		4	Collectorate	505	12,916	71,121
19	Haldi Ghati Gate	27	12,498	28,164		3	Subhash Nagar	208	8,337	58,710
20	Kumbha Marg	6	10,326	15,693		2	Pani Petch	141	11,849	50,581
21	India Gate (SIA)	0	5,373	5,373		1	Ambabari	0	38,874	38,874
	Total	**1,82,576**	**1,82,576**				**Total**	**1,89,014**	**1,89,014**	

Table 2.37: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2021										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	260	0	0		13	Transport Nagar	270	0	0
2	New Aatish Market	143	2	260		12	Ramganj Chaupar	327	5	270
3	Vivek Vihar	106	5	401		11	Badi Chaupar	311	16	592
4	Shyam Nagar	193	11	502		10	Choti Chaupar	310	35	887
5	Ram Nagar	358	44	684		9	Chandpole	764	682	1,162
6	Civil Lines	168	39	998		8	Sindhi Camp	60	95	1,244
7	Jaipur Railway Stn.	176	65	1,127		7	Jaipur Railway Stn.	74	344	1,209
8	Sindhi Camp	90	63	1,238		6	Civil Lines	38	169	939
9	Chandpole	708	784	1,265		5	Ram Nagar	31	200	808
10	Choti Chaupar	32	342	1,189		4	Shyam Nagar	10	187	639
11	Badi Chaupar	15	327	879		3	Vivek Vihar	5	97	462
12	Ramganj Chaupar	5	314	567		2	New Aatish Market	2	134	370
13	Transport Nagar	0	258	258		1	Mansarovar	0	239	238
	Total	**2,254**	**2,254**				**Total**	**2,202**	**2,202**	

Table 2.38: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2021										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	525	0	0		21	India Gate (SIA)	50	0	0
2	Pani Petch	165	5	525		20	Kumbha Marg	121	0	50
3	Subhash Nagar	126	6	685		19	Haldi Ghati Gate	138	1	171
4	Collectorate	254	16	805		18	Pinjarapole Gaushala	234	2	308
5	Chandpole	1,132	376	1,043		17	Sanganer Sethu	271	6	540
6	Government Hostel	169	62	1,799		16	B2 Bypass	223	10	805
7	Ashok Marg	105	124	1,906		15	Durgapura	196	16	1,018
8	SMS Hospital	154	147	1,887		14	Mahaveer Nagar	134	13	1,198
9	Narayan Singh Circle	125	176	1,894		13	Dev Nagar	260	42	1,319
10	Ram Bagh Circle	136	252	1,843		12	Gandhi Nagar Rly. Stn.	75	16	1,537
11	Tonk Phatak	96	316	1,727		11	Tonk Phatak	313	100	1,596
12	Gandhi Nagar Rly. Stn.	16	71	1,507		10	Ram Bagh Circle	244	147	1,809
13	Dev Nagar	40	258	1,452		9	Narayan Singh Circle	164	134	1,906
14	Mahaveer Nagar	13	126	1,234		8	SMS Hospital	141	160	1,936
15	Durgapura	16	193	1,121		7	Ashok Marg	111	112	1,917
16	B2 Bypass	10	206	944		6	Government Hostel	62	182	1,916
17	Sanganer Sethu	6	240	748		5	Chandpole	375	1,133	1,796
18	Pinjarapole Gaushala	2	211	514		4	Collectorate	16	247	1,038
19	Haldi Ghati Gate	1	131	305		3	Subhash Nagar	6	132	807
20	Kumbha Marg	0	114	175		2	Pani Petch	4	168	681
21	India Gate (SIA)	0	62	61		1	Ambabari	0	516	517
	Total	**3,091**	**3,091**				**Total**	**3,138**	**3,138**	

Table 2.39: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2023										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	315	0	0		13	Transport Nagar	309	0	0
2	New Aatish Market	171	3	315		12	Ramganj Chaupar	406	6	309
3	Vivek Vihar	123	6	483		11	Badi Chaupar	369	18	709
4	Shyam Nagar	225	12	600		10	Choti Chaupar	376	41	1,060
5	Ram Nagar	354	50	813		9	Chandpole	876	805	1,395
6	Civil Lines	258	46	1,117		8	Sindhi Camp	71	111	1,466
7	Jaipur Railway Stn.	208	75	1,329		7	Jaipur Railway Stn.	82	343	1,426
8	Sindhi Camp	105	74	1,462		6	Civil Lines	43	259	1,165
9	Chandpole	835	901	1,493		5	Ram Nagar	38	226	949
10	Choti Chaupar	38	415	1,427		4	Shyam Nagar	11	216	761
11	Badi Chaupar	17	388	1,050		3	Vivek Vihar	6	113	556
12	Ramganj Chaupar	6	389	679		2	New Aatish Market	3	161	449
13	Transport Nagar	0	295	296		1	Mansarovar	0	292	291
	Total	**2,655**	**2,655**				**Total**	**2,590**	**2,590**	

Table 2.40: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2023										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	655	0	0		21	India Gate (SIA)	65	0	0
2	Pani Petch	202	5	655		20	Kumbha Marg	157	0	65
3	Subhash Nagar	153	7	852		19	Haldi Ghati Gate	183	1	222
4	Collectorate	298	18	998		18	Pinjarapole Gaushala	288	2	404
5	Chandpole	1,314	443	1,278		17	Sanganer Sethu	327	7	690
6	Government Hostel	207	73	2,149		16	B2 Bypass	263	12	1,010
7	Ashok Marg	127	145	2,283		15	Durgapura	235	19	1,261
8	SMS Hospital	176	159	2,265		14	Mahaveer Nagar	164	15	1,477
9	Narayan Singh Circle	153	207	2,282		13	Dev Nagar	295	47	1,626
10	Ram Bagh Circle	159	292	2,228		12	Gandhi Nagar Rly. Stn.	88	19	1,874
11	Tonk Phatak	115	375	2,095		11	Tonk Phatak	372	121	1,943
12	Gandhi Nagar Rly. Stn.	19	84	1,835		10	Ram Bagh Circle	282	171	2,194
13	Dev Nagar	45	292	1,770		9	Narayan Singh Circle	194	164	2,305
14	Mahaveer Nagar	15	154	1,523		8	SMS Hospital	153	184	2,335
15	Durgapura	18	232	1,384		7	Ashok Marg	130	135	2,304
16	B2 Bypass	12	243	1,170		6	Government Hostel	71	226	2,299
17	Sanganer Sethu	7	290	939		5	Chandpole	443	1,315	2,144
18	Pinjarapole Gaushala	3	258	656		4	Collectorate	18	291	1,272
19	Haldi Ghati Gate	1	173	401		3	Subhash Nagar	7	160	999
20	Kumbha Marg	0	149	229		2	Pani Petch	5	207	846
21	India Gate (SIA)	0	82	80		1	Ambabari	0	647	644
	Total	**3,679**	**3,679**				**Total**	**3,740**	**3,740**	

Table 2.41: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2031										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	535	0	0		13	Transport Nagar	465	0	0
2	New Aatish Market	284	4	535		12	Ramganj Chaupar	724	8	465
3	Vivek Vihar	191	8	815		11	Badi Chaupar	604	27	1,181
4	Shyam Nagar	350	16	998		10	Choti Chaupar	642	65	1,758
5	Ram Nagar	336	70	1,332		9	Chandpole	1,322	1,297	2,335
6	Civil Lines	617	70	1,598		8	Sindhi Camp	115	174	2,360
7	Jaipur Railway Stn.	335	116	2,145		7	Jaipur Railway Stn.	111	339	2,301
8	Sindhi Camp	164	121	2,364		6	Civil Lines	66	618	2,073
9	Chandpole	1,345	1,372	2,407		5	Ram Nagar	66	330	1,521
10	Choti Chaupar	60	707	2,380		4	Shyam Nagar	16	335	1,257
11	Badi Chaupar	25	631	1,733		3	Vivek Vihar	8	177	938
12	Ramganj Chaupar	8	690	1,127		2	New Aatish Market	4	270	769
13	Transport Nagar	0	444	445		1	Mansarovar	0	503	503
	Total	**4,250**	**4,250**				**Total**	**4,143**	**4,143**	

Table 2.42: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2031										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	1,175	0	0		21	India Gate (SIA)	127	0	0
2	Pani Petch	353	7	1,175		20	Kumbha Marg	303	0	127
3	Subhash Nagar	260	11	1,521		19	Haldi Ghati Gate	362	1	430
4	Collectorate	472	25	1,770		18	Pinjarapole Gaushala	505	4	791
5	Chandpole	2,041	712	2,217		17	Sanganer Sethu	554	10	1,292
6	Government Hostel	358	115	3,546		16	B2 Bypass	424	17	1,836
7	Ashok Marg	213	231	3,789		15	Durgapura	391	30	2,243
8	SMS Hospital	264	206	3,771		14	Mahaveer Nagar	283	24	2,604
9	Narayan Singh Circle	265	333	3,829		13	Dev Nagar	434	69	2,863
10	Ram Bagh Circle	251	452	3,761		12	Gandhi Nagar Rly. Stn.	141	31	3,228
11	Tonk Phatak	193	610	3,560		11	Tonk Phatak	611	202	3,338
12	Gandhi Nagar Rly. Stn.	31	133	3,143		10	Ram Bagh Circle	434	269	3,747
13	Dev Nagar	66	427	3,041		9	Narayan Singh Circle	314	284	3,912
14	Mahaveer Nagar	25	266	2,680		8	SMS Hospital	201	276	3,942
15	Durgapura	30	386	2,439		7	Ashok Marg	206	230	3,867
16	B2 Bypass	18	388	2,083		6	Government Hostel	109	398	3,843
17	Sanganer Sethu	11	491	1,713		5	Chandpole	718	2,040	3,554
18	Pinjarapole Gaushala	4	448	1,233		4	Collectorate	26	468	2,232
19	Haldi Ghati Gate	1	342	789		3	Subhash Nagar	10	275	1,790
20	Kumbha Marg	0	286	448		2	Pani Petch	7	365	1,525
21	India Gate (SIA)	0	161	162		1	Ambabari	0	1,170	1,167
	Total	**6,031**	**6,031**				**Total**	**6,160**	**6,160**	

Table 2.43: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2041										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	984	0	0		13	Transport Nagar	752	0	0
2	New Aatish Market	501	7	984		12	Ramganj Chaupar	1,345	11	752
3	Vivek Vihar	307	11	1,478		11	Badi Chaupar	1,033	39	2,086
4	Shyam Nagar	566	23	1,774		10	Choti Chaupar	1,162	100	3,080
5	Ram Nagar	527	100	2,317		9	Chandpole	2,217	2,297	4,142
6	Civil Lines	1,020	115	2,744		8	Sindhi Camp	188	299	4,062
7	Jaipur Railway Stn.	577	189	3,649		7	Jaipur Railway Stn.	181	587	3,951
8	Sindhi Camp	279	197	4,037		6	Civil Lines	108	1,023	3,545
9	Chandpole	2,388	2,298	4,119		5	Ram Nagar	96	519	2,630
10	Choti Chaupar	92	1,287	4,209		4	Shyam Nagar	23	540	2,207
11	Badi Chaupar	36	1,071	3,014		3	Vivek Vihar	12	287	1,690
12	Ramganj Chaupar	12	1,273	1,979		2	New Aatish Market	7	480	1,415
13	Transport Nagar	0	718	718		1	Mansarovar	0	941	942
	Total	**7,289**	**7,289**				**Total**	**7,124**	**7,124**	

Table 2.44: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2041										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	2,255	0	0		21	India Gate (SIA)	257	0	0
2	Pani Petch	665	11	2,255		20	Kumbha Marg	628	0	257
3	Subhash Nagar	482	16	2,909		19	Haldi Ghati Gate	761	2	885
4	Collectorate	803	37	3,375		18	Pinjarapole Gaushala	948	5	1,644
5	Chandpole	3,544	1,217	4,141		17	Sanganer Sethu	1,101	17	2,587
6	Government Hostel	673	192	6,468		16	B2 Bypass	1,015	42	3,671
7	Ashok Marg	417	393	6,949		15	Durgapura	712	56	4,644
8	SMS Hospital	418	275	6,973		14	Mahaveer Nagar	516	45	5,300
9	Narayan Singh Circle	505	560	7,116		13	Dev Nagar	678	115	5,771
10	Ram Bagh Circle	443	733	7,061		12	Gandhi Nagar Rly. Stn.	237	59	6,334
11	Tonk Phatak	375	1,045	6,771		11	Tonk Phatak	1,055	394	6,512
12	Gandhi Nagar Rly. Stn.	58	223	6,101		10	Ram Bagh Circle	710	474	7,173
13	Dev Nagar	111	662	5,936		9	Narayan Singh Circle	532	544	7,409
14	Mahaveer Nagar	45	484	5,385		8	SMS Hospital	272	437	7,397
15	Durgapura	57	703	4,946		7	Ashok Marg	349	450	7,232
16	B2 Bypass	44	921	4,300		6	Government Hostel	183	762	7,131
17	Sanganer Sethu	19	984	3,423		5	Chandpole	1,234	3,570	6,552
18	Pinjarapole Gaushala	6	828	2,458		4	Collectorate	38	808	4,216
19	Haldi Ghati Gate	2	720	1,636		3	Subhash Nagar	16	511	3,446
20	Kumbha Marg	0	592	918		2	Pani Petch	10	694	2,951
21	India Gate (SIA)	0	326	326		1	Ambabari	0	2,265	2,267
	Total	**10,922**	**10,922**				**Total**	**11,252**	**11,252**	

Table 2.45: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Moderate Scenario - Horizon Year 2051										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	1,127	0	0		13	Transport Nagar	1,166	0	0
2	New Aatish Market	830	5	1,127		12	Ramganj Chaupar	2,129	14	1,166
3	Vivek Vihar	472	11	1,952		11	Badi Chaupar	1,533	46	3,281
4	Shyam Nagar	900	30	2,413		10	Choti Chaupar	1,843	127	4,768
5	Ram Nagar	785	122	3,283		9	Chandpole	3,335	3,685	6,484
6	Civil Lines	1,590	145	3,946		8	Sindhi Camp	265	468	6,134
7	Jaipur Railway Stn.	929	276	5,391		7	Jaipur Railway Stn.	265	947	5,931
8	Sindhi Camp	434	280	6,044		6	Civil Lines	136	1,595	5,249
9	Chandpole	3,849	3,453	6,198		5	Ram Nagar	116	776	3,790
10	Choti Chaupar	117	2,059	6,594		4	Shyam Nagar	30	858	3,130
11	Badi Chaupar	43	1,583	4,652		3	Vivek Vihar	12	445	2,302
12	Ramganj Chaupar	14	2,013	3,112		2	New Aatish Market	5	802	1,869
13	Transport Nagar	0	1,114	1,113		1	Mansarovar	0	1,071	1,072
	Total	**11,090**	**11,090**				**Total**	**10,835**	**10,835**	

Table 2.46: Corridor-wise Peak Hour Ridership

Moderate Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Moderate Scenario - Horizon Year 2051										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	3,858	0	0		21	India Gate (SIA)	424	0	0
2	Pani Petch	1,127	15	3,858		20	Kumbha Marg	1,088	0	424
3	Subhash Nagar	785	22	4,970		19	Haldi Ghati Gate	1,308	2	1,512
4	Collectorate	1,272	50	5,733		18	Pinjarapole Gaushala	1,578	8	2,818
5	Chandpole	5,585	1,866	6,955		17	Sanganer Sethu	2,143	31	4,388
6	Government Hostel	1,176	296	10,674		16	B2 Bypass	2,051	88	6,500
7	Ashok Marg	766	584	11,554		15	Durgapura	1,227	101	8,463
8	SMS Hospital	671	366	11,736		14	Mahaveer Nagar	900	81	9,589
9	Narayan Singh Circle	904	837	12,041		13	Dev Nagar	1,071	201	10,408
10	Ram Bagh Circle	784	1,111	12,108		12	Gandhi Nagar Rly. Stn.	378	109	11,278
11	Tonk Phatak	705	1,656	11,781		11	Tonk Phatak	1,686	742	11,547
12	Gandhi Nagar Rly. Stn.	107	352	10,830		10	Ram Bagh Circle	1,087	835	12,491
13	Dev Nagar	194	1,039	10,585		9	Narayan Singh Circle	805	971	12,743
14	Mahaveer Nagar	82	829	9,740		8	SMS Hospital	367	699	12,577
15	Durgapura	103	1,212	8,993		7	Ashok Marg	518	827	12,245
16	B2 Bypass	93	1,863	7,884		6	Government Hostel	283	1,340	11,936
17	Sanganer Sethu	34	1,963	6,114		5	Chandpole	1,900	5,667	10,879
18	Pinjarapole Gaushala	9	1,377	4,185		4	Collectorate	51	1,292	7,112
19	Haldi Ghati Gate	3	1,250	2,817		3	Subhash Nagar	21	834	5,871
20	Kumbha Marg	1	1,033	1,570		2	Pani Petch	14	1,185	5,058
21	India Gate (SIA)	0	537	538		1	Ambabari	0	3,887	3,887
	Total	**18,259**	**18,259**				**Total**	**18,900**	**18,900**	

2.6.4 Ridership Details for Optimistic Scenario in Option-6

Estimation of Line-wise Ridership for Optimistic Scenario

Corridor (line)-wise ridership summary estimated for Master Plan (optimistic) scenario at an aggregated network level including daily ridership, peak hour peak direction traffic (PHPDT), daily passenger-km and average trip length is given below:

Table 2.47: Proposed Jaipur Metro Phase-2 Ridership Summary (Line Wise) for Master Plan (Optimistic) Scenario

Target Year	Corridor	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger Kilometres (km)	Average Trip Length/ Passenger Lead (km)
2021	Mansarovar - Transport Nagar	68,504	1,920	2,99,716	4.38
2021	Ambabari - India Gate (SIA)	98,602	3,161	7,97,057	8.08
2023	Mansarovar - Transport Nagar	82,495	2,311	3,59,877	4.36
2023	Ambabari - India Gate (SIA)	1,20,667	3,930	10,09,490	8.37
2031	Mansarovar - Transport Nagar	1,38,459	3,995	6,00,524	4.34
2031	Ambabari - India Gate (SIA)	2,08,926	6,993	18,59,223	8.90
2041	Mansarovar - Transport Nagar	2,23,392	6,979	9,49,623	4.25
2041	Ambabari - India Gate (SIA)	3,64,200	12,627	34,43,590	9.46
2051	Mansarovar - Transport Nagar	4,01,776	12,523	17,93,822	4.46
2051	Ambabari - India Gate (SIA)	5,95,440	20,703	57,41,401	9.64

Station-wise Boarding and Alighting for Optimistic Scenario

The route wise stop to stop passengers obtained from the public transport assignment model have been extracted for different horizon years for optimistic scenario and presented below. Applying 10% as peak hour factor, peak hour boarding and alighting was also estimated, which helps in identification of the line PHPDT.

Table 2.48: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2021										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	4,608	0	0		13	Transport Nagar	3,625	0	0
2	New Aatish Market	2,052	41	4,608		12	Ramganj Chaupar	5,403	78	3,625
3	Vivek Vihar	1,430	69	6,619		11	Badi Chaupar	5,052	256	8,951
4	Shyam Nagar	2,556	128	7,980		10	Choti Chaupar	5,053	592	13,747
5	Ram Nagar	4,898	546	10,408		9	Chandpole	11,819	11,251	18,207
6	Civil Lines	2,473	483	14,760		8	Sindhi Camp	808	1,557	18,775
7	Jaipur Railway Stn.	2,636	825	16,750		7	Jaipur Railway Stn.	912	4,838	18,026
8	Sindhi Camp	1,472	835	18,561		6	Civil Lines	462	2,493	14,100
9	Chandpole	11,770	12,156	19,198		5	Ram Nagar	384	2,784	12,070
10	Choti Chaupar	547	5,596	18,813		4	Shyam Nagar	125	2,463	9,669
11	Badi Chaupar	234	5,346	13,764		3	Vivek Vihar	69	1,317	7,331
12	Ramganj Chaupar	76	5,252	8,651		2	New Aatish Market	39	1,941	6,083
13	Transport Nagar	0	3,475	3,475		1	Mansarovar	0	4,181	4,181
	Total	**34,753**	**34,753**				**Total**	**33,751**	**33,751**	

Table 2.49: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2021										
Ambabari to India Gate (SIA) Direction						**India Gate (SIA) to Ambabari Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ambabari	7,743	0	0		21	India Gate (SIA)	674	0	0
2	Pani Petch	2,517	62	7,743		20	Kumbha Marg	1,814	4	674
3	Subhash Nagar	1,944	88	10,198		19	Haldi Ghati Gate	3,439	7	2,485
4	Collectorate	3,639	206	12,054		18	Pinjarapole Gaushala	3,090	32	5,917
5	Chandpole	18,841	5,301	15,488		17	Sanganer Sethu	3,109	67	8,975
6	Government Hostel	2,589	914	29,028		16	B2 Bypass	3,854	174	12,017
7	Ashok Marg	1,645	1,784	30,703		15	Durgapura	2,786	231	15,698
8	SMS Hospital	1,985	1,739	30,563		14	Mahaveer Nagar	4,269	402	18,253
9	Narayan Singh Circle	1,841	2,405	30,810		13	Dev Nagar	3,295	917	22,120
10	Ram Bagh Circle	2,547	4,485	30,246		12	Gandhi Nagar Rly. Stn.	2,571	248	24,498
11	Tonk Phatak	1,500	4,434	28,307		11	Tonk Phatak	4,395	1,582	26,821
12	Gandhi Nagar Rly. Stn.	242	2,553	25,372		10	Ram Bagh Circle	4,384	2,689	29,633
13	Dev Nagar	865	3,253	23,061		9	Narayan Singh Circle	2,261	1,960	31,328
14	Mahaveer Nagar	400	4,094	20,674		8	SMS Hospital	1,669	2,060	31,629
15	Durgapura	223	2,753	16,980		7	Ashok Marg	1,610	1,753	31,238
16	B2 Bypass	179	3,480	14,450		6	Government Hostel	903	2,803	31,095
17	Sanganer Sethu	73	2,759	11,149		5	Chandpole	5,305	18,999	29,195
18	Pinjarapole Gaushala	35	2,787	8,463		4	Collectorate	210	3,582	15,501
19	Haldi Ghati Gate	8	3,153	5,711		3	Subhash Nagar	83	2,033	12,129
20	Kumbha Marg	5	1,728	2,566		2	Pani Petch	59	2,577	10,179
21	India Gate (SIA)	0	843	843		1	Ambabari	0	7,661	7,661
	Total	**48,821**	**48,821**				**Total**	**49,781**	**49,781**	

Table 2.50: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2023										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	5,220	0	0		13	Transport Nagar	4,284	0	0
2	New Aatish Market	2,484	43	5,220		12	Ramganj Chaupar	6,797	88	4,284
3	Vivek Vihar	1,702	76	7,661		11	Badi Chaupar	6,133	297	10,993
4	Shyam Nagar	3,235	150	9,287		10	Choti Chaupar	6,209	710	16,829
5	Ram Nagar	5,965	616	12,372		9	Chandpole	13,957	13,533	22,328
6	Civil Lines	2,954	565	17,721		8	Sindhi Camp	974	1,848	22,752
7	Jaipur Railway Stn.	3,273	990	20,110		7	Jaipur Railway Stn.	1,087	6,146	21,878
8	Sindhi Camp	1,743	1,009	22,393		6	Civil Lines	541	2,988	16,819
9	Chandpole	14,227	14,313	23,127		5	Ram Nagar	429	3,238	14,372
10	Choti Chaupar	659	6,894	23,041		4	Shyam Nagar	147	3,116	11,563
11	Badi Chaupar	272	6,453	16,806		3	Vivek Vihar	76	1,580	8,594
12	Ramganj Chaupar	86	6,599	10,625		2	New Aatish Market	41	2,360	7,090
13	Transport Nagar	0	4,109	4,112		1	Mansarovar	0	4,773	4,771
	Total	**41,820**	**41,820**				**Total**	**40,675**	**40,675**	

Table 2.51: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2023										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	10,002	0	0		21	India Gate (SIA)	1,110	0	0
2	Pani Petch	3,133	71	10,002		20	Kumbha Marg	2,394	5	1,110
3	Subhash Nagar	2,406	103	13,064		19	Haldi Ghati Gate	4,668	9	3,499
4	Collectorate	4,365	238	15,367		18	Pinjarapole Gaushala	4,047	40	8,158
5	Chandpole	22,363	6,382	19,494		17	Sanganer Sethu	3,967	84	12,165
6	Government Hostel	3,237	1,082	35,475		16	B2 Bypass	4,856	219	16,048
7	Ashok Marg	2,022	2,100	37,630		15	Durgapura	3,416	289	20,685
8	SMS Hospital	2,400	1,961	37,552		14	Mahaveer Nagar	4,937	460	23,812
9	Narayan Singh Circle	2,284	2,854	37,991		13	Dev Nagar	3,799	1,098	28,289
10	Ram Bagh Circle	3,045	5,226	37,421		12	Gandhi Nagar Rly. Stn.	3,100	304	30,990
11	Tonk Phatak	1,867	5,333	35,240		11	Tonk Phatak	5,306	1,978	33,786
12	Gandhi Nagar Rly. Stn.	295	3,074	31,774		10	Ram Bagh Circle	5,130	3,215	37,114
13	Dev Nagar	1,039	3,719	28,995		9	Narayan Singh Circle	2,699	2,441	39,029
14	Mahaveer Nagar	455	4,745	26,315		8	SMS Hospital	1,899	2,500	39,287
15	Durgapura	280	3,374	22,025		7	Ashok Marg	1,899	2,165	38,686
16	B2 Bypass	226	4,369	18,931		6	Government Hostel	1,074	3,551	38,420
17	Sanganer Sethu	90	3,504	14,788		5	Chandpole	6,390	22,715	35,943
18	Pinjarapole Gaushala	43	3,628	11,374		4	Collectorate	242	4,336	19,618
19	Haldi Ghati Gate	10	4,262	7,789		3	Subhash Nagar	97	2,523	15,524
20	Kumbha Marg	6	2,277	3,537		2	Pani Petch	69	3,227	13,098
21	India Gate (SIA)	0	1,264	1,266		1	Ambabari	0	9,941	9,940
	Total	**59,568**	**59,568**				**Total**	**61,099**	**61,099**	

Table 2.52: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2031										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	7,666	0	0		13	Transport Nagar	6,920	0	0
2	New Aatish Market	4,210	52	7,666		12	Ramganj Chaupar	12,373	128	6,920
3	Vivek Vihar	2,790	104	11,824		11	Badi Chaupar	10,457	460	19,164
4	Shyam Nagar	5,950	238	14,509		10	Choti Chaupar	10,833	1,179	29,161
5	Ram Nagar	10,236	897	20,222		9	Chandpole	22,510	22,662	38,814
6	Civil Lines	4,876	894	29,560		8	Sindhi Camp	1,640	3,014	38,662
7	Jaipur Railway Stn.	5,822	1,652	33,542		7	Jaipur Railway Stn.	1,788	11,376	37,289
8	Sindhi Camp	2,824	1,706	37,712		6	Civil Lines	854	4,967	27,700
9	Chandpole	24,055	22,942	38,829		5	Ram Nagar	611	5,053	23,587
10	Choti Chaupar	1,105	12,085	39,941		4	Shyam Nagar	236	5,729	19,144
11	Badi Chaupar	424	10,881	28,961		3	Vivek Vihar	104	2,630	13,652
12	Ramganj Chaupar	126	11,987	18,504		2	New Aatish Market	50	4,036	11,126
13	Transport Nagar	0	6,643	6,643		1	Mansarovar	0	7,141	7,141
	Total	**70,083**	**70,083**				**Total**	**68,376**	**68,376**	

Table 2.53: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2031										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	19,037	0	0		21	India Gate (SIA)	2,854	0	0
2	Pani Petch	5,595	110	19,037		20	Kumbha Marg	4,713	11	2,854
3	Subhash Nagar	4,256	161	24,523		19	Haldi Ghati Gate	9,585	16	7,556
4	Collectorate	7,269	365	28,617		18	Pinjarapole Gaushala	7,876	70	17,125
5	Chandpole	36,452	10,703	35,521		17	Sanganer Sethu	7,399	149	24,931
6	Government Hostel	5,827	1,755	61,270		16	B2 Bypass	8,862	403	32,181
7	Ashok Marg	3,530	3,365	65,343		15	Durgapura	5,936	522	40,639
8	SMS Hospital	4,060	2,851	65,507		14	Mahaveer Nagar	7,609	692	46,053
9	Narayan Singh Circle	4,056	4,646	66,717		13	Dev Nagar	5,815	1,826	52,971
10	Ram Bagh Circle	5,039	8,191	66,127		12	Gandhi Nagar Rly. Stn.	5,217	529	56,960
11	Tonk Phatak	3,338	8,928	62,975		11	Tonk Phatak	8,950	3,560	61,649
12	Gandhi Nagar Rly. Stn.	507	5,159	57,385		10	Ram Bagh Circle	8,115	5,318	67,039
13	Dev Nagar	1,736	5,584	52,732		9	Narayan Singh Circle	4,449	4,362	69,836
14	Mahaveer Nagar	674	7,350	48,884		8	SMS Hospital	2,819	4,256	69,923
15	Durgapura	505	5,860	42,209		7	Ashok Marg	3,054	3,811	68,486
16	B2 Bypass	413	7,926	36,854		6	Government Hostel	1,759	6,543	67,730
17	Sanganer Sethu	159	6,485	29,341		5	Chandpole	10,730	37,581	62,947
18	Pinjarapole Gaushala	74	6,995	23,016		4	Collectorate	368	7,352	36,096
19	Haldi Ghati Gate	17	8,699	16,095		3	Subhash Nagar	152	4,485	29,111
20	Kumbha Marg	12	4,473	7,413		2	Pani Petch	105	5,825	24,778
21	India Gate (SIA)	0	2,952	2,952		1	Ambabari	0	19,059	19,059
	Total	**1,02,557**	**1,02,557**				**Total**	**1,06,369**	**1,06,369**	

Table 2.54: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2041										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	9,906	0	0		13	Transport Nagar	11,096	0	0
2	New Aatish Market	7,540	48	9,906		12	Ramganj Chaupar	22,264	187	11,096
3	Vivek Vihar	4,824	137	17,398		11	Badi Chaupar	17,740	745	33,173
4	Shyam Nagar	12,269	433	22,084		10	Choti Chaupar	18,830	1,991	50,169
5	Ram Nagar	7,953	882	33,921		9	Chandpole	32,320	41,047	67,007
6	Civil Lines	8,488	1,308	40,992		8	Sindhi Camp	2,524	5,323	58,279
7	Jaipur Railway Stn.	10,955	2,404	48,173		7	Jaipur Railway Stn.	2,370	10,949	55,480
8	Sindhi Camp	4,971	2,623	56,724		6	Civil Lines	1,258	8,688	46,901
9	Chandpole	43,862	33,148	59,072		5	Ram Nagar	852	7,849	39,471
10	Choti Chaupar	1,870	21,209	69,786		4	Shyam Nagar	443	11,734	32,475
11	Badi Chaupar	690	18,626	50,447		3	Vivek Vihar	136	4,635	21,183
12	Ramganj Chaupar	183	22,022	32,511		2	New Aatish Market	47	7,292	16,685
13	Transport Nagar	0	10,672	10,672		1	Mansarovar	0	9,440	9,440
	Total	**1,13,512**	**1,13,512**				**Total**	**1,09,880**	**1,09,880**	

Table 2.55: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2041										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	37,399	0	0		21	India Gate (SIA)	5,728	0	0
2	Pani Petch	10,422	178	37,399		20	Kumbha Marg	9,726	6	5,728
3	Subhash Nagar	7,798	264	47,643		19	Haldi Ghati Gate	11,690	28	15,448
4	Collectorate	12,148	595	55,177		18	Pinjarapole Gaushala	18,367	111	27,111
5	Chandpole	59,086	18,528	66,730		17	Sanganer Sethu	15,016	253	45,366
6	Government Hostel	10,957	3,122	1,07,288		16	B2 Bypass	17,464	728	60,129
7	Ashok Marg	6,645	5,494	1,15,124		15	Durgapura	11,004	937	76,865
8	SMS Hospital	6,281	3,655	1,16,275		14	Mahaveer Nagar	19,136	1,710	86,933
9	Narayan Singh Circle	7,644	7,702	1,18,902		13	Dev Nagar	9,710	1,749	1,04,359
10	Ram Bagh Circle	6,898	10,112	1,18,844		12	Gandhi Nagar Rly. Stn.	3,458	1,004	1,12,321
11	Tonk Phatak	6,611	15,659	1,15,631		11	Tonk Phatak	15,871	7,027	1,14,774
12	Gandhi Nagar Rly. Stn.	968	3,248	1,06,583		10	Ram Bagh Circle	9,974	7,317	1,23,618
13	Dev Nagar	1,731	9,082	1,04,302		9	Narayan Singh Circle	7,484	8,159	1,26,275
14	Mahaveer Nagar	1,710	18,358	96,952		8	SMS Hospital	3,657	6,539	1,25,601
15	Durgapura	926	10,851	80,304		7	Ashok Marg	5,012	7,149	1,22,719
16	B2 Bypass	749	15,742	70,379		6	Government Hostel	2,983	12,501	1,20,582
17	Sanganer Sethu	271	13,382	55,386		5	Chandpole	18,505	61,572	1,11,064
18	Pinjarapole Gaushala	122	16,212	42,275		4	Collectorate	592	12,484	67,997
19	Haldi Ghati Gate	29	11,110	26,184		3	Subhash Nagar	249	8,224	56,104
20	Kumbha Marg	7	9,222	15,103		2	Pani Petch	170	10,922	48,128
21	India Gate (SIA)	0	5,888	5,888		1	Ambabari	0	37,377	37,377
	Total	**1,78,403**	**1,78,403**				**Total**	**1,85,797**	**1,85,797**	

Table 2.56: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Mansarovar-Transport Nagar Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2051										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	18,715	0	0		13	Transport Nagar	18,642	0	0
2	New Aatish Market	14,021	73	18,715		12	Ramganj Chaupar	41,346	262	18,642
3	Vivek Vihar	9,555	282	32,664		11	Badi Chaupar	31,508	1,150	59,725
4	Shyam Nagar	30,462	1,174	41,937		10	Choti Chaupar	33,957	3,082	90,083
5	Ram Nagar	12,712	1,560	71,224		9	Chandpole	57,238	68,259	1,20,959
6	Civil Lines	14,200	2,455	82,376		8	Sindhi Camp	5,059	8,726	1,09,938
7	Jaipur Railway Stn.	18,883	4,709	94,122		7	Jaipur Railway Stn.	4,656	18,796	1,06,271
8	Sindhi Camp	8,107	5,259	1,08,296		6	Civil Lines	2,376	14,566	92,131
9	Chandpole	73,040	58,965	1,11,144		5	Ram Nagar	1,531	12,605	79,941
10	Choti Chaupar	2,889	38,104	1,25,219		4	Shyam Nagar	1,209	29,406	68,867
11	Badi Chaupar	1,067	32,721	90,004		3	Vivek Vihar	275	9,418	40,671
12	Ramganj Chaupar	256	40,761	58,349		2	New Aatish Market	71	13,644	31,528
13	Transport Nagar	0	17,845	17,845		1	Mansarovar	0	17,955	17,955
	Total	**2,03,908**	**2,03,908**				**Total**	**1,97,868**	**1,97,868**	

Table 2.57: Corridor-wise Daily Ridership

Optimistic Scenario (Option 6)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2051										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	53,825	0	0		21	India Gate (SIA)	9,553	0	0
2	Pani Petch	18,673	196	53,825		20	Kumbha Marg	17,921	9	9,553
3	Subhash Nagar	13,721	322	72,302		19	Haldi Ghati Gate	21,571	45	27,465
4	Collectorate	20,229	743	85,700		18	Pinjarapole Gaushala	41,977	228	48,991
5	Chandpole	1,00,292	31,484	1,05,186		17	Sanganer Sethu	18,312	371	90,740
6	Government Hostel	18,757	4,905	1,73,994		16	B2 Bypass	27,015	1,012	1,08,681
7	Ashok Marg	11,905	9,488	1,87,846		15	Durgapura	20,825	1,686	1,34,684
8	SMS Hospital	8,823	4,998	1,90,263		14	Mahaveer Nagar	15,893	1,329	1,53,824
9	Narayan Singh Circle	12,757	12,995	1,94,088		13	Dev Nagar	16,232	2,540	1,68,388
10	Ram Bagh Circle	10,763	16,505	1,93,850		12	Gandhi Nagar Rly. Stn.	6,057	1,702	1,82,079
11	Tonk Phatak	12,200	27,647	1,88,108		11	Tonk Phatak	28,325	12,903	1,86,434
12	Gandhi Nagar Rly. Stn.	1,646	5,595	1,72,661		10	Ram Bagh Circle	16,534	11,350	2,01,856
13	Dev Nagar	2,555	14,907	1,68,712		9	Narayan Singh Circle	12,821	13,548	2,07,039
14	Mahaveer Nagar	1,304	14,897	1,56,360		8	SMS Hospital	5,100	9,095	2,06,312
15	Durgapura	1,697	20,450	1,42,766		7	Ashok Marg	8,545	12,740	2,02,318
16	B2 Bypass	1,026	24,606	1,24,013		6	Government Hostel	4,753	21,576	1,98,122
17	Sanganer Sethu	397	16,264	1,00,433		5	Chandpole	31,880	1,04,738	1,81,299
18	Pinjarapole Gaushala	248	37,449	84,566		4	Collectorate	750	20,885	1,08,441
19	Haldi Ghati Gate	46	20,630	47,365		3	Subhash Nagar	311	14,429	88,305
20	Kumbha Marg	10	17,034	26,781		2	Pani Petch	192	19,567	74,187
21	India Gate (SIA)	0	9,756	9,756		1	Ambabari	0	54,812	54,812
	Total	**2,90,873**	**2,90,873**				**Total**	**3,04,567**	**3,04,567**	

Table 2.58: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2021										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	461	0	0		13	Transport Nagar	363	0	0
2	New Aatish Market	205	4	461		12	Ramganj Chaupar	540	8	363
3	Vivek Vihar	143	7	662		11	Badi Chaupar	505	26	895
4	Shyam Nagar	256	13	798		10	Choti Chaupar	505	59	1,374
5	Ram Nagar	490	55	1,041		9	Chandpole	1,182	1,125	1,820
6	Civil Lines	247	48	1,476		8	Sindhi Camp	81	156	1,877
7	Jaipur Railway Stn.	264	82	1,675		7	Jaipur Railway Stn.	91	484	1,802
8	Sindhi Camp	147	84	1,857		6	Civil Lines	46	249	1,409
9	Chandpole	1,177	1,216	1,920		5	Ram Nagar	38	278	1,206
10	Choti Chaupar	55	560	1,881		4	Shyam Nagar	12	246	966
11	Badi Chaupar	23	535	1,376		3	Vivek Vihar	7	132	732
12	Ramganj Chaupar	8	525	864		2	New Aatish Market	4	194	607
13	Transport Nagar	0	348	347		1	Mansarovar	0	418	417
	Total	**3,476**	**3,476**				**Total**	**3,374**	**3,374**	

Table 2.59: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Ambabari-India Gate (SIA) Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2021										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	774	0	0		21	India Gate (SIA)	67	0	0
2	Pani Petch	252	6	774		20	Kumbha Marg	181	0	67
3	Subhash Nagar	194	9	1,020		19	Haldi Ghati Gate	344	1	248
4	Collectorate	364	21	1,205		18	Pinjarapole Gaushala	309	3	591
5	Chandpole	1,884	530	1,548		17	Sanganer Sethu	311	7	897
6	Government Hostel	259	91	2,902		16	B2 Bypass	385	17	1,201
7	Ashok Marg	164	178	3,070		15	Durgapura	279	23	1,569
8	SMS Hospital	199	174	3,056		14	Mahaveer Nagar	427	40	1,825
9	Narayan Singh Circle	184	241	3,081		13	Dev Nagar	329	92	2,212
10	Ram Bagh Circle	255	449	3,024		12	Gandhi Nagar Rly. Stn.	257	25	2,449
11	Tonk Phatak	150	443	2,830		11	Tonk Phatak	439	158	2,681
12	Gandhi Nagar Rly. Stn.	24	255	2,537		10	Ram Bagh Circle	438	269	2,962
13	Dev Nagar	87	325	2,306		9	Narayan Singh Circle	226	196	3,131
14	Mahaveer Nagar	40	409	2,068		8	SMS Hospital	167	206	3,161
15	Durgapura	22	275	1,699		7	Ashok Marg	161	175	3,122
16	B2 Bypass	18	348	1,446		6	Government Hostel	90	280	3,108
17	Sanganer Sethu	7	276	1,116		5	Chandpole	531	1,900	2,918
18	Pinjarapole Gaushala	3	279	847		4	Collectorate	21	358	1,549
19	Haldi Ghati Gate	1	315	571		3	Subhash Nagar	8	203	1,212
20	Kumbha Marg	0	173	257		2	Pani Petch	6	258	1,017
21	India Gate (SIA)	0	84	84		1	Ambabari	0	766	765
	Total	**4,881**	**4,881**				**Total**	**4,976**	**4,976**	

Table 2.60: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Optimistic Scenario – Horizon Year 2023										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	522	0	0		13	Transport Nagar	428	0	0
2	New Aatish Market	248	4	522		12	Ramganj Chaupar	680	9	428
3	Vivek Vihar	170	8	766		11	Badi Chaupar	613	30	1,099
4	Shyam Nagar	324	15	928		10	Choti Chaupar	621	71	1,682
5	Ram Nagar	597	62	1,237		9	Chandpole	1,396	1,353	2,232
6	Civil Lines	295	57	1,772		8	Sindhi Camp	97	185	2,275
7	Jaipur Railway Stn.	327	99	2,010		7	Jaipur Railway Stn.	109	615	2,187
8	Sindhi Camp	174	101	2,238		6	Civil Lines	54	299	1,681
9	Chandpole	1,423	1,431	2,311		5	Ram Nagar	43	324	1,436
10	Choti Chaupar	66	689	2,303		4	Shyam Nagar	15	312	1,155
11	Badi Chaupar	27	645	1,680		3	Vivek Vihar	8	158	858
12	Ramganj Chaupar	9	660	1,062		2	New Aatish Market	4	236	708
13	Transport Nagar	0	411	411		1	Mansarovar	0	477	476
	Total	**4,182**	**4,182**				**Total**	**4,068**	**4,068**	

Table 2.61: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Ambabari-India Gate (SIA) Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2023										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	1,000	0	0		21	India Gate (SIA)	111	0	0
2	Pani Petch	313	7	1,000		20	Kumbha Marg	239	1	111
3	Subhash Nagar	241	10	1,306		19	Haldi Ghati Gate	467	1	349
4	Collectorate	437	24	1,537		18	Pinjarapole Gaushala	405	4	815
5	Chandpole	2,236	638	1,950		17	Sanganer Sethu	397	8	1,216
6	Government Hostel	324	108	3,548		16	B2 Bypass	486	22	1,605
7	Ashok Marg	202	210	3,764		15	Durgapura	342	29	2,069
8	SMS Hospital	240	196	3,756		14	Mahaveer Nagar	494	46	2,382
9	Narayan Singh Circle	228	285	3,800		13	Dev Nagar	380	110	2,830
10	Ram Bagh Circle	305	523	3,743		12	Gandhi Nagar Rly. Stn.	310	30	3,100
11	Tonk Phatak	187	533	3,525		11	Tonk Phatak	531	198	3,380
12	Gandhi Nagar Rly. Stn.	30	307	3,179		10	Ram Bagh Circle	513	322	3,713
13	Dev Nagar	104	372	2,902		9	Narayan Singh Circle	270	244	3,904
14	Mahaveer Nagar	46	475	2,634		8	SMS Hospital	190	250	3,930
15	Durgapura	28	337	2,205		7	Ashok Marg	190	217	3,870
16	B2 Bypass	23	437	1,896		6	Government Hostel	107	355	3,843
17	Sanganer Sethu	9	350	1,482		5	Chandpole	639	2,272	3,595
18	Pinjarapole Gaushala	4	363	1,141		4	Collectorate	24	434	1,962
19	Haldi Ghati Gate	1	426	782		3	Subhash Nagar	10	252	1,552
20	Kumbha Marg	1	228	357		2	Pani Petch	7	323	1,310
21	India Gate (SIA)	0	126	130		1	Ambabari	0	994	994
	Total	**5,959**	**5,959**				**Total**	**6,112**	**6,112**	

Table 2.62: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2031										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	767	0	0		13	Transport Nagar	692	0	0
2	New Aatish Market	421	5	767		12	Ramganj Chaupar	1,237	13	692
3	Vivek Vihar	279	10	1,183		11	Badi Chaupar	1,046	46	1,916
4	Shyam Nagar	595	24	1,452		10	Choti Chaupar	1,083	118	2,916
5	Ram Nagar	1,024	90	2,023		9	Chandpole	2,251	2,266	3,881
6	Civil Lines	488	89	2,957		8	Sindhi Camp	164	301	3,866
7	Jaipur Railway Stn.	582	165	3,356		7	Jaipur Railway Stn.	179	1,138	3,729
8	Sindhi Camp	282	171	3,773		6	Civil Lines	85	497	2,770
9	Chandpole	2,405	2,294	3,884		5	Ram Nagar	61	505	2,358
10	Choti Chaupar	110	1,209	3,995		4	Shyam Nagar	24	573	1,914
11	Badi Chaupar	42	1,088	2,896		3	Vivek Vihar	10	263	1,365
12	Ramganj Chaupar	13	1,199	1,850		2	New Aatish Market	5	404	1,112
13	Transport Nagar	0	664	664		1	Mansarovar	0	714	713
	Total	**7,008**	**7,008**				**Total**	**6,837**	**6,837**	

Table 2.63: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2031										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	1,904	0	0		21	India Gate (SIA)	285	0	0
2	Pani Petch	559	11	1,904		20	Kumbha Marg	471	1	285
3	Subhash Nagar	426	16	2,452		19	Haldi Ghati Gate	958	2	755
4	Collectorate	727	37	2,862		18	Pinjarapole Gaushala	788	7	1,711
5	Chandpole	3,645	1,070	3,552		17	Sanganer Sethu	740	15	2,492
6	Government Hostel	583	175	6,127		16	B2 Bypass	886	40	3,217
7	Ashok Marg	353	337	6,535		15	Durgapura	594	52	4,063
8	SMS Hospital	406	285	6,551		14	Mahaveer Nagar	761	69	4,605
9	Narayan Singh Circle	406	465	6,672		13	Dev Nagar	582	183	5,297
10	Ram Bagh Circle	504	819	6,613		12	Gandhi Nagar Rly. Stn.	522	53	5,696
11	Tonk Phatak	334	893	6,298		11	Tonk Phatak	895	356	6,165
12	Gandhi Nagar Rly. Stn.	51	516	5,739		10	Ram Bagh Circle	812	532	6,704
13	Dev Nagar	174	558	5,274		9	Narayan Singh Circle	445	436	6,984
14	Mahaveer Nagar	67	735	4,890		8	SMS Hospital	282	426	6,993
15	Durgapura	51	586	4,222		7	Ashok Marg	305	381	6,849
16	B2 Bypass	41	793	3,687		6	Government Hostel	176	654	6,773
17	Sanganer Sethu	16	648	2,935		5	Chandpole	1,073	3,758	6,295
18	Pinjarapole Gaushala	7	699	2,303		4	Collectorate	37	735	3,610
19	Haldi Ghati Gate	2	870	1,611		3	Subhash Nagar	15	449	2,912
20	Kumbha Marg	1	447	743		2	Pani Petch	11	582	2,478
21	India Gate (SIA)	0	295	297		1	Ambabari	0	1,906	1,907
	Total	**10,257**	**10,257**				**Total**	**10,638**	**10,638**	

Table 2.64: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2041										
Mansarovar to Transport Nagar Direction						Transport Nagar to Mansarovar Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Mansarovar	991	0	0		13	Transport Nagar	1,110	0	0
2	New Aatish Market	754	5	991		12	Ramganj Chaupar	2,226	19	1,110
3	Vivek Vihar	482	14	1,740		11	Badi Chaupar	1,774	74	3,317
4	Shyam Nagar	1,227	43	2,208		10	Choti Chaupar	1,883	199	5,017
5	Ram Nagar	795	88	3,392		9	Chandpole	3,232	4,105	6,701
6	Civil Lines	849	131	4,099		8	Sindhi Camp	252	532	5,828
7	Jaipur Railway Stn.	1,096	240	4,817		7	Jaipur Railway Stn.	237	1,095	5,548
8	Sindhi Camp	497	262	5,673		6	Civil Lines	126	869	4,690
9	Chandpole	4,386	3,315	5,908		5	Ram Nagar	85	785	3,947
10	Choti Chaupar	187	2,121	6,979		4	Shyam Nagar	44	1,173	3,247
11	Badi Chaupar	69	1,863	5,045		3	Vivek Vihar	14	463	2,118
12	Ramganj Chaupar	18	2,202	3,251		2	New Aatish Market	5	729	1,669
13	Transport Nagar	0	1,067	1,067		1	Mansarovar	0	944	945
	Total	**11,351**	**11,351**				**Total**	**10,988**	**10,988**	

Table 2.65: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2041										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	3,740	0	0		21	India Gate (SIA)	573	0	0
2	Pani Petch	1,042	18	3,740		20	Kumbha Marg	973	1	573
3	Subhash Nagar	780	26	4,764		19	Haldi Ghati Gate	1,169	3	1,545
4	Collectorate	1,215	59	5,518		18	Pinjarapole Gaushala	1,837	11	2,711
5	Chandpole	5,909	1,853	6,674		17	Sanganer Sethu	1,502	25	4,537
6	Government Hostel	1,096	312	10,730		16	B2 Bypass	1,746	73	6,014
7	Ashok Marg	665	549	11,514		15	Durgapura	1,100	94	7,687
8	SMS Hospital	628	365	11,630		14	Mahaveer Nagar	1,914	171	8,693
9	Narayan Singh Circle	764	770	11,893		13	Dev Nagar	971	175	10,436
10	Ram Bagh Circle	690	1,011	11,887		12	Gandhi Nagar Rly. Stn.	346	100	11,232
11	Tonk Phatak	661	1,566	11,566		11	Tonk Phatak	1,587	703	11,478
12	Gandhi Nagar Rly. Stn.	97	325	10,661		10	Ram Bagh Circle	997	732	12,362
13	Dev Nagar	173	908	10,433		9	Narayan Singh Circle	748	816	12,627
14	Mahaveer Nagar	171	1,836	9,698		8	SMS Hospital	366	654	12,559
15	Durgapura	93	1,085	8,033		7	Ashok Marg	501	715	12,271
16	B2 Bypass	75	1,574	7,041		6	Government Hostel	298	1,250	12,057
17	Sanganer Sethu	27	1,338	5,542		5	Chandpole	1,850	6,157	11,105
18	Pinjarapole Gaushala	12	1,621	4,231		4	Collectorate	59	1,248	6,798
19	Haldi Ghati Gate	3	1,111	2,622		3	Subhash Nagar	25	822	5,609
20	Kumbha Marg	1	922	1,514		2	Pani Petch	17	1,092	4,812
21	India Gate (SIA)	0	589	593		1	Ambabari	0	3,738	3,737
	Total	**17,842**	**17,842**				**Total**	**18,579**	**18,579**	

Table 2.66: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Mansarovar-Transport Nagar Corridor Peak Hour Ridership for Optimistic Scenario - Horizon Year 2051										
Mansarovar to Transport Nagar Direction						**Transport Nagar to Mansarovar Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Mansarovar	1,872	0	0		13	Transport Nagar	1,864	0	0
2	New Aatish Market	1,402	7	1,872		12	Ramganj Chaupar	4,135	26	1,864
3	Vivek Vihar	956	28	3,267		11	Badi Chaupar	3,151	115	5,973
4	Shyam Nagar	3,046	117	4,195		10	Choti Chaupar	3,396	308	9,009
5	Ram Nagar	1,271	156	7,124		9	Chandpole	5,724	6,826	12,097
6	Civil Lines	1,420	245	8,239		8	Sindhi Camp	506	873	10,995
7	Jaipur Railway Stn.	1,888	471	9,414		7	Jaipur Railway Stn.	466	1,880	10,628
8	Sindhi Camp	811	526	10,831		6	Civil Lines	238	1,457	9,214
9	Chandpole	7,304	5,897	11,116		5	Ram Nagar	153	1,261	7,995
10	Choti Chaupar	289	3,810	12,523		4	Shyam Nagar	121	2,941	6,887
11	Badi Chaupar	107	3,272	9,002		3	Vivek Vihar	27	942	4,067
12	Ramganj Chaupar	26	4,076	5,837		2	New Aatish Market	7	1,364	3,152
13	Transport Nagar	0	1,784	1,787		1	Mansarovar	0	1,796	1,795
	Total	**20,392**	**20,392**				**Total**	**19,788**	**19,788**	

Table 2.67: Corridor-wise Peak Hour Ridership

Optimistic Scenario (option)

Ambabari-India Gate (SIA) Corridor Daily Ridership for Optimistic Scenario - Horizon Year 2051										
Ambabari to India Gate (SIA) Direction						India Gate (SIA) to Ambabari Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ambabari	5,382	0	0		21	India Gate (SIA)	955	0	0
2	Pani Petch	1,867	20	5,382		20	Kumbha Marg	1,792	1	955
3	Subhash Nagar	1,372	32	7,229		19	Haldi Ghati Gate	2,157	4	2,746
4	Collectorate	2,023	74	8,569		18	Pinjarapole Gaushala	4,198	23	4,899
5	Chandpole	10,029	3,148	10,518		17	Sanganer Sethu	1,831	37	9,074
6	Government Hostel	1,876	491	17,399		16	B2 Bypass	2,701	101	10,868
7	Ashok Marg	1,191	949	18,784		15	Durgapura	2,083	169	13,468
8	SMS Hospital	882	500	19,026		14	Mahaveer Nagar	1,589	133	15,382
9	Narayan Singh Circle	1,276	1,300	19,408		13	Dev Nagar	1,623	254	16,838
10	Ram Bagh Circle	1,076	1,650	19,384		12	Gandhi Nagar Rly. Stn.	606	170	18,207
11	Tonk Phatak	1,220	2,765	18,810		11	Tonk Phatak	2,832	1,290	18,643
12	Gandhi Nagar Rly. Stn.	165	559	17,265		10	Ram Bagh Circle	1,653	1,135	20,185
13	Dev Nagar	256	1,491	16,871		9	Narayan Singh Circle	1,282	1,355	20,703
14	Mahaveer Nagar	130	1,490	15,636		8	SMS Hospital	510	909	20,630
15	Durgapura	170	2,045	14,276		7	Ashok Marg	854	1,274	20,231
16	B2 Bypass	103	2,461	12,401		6	Government Hostel	475	2,158	19,811
17	Sanganer Sethu	40	1,626	10,043		5	Chandpole	3,188	10,474	18,128
18	Pinjarapole Gaushala	25	3,745	8,457		4	Collectorate	75	2,089	10,842
19	Haldi Ghati Gate	5	2,063	4,737		3	Subhash Nagar	31	1,443	8,828
20	Kumbha Marg	1	1,703	2,679		2	Pani Petch	19	1,957	7,416
21	India Gate (SIA)	0	976	977		1	Ambabari	0	5,481	5,478
	Total	**29,089**	**29,089**				**Total**	**30,454**	**30,454**	

CHAPTER 3- SYSTEM AND TECHNOLOGY SELECTION

CHAPTER – 3

SYSTEM AND TECHNOLOGY SELECTION

3.1 GENERAL

The population growth in cities and urban centers has put a lot of pressure on the infrastructure of these cities. In rapidly developing countries like India the urban infrastructure is stretched to limit and requires very effective solutions. The rapid development in India is not unprecedented and such development earlier took place in several nations of Europe, America and in Japan.

3.2 BENEFITS OF MASS TRANSPORT SYSTEM

The main benefits addressed by mass transport are the mobility and freedom. The sustainability of mass transport has greater potential and major benefits occur through immediate means of helping the environment and conserving energy. In developing countries, like India, benefit through mass transit systems extend to urban poor with affordable fare structure when compared with costs incurred by private transportation on fuels, parking, congestion etc. The supply of planned and integrated mass public transport is the only way to relieve traffic congestion and reduce hours of delay on major travel corridors.

3.3 CHOICE OF MODE OF MASS RAPID TRANSIT SYSTEM (MRTS)

The choice of a particular MRTS will depend on a variety of factors like demand, capacity, cost and ease of implementation. A BRT or LRT systems at grade may require linear pathway to be carved out of existing land if additional space cannot be made available on the sideways and will reduce the space for other traffic depending on the width of existing roads. LRTs and Tramways without horizontal separation will have reduced speed and hence reduced capacity. The capacity of MRTS is generally denoted by passengers per hour per direction (PPHPD). A BRTS typically has a capacity of 10,000-15,000 PPHPD on a single lane but can be enhanced with additional lanes. Comparatively metro rail systems are able to carry much higher passenger volumes of 60,000 PPHPD and can go up to 80,000. Such rail-based systems also generally provide rapid service, a higher quality ride and service regularity due to grade separation. Metro Rail System may be designed for PPHPD demand varying from 25,000 to 80,000.

3.4 OPTIONS OF MASS RAPID TRANSIT SYSTEMS (MRTS)

The options available for Mass Rapid Transit Systems in cities/ urban agglomeration are as under.

(a) Busways and Bus Rapid Transit System (BRTS)

Busways are physically demarcated bus lanes along the main carriageway with a segregated corridor for movement of buses only. At the intersections, the buses may be given priority over other modes through a signalling system. BRTS, is an enhanced form of a busway which incorporates features such as facilities for pedestrians, Non-Motorised Vehicles (NMV) and many other associated infrastructures including operations and control mechanism. This system is good for the cities where sufficient ROW is available to accommodate exclusive lanes for buses and traffic demand is low.

(b) Light Rail Transit (LRT)

LRT is generally at-grade rail-based mass transit system, which is generally segregated from the main carriageway. These are extremely popular and operating in large number of European countries. Generally, the stations are spaced at 500m to 1 km and have high acceleration and deceleration characteristics. In most of the countries, they are operating at-grade with prioritized signaling at road inter-section.

(c) Metrolite

Metrolite in fact high breed version of LRT. Ministry of Housing and Urban Affairs (MoHUA) has come up with the idea of Metrolite to cut the cost of projects in tier 2, tier 3 cities and on the corridors in metropolitan cities having lower PPHPD demand. It is also proposed to be used as feeder system to MRTS. Lower cost of the system makes it viable option. This system should also be at grade and segregated from road traffic. However, in case of narrow road with this system may be elevates also.

(d) Metro Neo

Electric Bus system with overhead Traction is termed as Metro Neo System. This system has articulated/biarticulated/standard electric coaches(buses) with overhead traction system and will run on an entirely elevated corridor. These electric buses are also capable to run on theproposed feeder routes using the inbuilt batteries which allows them to run without overhead traction upto a distance of 20 km. The batteries are charged while operating with overhead traction and thus, will eliminate any need of separate charging points/stations.

(e) Tramways

These are at-grade rail-based system that are not segregated and often move in mixed traffic conditions.

(f) Metro Rail

Metro rail is a fully segregated rail-based mass transit system, which could be at grade, elevated or underground. Due to its physical segregation and system technology, metro rail can have a very high capacity upto 80,000 passengers per hour per direction (PPHPD). Further metro can be categorized in three parts as under.

- Light Capacity Metro Rail – System Capable to cater passengers per hour per direction (PPHPD) upto 30,000.
- Medium Capacity Metro Rail – System Capable to cater passengers per hour per direction (PPHPD) upto 50,000.

- High Capacity Metro Rail – System Capable to cater passengers per hour per direction (PPHPD) more than 50,000.

(g) Monorail

Monorail trains operate on grade separated dedicated corridors with sharp curves of up to 50m radius. This is a rubber tyred based rolling stock, electrically propelled on concrete beams known as guide-ways. It is suitable in narrow corridors as it requires minimum right of way on existing roads and permits light and air and is more environmentally friendly. However, it has lower capacities and higher maintenance cost.

(h) Maglev

This is an advanced Rail based transit system in which Magnetic Levitation is used to raise the vehicles above the rail surface. Rail wheel interaction is thus avoided and very high speeds are attainable. Maglev Levitation can either be due to attractive force or due to repulsive forces.

(i) Linear Induction Motor (LIM) Train

This is also an advanced Rail based transit system in which propulsion is through a Linear Induction Motor whose stator is spread along the track. The rotor is a magnetic material provided in the under frame of train. In the technology the tractive force is not transmitted through rail-wheel interaction, and so there is no limitation on account of adhesion. This technology is most appropriate for turnouts, as the height of the tunnel can be reduced to lower height of cars.

(j) Regional Rail

Regional rail caters to passenger services within a larger urban agglomerate or Metropolitan area connecting the outskirts to the center of the city. The services have greater number of halts at smaller distances compared to long distance railways but fewer halts and higher speeds compared to metro rail. Regional rails are common in large metropolitan cities and help in decongesting the city centre by providing safe, and speedy access to the city center for commuters residing in less congested suburbs.

Since there are various technologies available for mass rapid transit system (MRTS) and each technology has different requirements including capital investment, it is necessary to have certain guidelines for selection of suitable mode. Choice of mode for proposed MRTS depends mainly on projected corridor demand, available ROW and the capacity of the proposed mode. Selected mode should be adequate for the future demand level on a corridor, both in quantity and quality of service such as journey time. There are few other parameters like land-use along the corridor, the location of building lines and the potential for increasing the ROW should also needs to be reviewed for system selection of proposed MRTS. Other features such as speed, cost, safety, eco-friendliness, energy and land conservation, aesthetics and local technology maturity from consideration of maintaining the system should be given due weightage.

Some of the most suited options for Jaipur city out of the above described options are compared as under.

Table 3.1: Comparative Analysis of various Mass Rapid Transit Systems

Parameter	Conventional Metro	Light Metro	Metro Lite	Metro Neo
Train Type	16T Axle Load (4 to 8 coaches train)	16T Axle Load (3 coaches train)	12T Axle Load (Tram, low floor Articulated)	10-12T Axle Load (tyred buses powered with OHE)
Picture				
Train Capacity (passenger)	1000-2500	750	400-500	150-250
Train Length (meters)	90-180	70	40-50	18-25
Alignment	Elevated /Underground	Mostly Elevated	Mostly At-Grade/partly elevated	Mostly At-Grade/partly elevated
Peak Hour Capacity (PPHPD)	25000-80000	15000-25000	Upto 15000	Upto 9000
a) Station Design	Heavy with Concourse level	Light (minimum Facility)	Very light structure like Bus shelter	
b) Ticketing	AFC	AFC	No AFC proposed	Optional (Like BRTS)
c) Security	Scanning+ Frisking	Scanning+ Frisking	No Security	
Estimated cost/km (INR in crore)	Elevated: 300; UG: 500-600	180-200	130-160	60-80
Status	Functional and proven in Indian conditions	Functional and proven in Indian conditions	Specification issued by MoHUA. Metro Corporations have reservation on At-grade and without AFC system. (DMRC Dwarka-Kirti Ngr Section under DPR stage)	Specification presented by 'Maha Metro' for Nasik. DPR yet to be approved by MoHUA.

3.5 CAPACITY OF VARIOUS MODES (AS PER THE RECOMMENDATIONS OF WORKING GROUP ON URBAN TRANSPORT FOR 12TH FIVE YEAR PLAN)

In their report on **Urban Transport for 12th Five Year Plan**, the Working Group has set the guidelines for the choice of different modes is as follows:

Table 3.2: Guidelines for Choice of Different Modes

SYSTEM	PPHPD IN 2021	POPULATION IN 2011	AVG. TRIP LENGTH
Metro Rail #	>=15000 for at least 5km continuous length	More than 20 Lakhs	More than 7 Km
LRT primarily at grade	=<10,000	More than 10 Lakhs	More than 7 Km
Monorail @@	=<10,000	More than 20 Lakhs	About 5-6 Km
Bus Rapid Transit System	>=4,000 and upto 20000	More than 10 Lakhs	>5 Km
Organised City Bus Service as per urban bus specifications		>1 lac, >50,000 in case of hilly towns	>2 to 3 Km

 # for having Metro Rail, the city should have a ridership of at least 1 million on organized public transport (any mode)

@@ Monorail is desirable only as a feeder system or where the narrow roads are flanked on either side by high rise buildings. In monorail while the cost of construction, operation and maintenance is almost the same as elevated metro rail, the carrying capacity is much lesser.

3.6 SELECTION OF MODE

Selection of a particular mode for any pre-determined traffic corridor depends mainly on traffic demand level of a corridor, Right of Way (ROW) on the road and the capacity of the mode. The demand forecast is estimated considering the traffic growth for about 30 years. Other considerations in mode choice are location of building lines, possibility of increasing ROW. Cost of some mode may vary depending upon the location in view of engineering constraints. Therefore, final choice of mode to be adopted for a particular corridor is based on techno economic considerations. As regards the location of a particular mode like at-grade, elevated and underground, depends upon the ROW. If ROW is 20 m or more, elevated alignment is preferred over underground as the cost of underground alignment is 2- 2½ times of elevated alignment. Normally rail based MRT corridors are not considered at grade as that separates the city into two parts and providing cross passes for pedestrians and vehicular traffic at various locations is neither cost effective nor desirable from convenience point of view of public.

A detailed analysis of traffic demand forecast is carried out for various permutations and combinations of MRTS corridors to select most eligible corridors as described in chapter 2. The final network of MRT corridors has been selected after discussions with all stake holders of the project. The estimated traffic demand and other requirements like land availability and ease of construction for different options. The selected corridors' option is as under.

Option-6:

Corridor 1: Sitapura Industrial Area to Ambabari (on Tonk Road) without connecting Collectorate Circle and with dedicated bus services for Airport Terminal-1, Airport Terminal-2 and Collectorate Circle

Corridor 2: Mansarovar – Transport Nagar

The traffic and PPHPD projections are placed in the table below:

Table 3.3: Ridership Summary for Master Plan (Optimistic) Scenario

Horizon Year	Corridor	Daily Ridership (Passengers)	PPHPD (Passengers)	Average Trip Length/ Passenger Lead (km)
2021	Mansarovar - Transport Nagar	68,504	1,920	4.38
2021	Ambabari - India Gate (SIA)	98,602	3,161	8.08
2023	Mansarovar - Transport Nagar	82,495	2,311	4.36
2023	Ambabari - India Gate (SIA)	1,20,667	3,930	8.37
2031	Mansarovar - Transport Nagar	1,38,459	3,995	4.34
2031	Ambabari - India Gate (SIA)	2,08,926	6,993	8.90
2041	Mansarovar - Transport Nagar	2,23,392	6,979	4.25
2041	Ambabari - India Gate (SIA)	3,64,200	12,627	9.46
2051	Mansarovar - Transport Nagar	4,01,776	12,523	4.46
2051	Ambabari - India Gate (SIA)	5,95,440	20,703	9.64

The PPHPD and average trip length on India Gate (SIA) - Ambabari Corridor are 20703 and 9.64 km respectively in year 2051. Options of technology are:

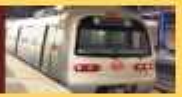
- BRT
- Metro Neo
- LRT
- Monorail
- Metrolite
- Light Capacity Metro Rail

As PPHPD demand is more than 20,000. Therefore, BRT and Metro Neo are out of consideration. Similarly, LRT also cannot be considered as viable option as ROW of the corridor is not sufficient to accommodate LRT at grade. Monorail system cannot be recommended due to following reasons.

- Technology is not proven.
- It has comparatively high maintenance cost due to wear and tear of rubber tyres.
- Problems in emergency evacuation thus posing disaster management problems.
- Total dependence on Rolling Stock supplier. No indigenous production of Rolling Stock. Total dependence on manufacturer of spares.
- It has poor ride quality as compared to metro.
- Rolling Stock cannot be purchased from another manufacturer without changing the guide beams.
- Higher Life Cycle Cost

Metrolite may provide adequate capacity only upto 2041 as PPHPD demand is 2051 is 20703. Hence, even if Metrolite is provided now, its upgradation will be necessary before we reach 2051. Moreover, there are indications from Metrolite Rolling Stock manufacturers that cost of Metrolite Rolling Stock will be much higher as compared to regular metro coaches for the same capacity.

Hence, in view the above, it is recommended to adopt a stable, tested and reliable Metro technology i.e. Light Capacity Metro Rail System capable to cater the PPHPD demand upto 30,000, with conventional Rolling Stock but with cost cutting features of the Metrolite. There will be no concourse and arrangement for frisking of the passengers for security at the stations.



CHAPTER 4- GEOMETRIC DESIGNING PARAMETERS AND ALIGNMENT DESCRIPTION

CHAPTER - 4

GEOMETRIC DESIGNING PARAMETERS AND ALIGNMENT DESCRIPTION

4.1 GENERAL

This chapter deals with geometrical standards adopted for horizontal and vertical alignments, route description, etc. The proposed corridors will be implemented with track on Standard Gauge (SG) 1435mm.

The geometrical design norms are based on international practices adopted for similar metro systems with standard gauge on the assumption that the maximum permissible speed on the section is limited to 80kmph. Planning for any higher speed is not desirable as the average inter-station distance is kept close to one km and trains will not be able to achieve higher speed.

The elevated tracks will be carried on twin-U/box/I-Girders supported on single circular piers, generally spaced at 28-m centres and located on the median or on the space available between main carriageway and service road to the extent possible. The horizontal alignment and vertical alignment are, therefore, dictated to a large extent by the geometry of the road and ground levels followed by the alignment.

The design parameters related to the Metro system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters but the best-suited ones have been adopted for the system as a whole.

As regards the type of alignment i.e. At-grade, Elevated and Underground depends upon the ROW. If ROW is 20 m or more, Elevated alignment is preferred over Underground as the cost of Underground alignment is 2 to 2½ times of Elevated alignment. The Merits and demerits of Elevated and Underground alignments are detailed at Annexure- 4.1

4.2 GEOMETRIC DESIGN NORMS

4.2.1 Horizontal Alignment

As far as possible, the alignment follows the existing roads. This leads to introduction of horizontal curves. On consideration of desirable maximum cant of 110 mm and cant deficiency of 85 mm on Metro tracks, the safe speed on curves of radii of 400 m or more is 80 km/h. Minimum radius of 125m has been used at nine location having speed potential upto 40 km/h.

Horizontal Curves:

Table 4.1: Horizontal Curves

Description	Elevated Section	Underground Section
Desirable Minimum radius	200m	300m
Absolute minimum radius	120m*	200m
Minimum curve radius at stations	1000m	1000m
Maximum permissible cant (C_a)	125 mm	125 mm
Maximum desirable cant	110mm	110mm
Maximum cant deficiency (C_d)	85mm	85mm

* used in special circumstance to avoid demolition.

Transition Curves:

It is necessary to provide transition curves at both ends of the circular curves for smooth riding on the curves and to counter act centrifugal force. Due to change in gradients at various locations in the corridor, it is necessary to provide frequent vertical curves along the alignment. In case of ballast less track, it is desirable that the vertical curves and transition curves of horizontal curves do not overlap. These constraints may lead to reduced lengths of transition curves at certain locations. The transition curves have certain minimum parameters:

- Length of transitions of horizontal curves (m)
  Minimum :0.44 times actual cant or cant deficiency (in mm), whichever is higher.
  Desirable :0.72 times actual cant or cant deficiency (in mm), whichever is higher.
- Overlap between transition curves and vertical curves not allowed.
- Minimum straight between two Transition curves (in case of reverse curves): either 25 m or Nil.
- Minimum straight between two Transition curves (in case of similar flexure curves): either 25 m or both curves should be converted in to the compound curve by introducing single transition between the two circulars.
- Minimum curve length between two transition curves: 25 m

4.2.2 Vertical Alignment and Track Centre

(a) Elevated Sections

The viaducts carrying the tracks will have a vertical clearance of minimum 5.5 m above road level as mandatory requirement of Indian Road Congress (IRC). For meeting this requirement with the ‘U’ shaped pre-stressed concrete girders and Segmental Box Girders, the rail level will be about 8.5 m and 9.8 m above the road level respectively. However, at stations which are located above central median, the rail level will be 10.2 m above the road level without concourse at mezzanine. These levels will, however, vary marginally depending upon where the stations are located.

The track centre on the elevated section having Double U Girder will be 4.7m and having Segmental Box Girder it will be 4.2m.

(b) Gradients

Normally the stations shall be on level stretch. In exceptional cases, station may be on a grade of 0.1 %. Between stations, generally the grades may not be steeper than 2.0 %. However, where existing road gradients are steeper than 2% or for Switch Over Ramps gradient up to 4% (compensated) can be provided in short stretches on the main line.

(c) Vertical Curves

Vertical curves are to be provided when change in gradient exceeds 0.4%. However, it is recommended to provide vertical curves at every change of gradient.

(d) Radius of vertical curves:

- On main line (desirable) : 2500 m
  (Absolute minimum) : 1500 m
- Other Locations : 1500 m
- Minimum length of vertical curve : 20 m

4.2.3 Design Speed

Design speed will be 90 km/h & maximum operating speed will be 80 km/h. However, the applied cant, and length of transition will be decided in relation to normal speeds at various locations, as determined by simulation studies of alignment, vertical profile and station locations. Computerized train simulation studies need to be conducted with proposed gradients at the time of detailed design stage. This is with the objective of keeping down the wear on rails on curves to the minimum.

Table 4.2: Cant, Maximum Speed & Minimum track centre for Curves

RADIUS	CANT	MAXIMUM PERMISSIBLE SPEED	MINIMUM TRACK CENTRE (ELEVATED & AT-GRADE)
m	mm	kmph	mm
3000	15	80	3650
2800	15	80	3650
2400	20	80	3650
2000	20	80	3650
1600	25	80	3650
1500	30	80	3650
1200	35	80	3650
1000	45	80	3700
800	55	80	3700
600	70	80	3750
500	85	80	3750

RADIUS	CANT	MAXIMUM PERMISSIBLE SPEED	MINIMUM TRACK CENTRE (ELEVATED & AT-GRADE)
m	mm	kmph	mm
450	95	80	3800
400	105	80	3800
350	110	75	3800
300	110	70	3850
200	110	55	3950
150	110	45	4050
150*	0	30	4050
120	110	40	4150
120*	0	25	4150

*The curves of 120 and 150 meters radii are used without transitions.

Notes: (a) The track spacing is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.

(b) Track spacing shown is not applicable to stations which should be calculated depending on specific requirement.

(c) Figures for any intermediate radius of curvature may be obtained by interpolating between two adjacent radii. For higher radii, values may be extrapolated.

4.2.4 Codes and Standards

The codes, standards and specifications applicable for design of the components of the Rail System and for its operation and maintenance are:

i) NFPA 130 – 'Standard for Fixed Guide way Transit and Passenger Rail Systems'
ii) European Norms (EN):
iii) International Electro Technical Commission Standards (IEC):
iv) International Standards organization (ISO):
v) Japanese Industrial Standards (JIS):
vi) United States of America, AIS, AAR:
vii) British standards (BS):
viii) Indian Standards (IS)
ix) German Standards (DIN)
x) Indian Railway Standards (IRS):
xi) Indian Roads Congress (IRC): and
xii) Any other specified standards.

4.2.5 General technical requirements of the Rail System

The rail system shall be designed to:

i) Handle the user demand efficiently;
ii) Minimize noise pollution;
iii) Provide adequate interchange facilities including pedestrian facilities;

The design of the Rail System shall also conform to:

i) Local building bye-laws;
ii) Relevant published standards of UIC;
iii) All statutory requirements, guidelines and directives; and
iv) Stipulations of fire service department.

4.3 TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy in view.

General

Two types of track structures are proposed for any Metro. The normal ballasted track is suitable for At-Grade (surface) portion of Main Lines and in Depot (except inside the Workshops, inspection lines and washing plant lines). The ballastless track is recommended on viaducts as the regular cleaning and replacement of ballast at such location will not be possible. Only in case of the depot, normal ballasted track is proposed for adoption.

From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be joint-less and for this purpose even the turnouts will have to be incorporated in LWR/CWR. The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

Rail Section

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section. Since main lines will have sharp curves and steep gradients, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T- 12-2009. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the grade of rails should be 880, which can be easily manufactured indigenously.

Ballastless Track on Viaducts

On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths (shown in **Fig.4.1**). It is proposed to adopt suitable Fastenings System with a base-plate to base-plate spacing of 60-65 cm, on viaducts complying of performance criteria laid down by Railway Board vide letter Circular No. 2009/Proj/InAs/9/2, dated 02.05.2010.

Ballastless Track in Depot

The ballastless track in Depot will be of the following types:

- Discretely supported on concrete/steel pedestals for inspection lines.

- Embedded rail type inside the Workshop.
- Plinth type for Washing Plant line.
- Normal Ballastless (as on viaduct) for Washing lines, Stabling and other running lines.

Turnouts

- From considerations of maintainability and riding comfort, it is proposed to lay the turnouts also with 1 in 20 cant. Further, it is proposed to adopt the following two types of turnouts:

i) On main lines, 1 in 9 type turnout with a lead radius of 300 metres and permissible speed on divergent track as 40 km/h (shown in **Fig. 4.2**).
ii) On Depot lines, 1 in 7 type turnout with a lead radius of 190 metres and permissible speed on divergent track as 25 km/h (shown in **Fig. 4.3**).

The Scissors crossovers on Main Lines (1 in 9 type) will be with a minimum track centre of 4.5 m (shown in **Fig. 4.4**).

- The proposed specifications for turnouts are given below: -

i) The turnouts should have fan-shaped layout throughout the turnout so as to have same sleepers/base-plates and slide chairs for both LH and RH turnouts.
ii) The switches and crossings should be interchangeable between ballasted and ballastless turnouts (if required).

- The switch rail should be with thick web section, having forged end near heel of switch for easy connection with lead rails, behind the heel of switch. The switches should have anti creep device at heel of switch for minimising the additional LWR forces transmitted from tongue rail to stock rail.

- The crossings should be made of cast manganese steel and with welded leg extensions. These crossings should be explosive hardened type for main lines and without surface hardening for Depot lines.

- The check rails should be with UIC-33 rail section without being directly connected to the running rails.

Buffer Stops

On main lines and Depot lines, friction buffer stops with mechanical impact absorption (non-hydraulic type) need to be provided. On elevated section the spans on which friction buffer stops are to be installed are to be designed for an additional longitudinal force of 85 T, which is likely to be transmitted in case of Rolling Stock impacting the friction Buffer Stops.

4.3.1 Rail Structure Interaction

For continuing the LWR/CWR on viaducts, the elevated structures are to be adequately designed for the additional longitudinal forces likely to be transmitted as a result of Rail-Structure interaction. Rail structure interaction study will determine the need and locations of Rail Expansion Joints (REJ) also. REJ in ballasted track will be for a maximum gap of 120 mm, whereas on ballastless track for a maximum gap of 180 mm.

Welding

Flash Butt Welding Technique is to be used for welding of rails. Alumino-Thermic Welding is to be done only for those joints which cannot be welded by Flash Butt Welding Technique, such as joints at destressing locations and approach welds of switches & crossings. For minimising the population of Thermit welds, mobile (rail-cum-road or portable) Flash Butt Welding Plant will have to be deployed.

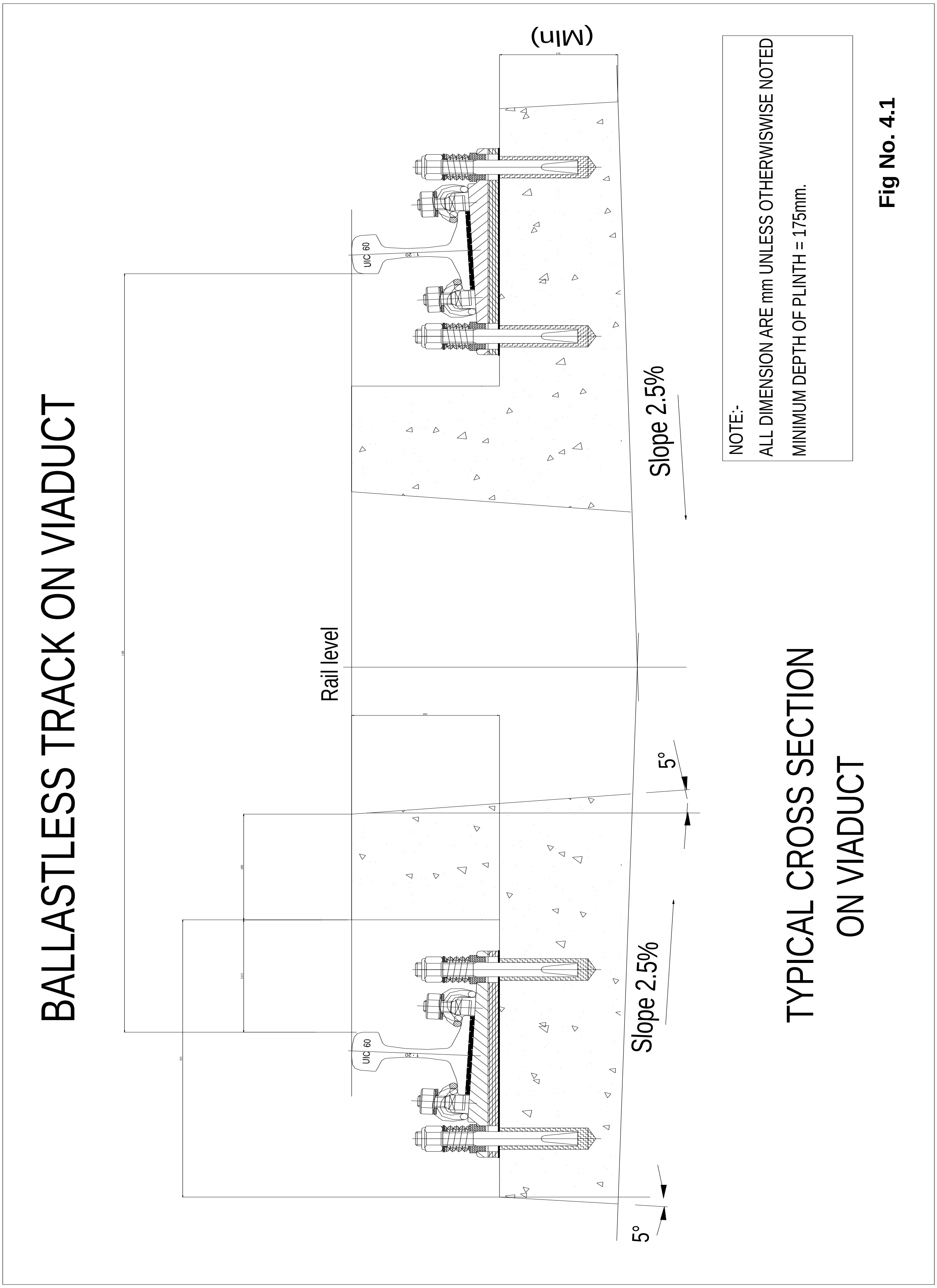
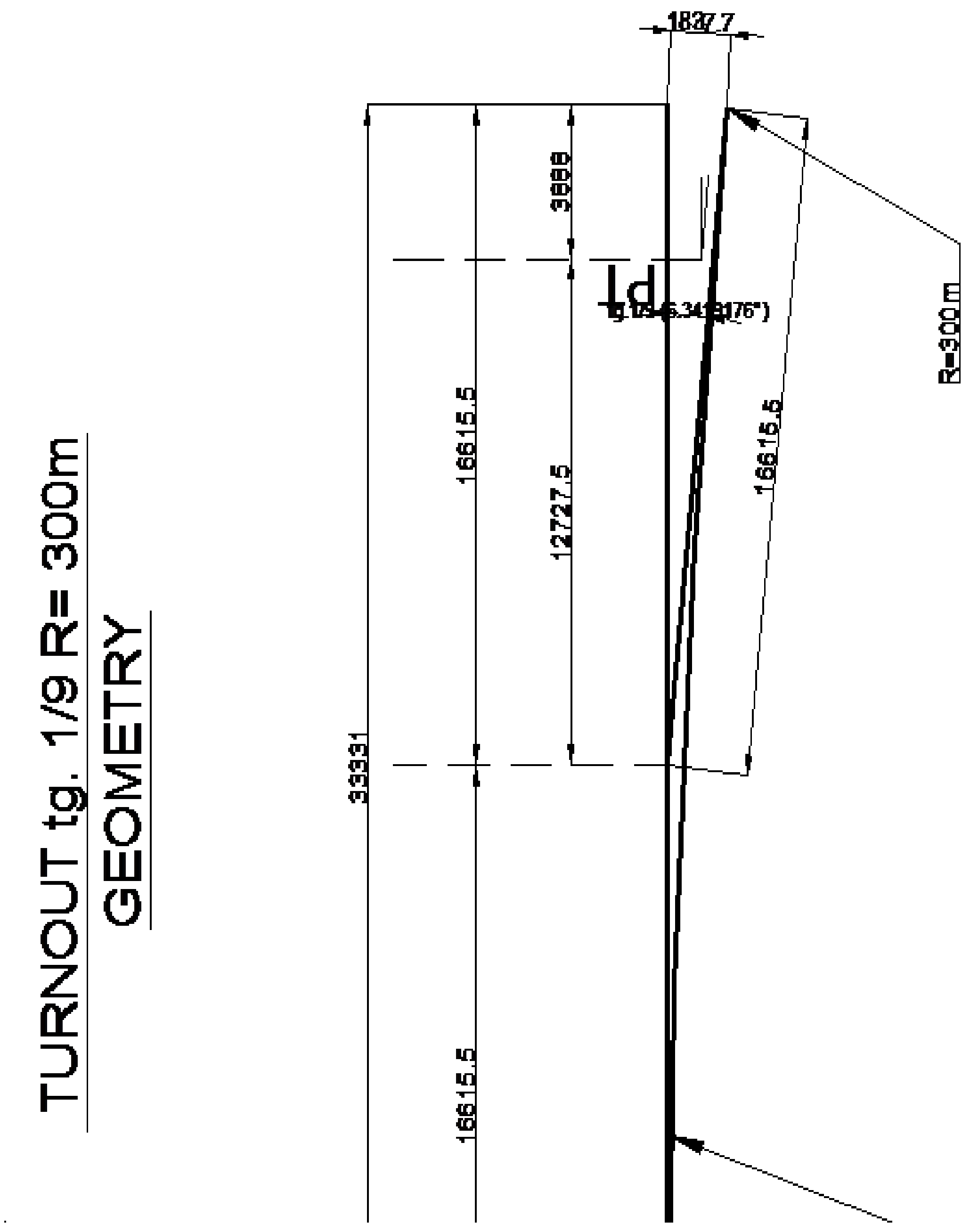

BALLASTLESS TRACK ON VIADUCT
UIC 60
UIC 60
Rail level
(Min)
Slope 2.5%
Slope 2.5%
5°
5°
NOTE:-
ALL DIMENSION ARE mm UNLESS OTHERWISWISE NOTED
MINIMUM DEPTH OF PLINTH = 175mm.
TYPICAL CROSS SECTION
ON VIADUCT

Fig No. 4.1

Fig No. 4.2


TURNOUT tg. 1/9 R= 300m
GEOMETRY
R=300 m
16615.5
12727.5
16615.5
33331
16615.5

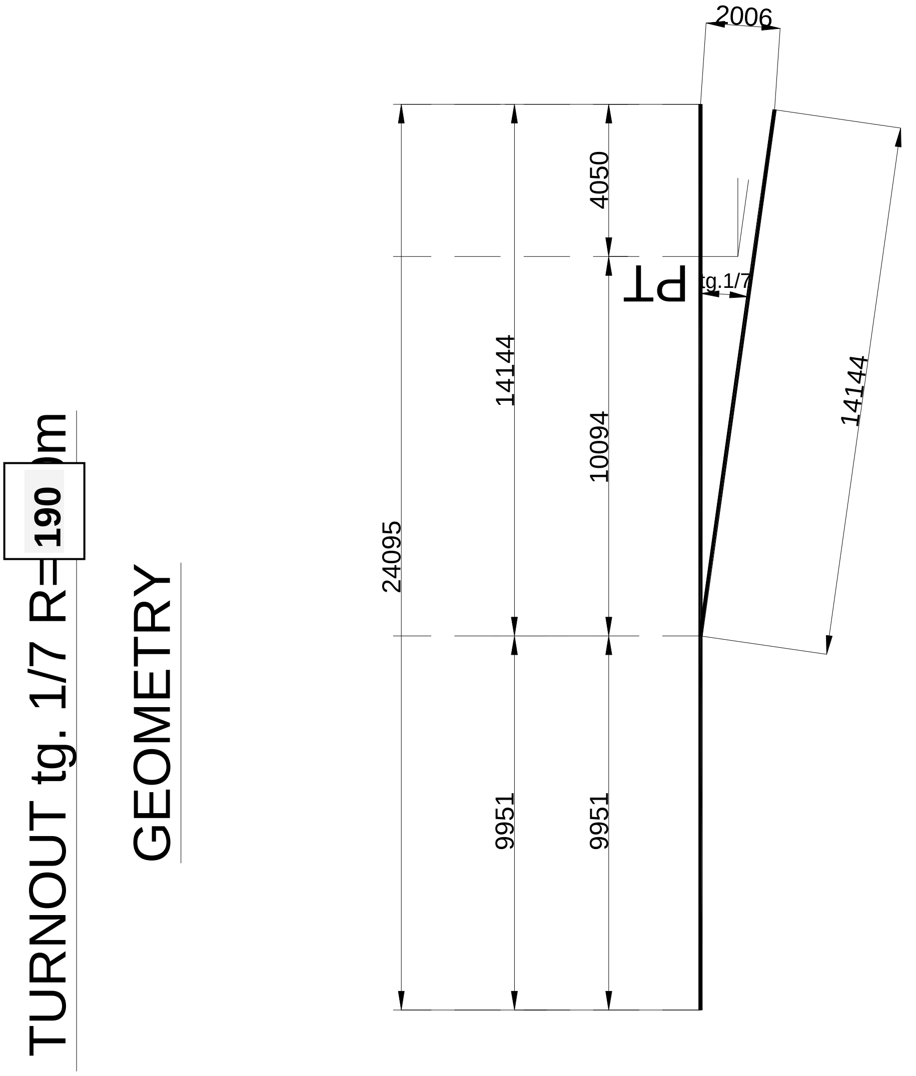

TURNOUT tg. 1/7 R=
190
m
GEOMETRY
2006
4050
PT
tg.1/7
14144
10094
24095
9951
9951
14144

Fig No. 4.3

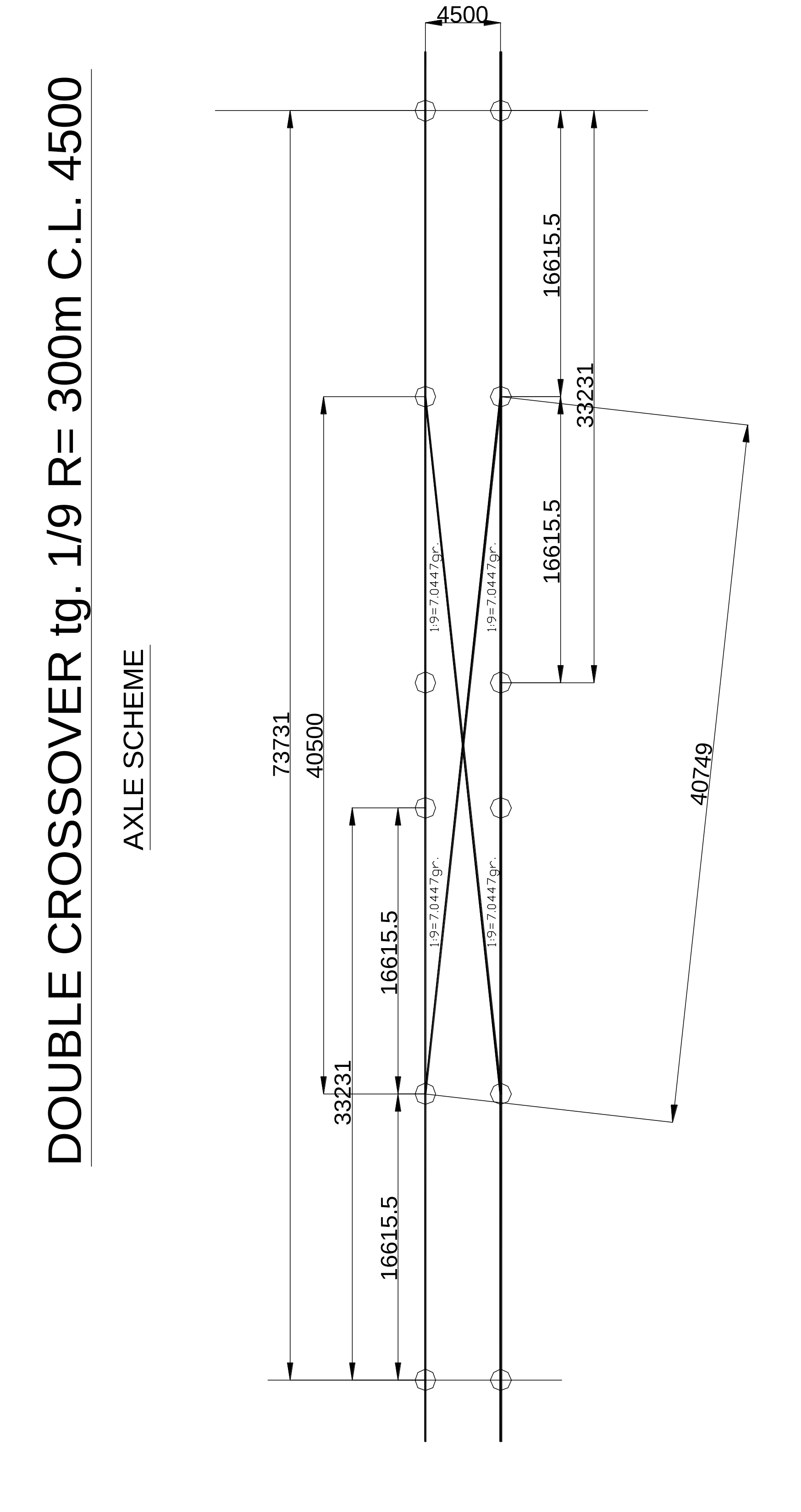

DOUBLE CROSSOVER tg. 1/9 R= 300m C.L. 4500
AXLE SCHEME
4500
16615.5
33231
16615.5
73731
40500
40749
1:9=7.0447gr.
1:9=7.0447gr.
1:9=7.0447gr.
1:9=7.0447gr.
16615.5
33231
16615.5

Fig No. 4.4

4.4 ALIGNMENT

4.4.1 Introduction

- First station on this Corridor is India Gate (SIA) and last station is Ambabari.

- Chainage of India Gate (SIA) station is considered as 0.0 for reference and dead-end chainage of this station is kept as (-) 350m.

- Total length of the corridor from dead end to dead end is 23.51km. The entire corridor proposed is elevated.

- Twenty-one stations have been proposed on this corridor. Names of stations are India Gate(SIA), Kumbha Marg, Haldi Ghati Gate, Pinjra Pole Gaushala, Sanganer Sethu, B2 Bypass Circle, Durgapura, Mahaveer Nagar, Dev Nagar, Gandhi Nagar, Tonk Phatak, Ram Bagh Circle, Narayan Singh Circle, SMS Hospital, Ashok Marg, Government Hostel, Chandpole, Collectorate, Subhash Nagar, Panipech And Ambabari. Attempt has been made to locate stations at about a kilometer apart. However due to various considerations such as ridership, accessibility, availability of land, design considerations etc; few stations could not be located at one km distance apart. The maximum and minimum inter station distances are 2483.011m and 676.801m respectively. Depot for this corridor has been planned at Sitapura.

- This corridor runs in South to North direction. It connects different areas of the city like Sitapura Industrial Area, Shatabdi Nagar, Pratap Nagar, Sanganer, Sitabari, Bapu Nagar, Rambagh, C Scheme, Chandpole, Bani Park, Sirampura, Ambabari, Prominent hospitals like SMS Hospital, Apollo Spectra, Zanana and also connects Jaipur International Airport.

4.4.2 Station Locations

- Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport such as Railway Stations, Bus Terminals, etc. However effort has also been made to propose station locations, such that inter station distances are as uniform as possible. The average spacing of stations is close to one km.

- All stations will be two level stations but without concourse. At lower level there will be a Foot Over Bridge (FOB), providing un-paid connection between left and right side of the road. The FOB will also comprise of passenger facilities and station facilities like ticketing, etc. Platforms along with AFC gates will be provided on the higher level.

4.4.3 Terminals

1. **India Gate (SIA) Terminal**

   This Station is proposed along the road median (on Tonk Road) in Sanganer area, near Sanganer Sadar Police Station. Scissors crossovers are proposed at the rear end of station.

2. Ambabari Terminal

This Station is proposed on right edge of Sikar Road/Jhotwara Road in Vidyadhar Nagar area. Scissors crossovers are proposed at the front end of the station.

4.4.4 Scissors Crossovers

Scissors Crossovers will be provided at both the terminal stations. In between, crossovers are proposed at Kumbha Marg, Mahaveer Nagar, Ram Bagh Circle and Collectorate station.

4.4.5 Depot

It is proposed to provide a depot on land identified at Sitapura Industrial Area on the banks of Dravyavati River. Total area for depot land will be 27 Ha.

4.4.6 Description of Alignment

1. Horizontal Alignment

The proposed alignment starts from CH: -350.0 m and first station is named as India Gate (SIA), located at CH: 0.0 m. This station is proposed off the median of Tonk road.

The alignment starts near Sanganer Sadar Police Station and runs along the median of Tonk Road. First station of this corridor is India Gate (SIA). It is is proposed at Ch. 0.0 on straight alignment. After this station, the alignment continues along the median of Tonk Road. Next station is Kumbha Marg, proposed at chainage 1599.564m along the road median. It is proposed on a straight alignment, at the junction of Tonk Road with Kumbha Marg. It is proposed to connect Sitapura Depot with this station, using 1 in 9 turnouts. Thereafter also, alignment continues to run along the road median. Next station is Haldi Ghati Gate at Ch. 2439.871m. This station is proposed on the median of Tonk Road, just before Haldighati road junction. After this station, the alignment again continues along the road median till next station. Next station is Pinjra Pole Gaushala at Ch. 3357.734m. This station is proposed adjacent to Pinjrapol Gaushala on a straight alignment. Soon after this station the alignment turns left from ch. 3412.727m with a curve of 125m and goes off the road. After a straight section of 118.27m, it turns right with a curve of 200m. It continues off the road with a straight length of 463.181m and then again turns right with a curve of 125m and runs parallel to Dravyavati River. It continues off the road, parallel to river and crosses New Sanganer Road near ch. 5375m. Just after crossing New Sanganer Road, next station i.e. Sanganer Sethu is proposed at ch. 5431.316m. Thereafter also it continues by the side of the river till ch. 6043.339m from where it turns right with a curve of 125m and moves away from Dravyavati River. After a straight section of 330.206m, it again turns right to move towards Tonk Road. From ch. 6921.823m, before Pink City Garden, it turns left with 125m curve to run onto the centerline of Tonk Road. It runs along the road median. Next station is B2 Bypass Circle at ch. 7914.327m. Soon after this station, from ch. 8000 – 8100m it crosses Jaipur-Jodhpur National Highway/B-2 Bypass Road. From ch. 8457m it goes onto Durgapura Flyover and runs along its centerline. At Durgapura provision for extension of piers/columns for construction of metro corridor is already there, thus the same can be used. Next station is Durgapura at ch. 9219.655m. This station is proposed over Durgapura Flyover near Durgapura Bus Stand. It is proposed on a curved alignment. After this station the alignment continues over the centerline of Durgapura Flyover. After the flyover ends, the alignment runs over the centerline of Tonk Road. Next station is Mahaveer Nagar at ch. 9984.491m. It continues along the median of Tonk Road till chainage 10304.519m, thereafter it turns left with reverse curve of 800m, goes onto Sawai Mansingh Road and runs by the side of the bridge/flyover. It continues along Sawai Mansingh Road, crosses Gopalpura Bypass Road from ch. 10625m to 10670m and thereafter from ch. 10742.294m it turns right with reverse curve of 800m to run onto median of Tonk Road. Next station i.e. Dev Nagar is proposed at ch. 11028.593m near City Square. Alignment continues along the median of Tonk Road, next station is Gandhi Nagar at ch. 11705.394m. This station is proposed near Gandhi Nagar Rail Station. From ch. 11900m to 12510m there is an existing flyover. This existing flyover will be demolished and new two level integrated structure having road bridge at lower level and metro corridor at higher level will be constructed. Soon after this flyover just before Nehru Bal Udyan, next station is proposed at ch. 12819.654m, named as Tonk Phatak. Hereafter also the alignment continues to run along the median of Tonk Road. Next station is Ram Bagh Circle at ch. 14363.115m. This station is proposed just before Rambagh Circle, adjacent to Sawai Mansingh Stadium. Next station is Narayan Singh Circle at ch. 15069.586m, proposed before Narayan Singh Circle FOB, adjacent to Narayan Singh Circle Bus Stand. Thereafter it continues along the median of Tonk Road. Next station is SMS Hospital at ch. 16085.106m, proposed in front of SMS Hospital. After this station, alignment will further continue along the median of Tonk Road/Sawai Mansingh Road till University Maharani's College (ch. 16482.672m), from here it will turn left with a curve of 125m to run on the left side of Ashok Marg. Since the road width of Ashok Marg is less that the desired ROW, thus the alignment is kept over the left footpath (south side) of the road i.e. at a distance of 8m from centerline of road. There is no structure closer to the compound wall, on the south side of the road, therefore some of the deck width of the viaduct will be projected in the open area of University Maharani's College, St. Xaviers School, St. Xaviers Church and Annie Besant Hostel. Next station is Ashok Marg at ch. 17516.843m, proposed about 100m before Ahinsa Circle on the left edge of the road, in front of Krishna, Gokhle and Vinobha Marg. From chainage 17600m to 17660m, it crosses Ahinsa Circle and continues along the left edge of Ashok Marg till ch. 18069.177, from here it turns right with a curve of 125m to run onto the median of Sardar Patel Marg. Just after this turn, next station i.e. Government Hostel is proposed at chainage 18332.952m. This station is followed by junction of SP/SC Marg and MI Road. Now the alignment runs along the median of Sansarchandra Road. Next station is Chandpole proposed at ch. 19372.919m on SC road, adjacent to existing operational Chandpole station of Jaipur Metro Corridor. After this station, from ch. 19430.795m, alignment turns left with a curve of 125m and runs onto Jhotwara Road. Now it runs along the median of Jhotwara Road, next station is Collectorate at ch. 20252.507m in front of SSG Pareek Public School/SSG Pareek PG College of Education, just before the road junction of Jhotwara Road/SC Road and Shiv Marg. It continues along the median of Jhotwara Road/SC Road. Next station is Subhash Nagar at ch. 21382.664m near Doodhmandi Bus Stand. It continues along the same road till ch. 22100m, hereafter near the Office of Inspector

General, Rajasthan Police, it goes off the road. Next station is Panipech at ch. 22223.813m, this station is proposed off the road. It continues off the road, crosses Dravyavati River from ch. 22509m to 22545m and runs onto the right edge of Sikar Road. Next station is terminal station of this corridor. It is named as Ambabari, proposed on the right side of Sikar Road, near Ambabari Vegetable Market at ch. 23060m. The corridor terminates at chainage 23160m (Dead end).

Critical Locations along the Corridor:

1. **Alignment Options for passing through Air Funnel:**
Alignment is passing on the Tonk Road by the side of the airport. It cannot be planned elevated due to height restrictions in Air Funnel area, therefore two options envisaged as under:

- Option-1: Detoured elevated route from Pinjra Pole Gaushala to Gupta Nursery
- Option-2: Straight underground route along the Tonk Road through Air Funnel Jaipur Airport

Pros and cons of both the options are tabulated below:

S.No.	Item Description	Option-1	Option-2	Remarks
1	Route Length	23.51 km	22.31 km	Route Length of the corridor along Option-1 is 1.2km more than Option-2
2	Estimated Cost	Rs. 4133 Cr.	Rs. 4231 Cr.	Estimated cost of the project for Option-1 is Rs. 98 Crore lower than Option-2 due to 1.49km of underground section and 1 underground station along Option-2
3	Daily Ridership	2,03,161 (in 2023) 9,97,216 (in 2051)	2,04,548 (in 2023) 10,34,097 (in 2051)	Daily ridership of the corridor decreases via Option-1 by 1,387 & 36,881 in the year 2023 & 2051 respectively
4	Proximity with Domestic Airport Terminal	About 1.125km	About 0.43km	In both the options, station is not directly connected with Domestic Airport Terminal, but will be connected through dedicated bus service
5	Ease of Construction	Easy to construct and less time	Difficult to construct and more time	Option-2 will be difficult to construct and will require more time compared to Option-1

S.No.	Item Description	Option-1	Option-2	Remarks
		consuming	consuming	due to 1.46km of underground portion in it
6	Land Acquisition	Option-1 will involve demolition of Private Residential Houses, passes through Pinjra Pole Gaushala and Gupta Nursery Farm, whereas Option-2 will involve demolition of some of the Police & Airport Authority of India (AAI) Quarters and Commercial Shops		
7	Environmental Issues	More Sensitive	Less Sensitive	Option-1 is environmentally more sensitive compared to Option-2, since passing through Gaushala and Gupta Nursery Farm will involve cutting of about 150 trees, whereas through Air Funnel will involve cutting of about 20 trees

It may be concluded from the above comparison that ridership in Option-1 is lower than Option-2. Although Option-1 is lengthier, but overall cost of construction is less than Option-2. In view of above, Option-1 is proposed and DPR has been prepared accordingly.

2. Alignment Options for passing through Collectorate:

ROW of Shiv Marg is only 15m, which is less than the desired ROW for construction of Elevated Viaduct in the center of the road. About 2.5m width is required to place piers at the center of the road and during construction about 9m width of road is required to be occupied for a period of about 2 years. Therefore, during construction there will be hardly any space for movement of traffic. It is practically not possible to close the road for traffic movement for such a long time. Further, viaduct can be supported on portal frame structure constructing two columns on both side of the road, instead of single column over the central verge of the road to keep carriageway of the road free from any obstruction, but this will increase cost as well as time of construction, therefore two options envisaged as under:

- Option-1: Straight alignment via Jhotwara Road
- Option-2: Alignment through Collectorate Circle via Shiv Marg

Pros and cons of both the options are tabulated below:

S.No.	Item Description	Option-1	Option-2	Remarks
1	Route Length	23.51 km	24.42 km	Route Length of the corridor along Option-1 is about 907m lesser than Option-2
2	Estimated Cost	Rs. 4133 Cr.	Rs. 4212 Cr.	Estimated cost of the

S.No.	Item Description	Option-1	Option-2	Remarks
				project for Option-1 is Rs. 79 Crore lower than Option-2 because the length of corridor along Option-2 is 907m more than Option-1, moreover cost of alignment and formation along Shiv Marg will also be higher because portal frame will be required for construction due to less road width of Shiv Marg(15m)
3	Daily Ridership	2,03,161 (in 2023) 9,97,216 (in 2051)	2,01,858 (in 2023) 9,96,526 (in 2051)	For option-1 ridership estimations are done considering dedicated bus service with integrated fares will be provided to and from Collectorate, thus Daily ridership of the corridor increases along Option-1 by 1,303 and 690 in the year 2023 & 2051 respectively.
4	Ease of Construction	Easier than Option-2	Difficult compared to Option-1	Option-2 will be difficult to construct and will require more time compared to Option-1, due to less road width of Shiv Marg. Moreover, due to less road width of Shiv Marg, viaduct will be supported on double column portal frame instead of columns over the central verge of the road, Shiv Marg will need to be closed during construction for a period of about 1.5 to 2 years

It may be concluded from the above comparison that ridership in Option-1 is marginally higher compared to Option-2 (considering dedicated bus service for

Collectorate with integrated fare). Moreover Option-1 is shorter in length and will be easier to construct. Cost of construction in Option-1 will also be less than Option-2. In view of above, Option-1 is proposed and DPR has been prepared accordingly.

3. Route alignment via Ashok Marg

Since the road width of Ashok Marg is less that the desired ROW, thus the alignment is kept over the left footpath (south side) of the road i.e. at a distance of 8m from centerline of road. There is no structure closer to the compound wall, on the south side of the road, therefore some of the deck width of the viaduct will be projected in the open area of University Maharani's College, St. Xaviers School, St. Xaviers Church and Annie Besant Hostel.

Curvature:

There are many sharp turns and curves along the road. This necessitates provision of curves for metro alignment also. The radius of curves is kept as low as 125 m to reduce the property acquisition. Total 70 Nos. of curves have been provided in the entire length of this Corridor. The details of curves and abstracts of horizontal curves are indicated in Table 4.3 and 4.4 respectively.

Table 4.3: Details of Horizontal Curves

Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle			Tangent (m)	Straight Length (m)
				L1	L2	D	M	S		822.063
1	Right	4750	25.616	20	20	00	18	32	12.808	1524.694
2	Left	7250	25.896	20	20	00	12	16	12.948	668.118
3	Right	9000	77.580	20	20	00	29	38	38.790	498.760
4	Left	125	120.219	55	55	55	06	14	65.215	118.627
5	Right	200	62.107	55	55	17	47	32	31.306	463.181
6	Right	125	93.897	55	55	43	02	20	49.288	31.855
7	Left	600	51.690	45	45	04	56	09	25.861	420.037
8	Right	1010	376.600	25	25	21	21	50	190.512	0.000
9	Left	520	263.889	50	50	29	04	35	134.851	58.511
10	Right	125	55.257	55	55	25	19	40	28.087	330.206
11	Right	125	95.336	55	55	43	41	55	50.121	177.685
12	Left	125	142.337	55	55	65	14	33	80.006	272.491
13	Right	1200	87.870	20	20	04	11	43	43.955	180.640
14	Left	3000	154.390	20	20	02	56	55	77.212	167.618
15	Left	10000	29.642	20	20	00	10	11	14.821	35.012
16	Right	10000	33.251	20	20	00	11	25	16.625	113.741
17	Right	5500	28.357	20	20	00	17	43	14.178	62.976
18	Right	1350	109.260	25	25	04	38	13	54.660	60.874
19	Right	2000	32.044	20	20	00	55	04	16.022	0.000
20	Left	1500	35.526	25	25	01	21	25	17.764	131.607
21	Right	1350	47.246	20	20	02	00	18	23.625	37.406
22	Right	1010	94.334	20	20	05	21	05	47.202	120.618
23	Left	1250	85.955	20	20	03	56	23	42.994	709.500
24	Left	800	33.647	40	40	02	24	35	16.826	0.000

Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle			Tangent (m)	Straight Length (m)
				L1	L2	D	M	S		822.063
25	Right	800	35.591	40	40	02	32	56	17.798	248.537
26	Right	800	29.203	40	40	02	05	29	14.603	0.000
27	Left	800	32.616	40	40	02	20	09	16.310	321.264
28	Left	5000	27.622	10	10	00	18	59	13.811	33.146
29	Right	3250	25.040	15	15	00	26	29	12.520	25.898
30	Left	3250	26.336	15	15	00	27	51	13.168	57.705
31	Left	1850	25.584	20	20	00	47	32	12.792	49.025
32	Left	3350	25.724	10	10	00	26	23	12.862	67.547
33	Right	2750	119.517	20	20	02	29	24	59.768	114.216
34	Right	950	115.972	30	30	06	59	39	58.058	254.534
35	Right	1500	70.874	20	20	02	42	25	35.444	104.430
36	Right	1650	96.668	25	25	03	21	24	48.348	77.961
37	Right	2750	31.148	15	15	00	38	56	15.574	135.980
38	Left	2750	25.996	20	20	00	32	29	12.998	321.899
39	Right	1275	279.234	20	20	12	32	53	140.178	416.224
40	Left	5700	25.533	15	15	00	15	23	12.766	187.282
41	Right	3750	25.715	20	20	00	23	34	12.857	54.639
42	Left	1350	25.266	20	20	01	04	20	12.633	90.120
43	Left	1500	37.778	20	20	01	26	34	18.890	126.563
44	Left	7500	118.076	15	15	00	54	07	59.039	0.000
45	Right	5000	27.786	25	25	00	19	06	13.893	47.501
46	Left	350	26.349	55	55	04	18	47	13.18	40.412
47	Left	3250	93.16	15	15	01	38	32	46.583	76.694
48	Left	710	25.591	35	35	02	03	54	12.797	57.244
49	Right	3250	29.907	15	15	00	31	38	14.954	75.799
50	Left	595	25.039	45	45	02	24	40	12.521	232.714
51	Left	2750	25.677	20	20	00	32	05	12.839	44.515
52	Right	600	19.656	45	45	01	52	37	9.829	0.000
53	Left	125	140.91	55	55	64	35	18	79.004	826.682
54	Right	2000	32.266	20	20	00	55	27	16.133	381.645
55	Right	125	154.586	55	55	70	51	25	88.927	100.339
56	Left	670	26.414	35	35	02	15	31	13.209	0.000
57	Right	200	28.123	55	55	08	03	23	14.085	57.928
58	Right	950	154.821	30	30	09	20	14	77.582	0.000
59	Left	850	169.988	35	35	11	27	29	85.278	128.189
60	Left	1100	26.998	20	20	01	24	22	13.5	109.234
61	Left	125	170.629	55	55	78	12	37	101.604	96.886
62	Right	310	50.442	55	55	09	19	22	25.277	538.656
63	Left	350	31.133	55	55	05	05	47	15.577	320.872
64	Right	1010	152.474	25	25	08	38	58	76.382	562.567
65	Left	4700	25.708	15	15	00	18	48	12.854	109.425
66	Left	200	30.128	55	55	08	37	52	15.093	472.363
67	Left	750	26.996	45	45	02	03	44	13.5	280.382
68	Right	650	25.233	35	35	02	13	27	12.618	0.000
69	Left	1010	82.294	25	25	04	40	06	41.17	139.878
70	Right	125	126.458	53.585	55	57	57	50	69.237	318.621

Table 4.4: Abstract of Horizontal Curves

S. No.	Radius (m)	Nos. Occurrences	Curved Length with TL(m)	% w. r. t. total curved length
1	>125m - 500m	15	2976.496	31.43%
2	>500m - 1020m	19	3112.048	32.87%
3	>1020m - 1500m	10	1226.007	12.95%
4	>1500m - 5000m	19	1555.904	16.43%
5	>5000m - 10000m	7	598.335	6.32%
	Total	**70**	**9468.79**	**100.00%**

2. Vertical Alignment

Vertical alignment has been designed with consideration of 5.5 m clear head room on the road. Minimum height difference from existing road level and proposed rail levels is about 10.2m at station locations and for other than station locations it is 8.5m (Double U Girder) and 9.8m (Box Girder). Efforts have been made to maintain minimum radius of vertical curves of 2500 m. However it is not possible to maintain this at certain locations due to space constraints or overlapping with the transition length of Horizontal curves. At such locations minimum vertical curve radius is 1500m. Length of vertical curve provided is more than 20m. Overlap between transition curves and vertical curves are strictly avoided. All proposed stations are kept on level gradient. The maximum gradient used is not steeper than 3.346%. Detailed description of vertical alignment is as follows:

The proposed rail levels are given in **Table 4.5** and abstracts of gradients are given in **Table 4.6.**

Table 4.5: Proposed Gradients of Rail Track (Vertical Curve Details)

S. No.	Chainage		Length	Rail Level		Gradient	Remarks
	From	To		From	To		
1	-350.000	150.000	500.000	375.000	375.000	0.000%	LEVEL
2	150.000	410.000	260.000	375.000	373.800	-0.462%	FALL
3	410.000	960.000	550.000	373.800	375.300	0.273%	RISE
4	960.000	1220.000	260.000	375.300	378.700	1.308%	RISE
5	1220.000	1780.000	560.000	378.700	378.700	0.000%	LEVEL
6	1780.000	2020.000	240.000	378.700	375.900	-1.167%	FALL
7	2020.000	2350.000	330.000	375.900	380.800	1.485%	RISE
8	2350.000	2540.000	190.000	380.800	380.800	0.000%	LEVEL
9	2540.000	2960.000	420.000	380.800	382.000	0.286%	RISE
10	2960.000	3270.000	310.000	382.000	385.700	1.194%	RISE
11	3270.000	3510.000	240.000	385.700	385.700	0.000%	LEVEL
12	3510.000	3850.000	340.000	385.700	381.400	-1.265%	FALL
13	3850.000	4220.000	370.000	381.400	382.500	0.297%	RISE
14	4220.000	4360.000	140.000	382.500	383.500	0.714%	RISE
15	4360.000	5080.000	720.000	383.500	385.500	0.278%	RISE
16	5080.000	5340.000	260.000	385.500	387.400	0.731%	RISE

S. No.	Chainage		Length	Rail Level		Gradient	Remarks
	From	To		From	To		
17	5340.000	5520.000	180.000	387.400	387.400	0.000%	LEVEL
18	5520.000	5830.000	310.000	387.400	384.000	-1.097%	FALL
19	5830.000	6130.000	300.000	384.000	383.500	-0.167%	FALL
20	6130.000	6480.000	350.000	383.500	389.500	1.714%	RISE
21	6480.000	6830.000	350.000	389.500	391.700	0.629%	RISE
22	6830.000	7080.000	250.000	391.700	396.000	1.720%	RISE
23	7080.000	7400.000	320.000	396.000	396.700	0.219%	RISE
24	7400.000	7820.000	420.000	396.700	402.200	1.310%	RISE
25	7820.000	8030.000	210.000	402.200	402.200	0.000%	LEVEL
26	8030.000	8380.000	350.000	402.200	402.800	0.171%	RISE
27	8380.000	8730.000	350.000	402.800	413.000	2.914%	RISE
28	8730.000	9092.623	362.623	413.000	419.200	1.710%	RISE
29	9092.623	9350.000	257.377	419.200	419.200	0.000%	LEVEL
30	9350.000	9610.000	260.000	419.200	410.500	-3.346%	FALL
31	9610.000	9830.000	220.000	410.500	415.100	2.091%	RISE
32	9830.000	10140.000	310.000	415.100	415.100	0.000%	LEVEL
33	10140.000	10321.342	181.342	415.100	417.500	1.323%	RISE
34	10321.342	10640.000	318.658	417.500	426.000	2.667%	RISE
35	10640.000	10907.806	267.806	426.000	423.300	-1.008%	FALL
36	10907.806	11120.000	212.194	423.300	423.300	0.000%	LEVEL
37	11120.000	11349.572	229.572	423.300	423.600	0.131%	RISE
38	11349.572	11593.916	244.344	423.600	427.700	1.678%	RISE
39	11593.916	11840.000	246.084	427.700	427.700	0.000%	LEVEL
40	11840.000	12170.000	330.000	427.700	436.400	2.636%	RISE
41	12170.000	12680.000	510.000	436.400	432.400	-0.784%	FALL
42	12680.000	12910.000	230.000	432.400	432.400	0.000%	LEVEL
43	12910.000	13260.000	350.000	432.400	433.500	0.314%	RISE
44	13260.000	13620.000	360.000	433.500	437.200	1.028%	RISE
45	13620.000	13940.000	320.000	437.200	438.400	0.375%	RISE
46	13940.000	14150.000	210.000	438.400	441.700	1.571%	RISE
47	14150.000	14590.000	440.000	441.700	441.700	0.000%	LEVEL
48	14590.000	14750.000	160.000	441.700	442.500	0.500%	RISE
49	14750.000	14940.000	190.000	442.500	444.000	0.789%	RISE
50	14940.000	15225.000	285.000	444.000	444.000	0.000%	LEVEL
51	15225.000	15580.000	355.000	444.000	442.900	-0.310%	FALL
52	15580.000	15880.000	300.000	442.900	444.900	0.667%	RISE
53	15880.000	16180.000	300.000	444.900	444.900	0.000%	LEVEL
54	16180.000	16580.000	400.000	444.900	443.500	-0.350%	FALL

S. No.	Chainage		Length	Rail Level		Gradient	Remarks
	From	To		From	To		
55	16580.000	16980.000	400.000	443.500	441.000	-0.625%	FALL
56	16980.000	17420.000	440.000	441.000	440.500	-0.114%	FALL
57	17420.000	17670.000	250.000	440.500	440.500	0.000%	LEVEL
58	17670.000	17930.000	260.000	440.500	439.500	-0.385%	FALL
59	17930.000	18190.000	260.000	439.500	443.100	1.385%	RISE
60	18190.000	18427.309	237.309	443.100	443.100	0.000%	LEVEL
61	18427.309	18820.000	392.691	443.100	445.000	0.484%	RISE
62	18820.000	19220.000	400.000	445.000	450.000	1.250%	RISE
63	19220.000	19530.000	310.000	450.000	450.000	0.000%	LEVEL
64	19530.000	19770.000	240.000	450.000	451.000	0.417%	RISE
65	19770.000	20100.000	330.000	451.000	457.200	1.879%	RISE
66	20100.000	20410.000	310.000	457.200	457.200	0.000%	LEVEL
67	20410.000	20860.000	450.000	457.200	457.000	-0.044%	FALL
68	20860.000	21290.000	430.000	457.000	458.800	0.419%	RISE
69	21290.000	21480.000	190.000	458.800	458.800	0.000%	LEVEL
70	21480.000	21820.000	340.000	458.800	457.800	-0.294%	FALL
71	21820.000	22120.000	300.000	457.800	455.600	-0.733%	FALL
72	22120.000	22310.000	190.000	455.600	455.600	0.000%	LEVEL
73	22310.000	22680.000	370.000	455.600	458.200	0.703%	RISE
74	22680.000	23830.525	1150.525	458.200	458.200	0.000%	LEVEL

Table 4.6: Abstract of Gradients

S. No.	Description	Nos. Occurrences	Length (m)	% w. r. t. Total Alignment length
1	Level	21	6798.489	28.12%
2	> 0% to = 1%	30	10477.263	43.33%
3	> 1% to = 2%	18	5426.115	22.44%
4	> 2% to = 3.7%	5	1478.658	6.11%
	Total	**74**	**24180.525**	**100.00%**

Annexure-4.1

SELECTION OF TYPE OF ALIGNMENT

The metro network may have the under-mentioned three types of alignments:

1. At-Grade
2. Elevated
3. Under-ground

1. At Grade - At-Grade type of alignment is technically feasible only in the areas where vacant land is available or a dedicated corridor of 14 meters width is provided in the mid of the road. However, the main limitation of providing At-Grade corridor is that city is divided in two parts and any crossing from one side to other side of At-Grade corridor has to be provided by grade separation i.e., either foot-over bridge or under passes. This alternative is the most economical. However, it should be noted that cost saving is only in Civil Engineering cost which is arrived if the land cost requirement for at grade alignment is taken into account and cost per km may come even more than elevated. Therefore, At-Grade type of alignment for metro systems in cities is normally ruled out.

2. Elevated – Elevated alignment is generally provided in the cities for metro network, but the pre-requisite is the right of way (ROW) of road should minimum be 20 meters. It will enable to provide a median of about 2.8 to 3.0 meters wide road, two lane each way (7 meters width) and foot-path 1.5 meter each way. The land requirement for elevated alignment is mainly for the exit and entries for the station. As the alignment pillars located on median of the roads, a rough estimate of land requirement is about 240 sq. meters on either side of the road, wherein even underground water tank and generator rooms can be accommodated under the staircase. Construction of elevated station is much easier, 8 meter wide strip for the platform length (say 185 meters) will be required temporarily for putting the pillars on the median. Small area of about 400 sq. meters is needed for execution of the work of exit and entries on either side of the road.

3. Under-ground – This type of alignment is adopted only in case when ROW is less than 20 meters and alignment has to necessarily pass through the area where no roads are available. In this case only station locations where metro stations can conveniently be located are identified and these are joined by under-ground tunnels. However, under-ground station need much ground surface area than elevated station for the reasons that in case of under-ground station, there is a space requirement for chiller plants in addition to exit and entries, which may be almost same as required for elevated station. Normally, the construction of under-ground stations require the area with 240 meters length and 24 meters width which need to be cut open. Finding out such a big space for construction of under-ground station in a congested city and even on passenger roads is very difficult if not impossible. For construction of under-ground station, the traffic is

necessarily required to be diverted. Advantages and dis-advantages of these two types of alignments are given in the table below:

S. No.	Item name	Under-ground alignment	Elevated alignment
1.	Permanent land	More area required	Comparatively less area required
2.	Land requirement for construction	Much more area required. At least twice of what required for elevated station	Area requirement is much less than under-ground
3.	Construction time	At least 5 years	At least 3 and 1/2 years
4.	Cost of construction	2.25 to 2.50 times of elevated cost.	Much cheaper compared to underground
5.	Operation cost	1.25 to 1.5 times of elevated operation cost	Much cheaper compared to underground
6.	Security concern	Under-ground metro stations are more prone to terrorist attacks.	Less prone to terrorist attacks.
7.	Risk	More risk to the passengers during the disruption	Less risk compared to underground.
8.	Drainage Arrangement	Very exhaustive drainage arrangement needed	Very simple arrangement
9.	Ramp	In case of under-ground, when alignment is changes from under-ground to elevated, 11 meters width and 650 meters long land portion is needed for providing the ramp with physical barrier between 2 sides of the city.	There is no requirement of such ramp and land.

The rough estimate of under-ground and elevated alignments for 20 kms length has been made at the price level of March, 2015. The cost per km (without land and Taxes) of under-ground alignment comes to Rs. 412 crores and elevated Rs. 176 crores. It indicates that per kilometre cost of under-ground alignment is about 2.3 times of elevated alignment.

In view of the above, the decision for opting a particular type of alignment has to be taken on techno-economic basis. For country like India, a balance has to be kept in two types of alignments for the reasons that we are already short of funds for our infrastructure projects. It is also recommended that underground alignment be opted only in the stretches where elevated alignment is not possible to provide.

To appreciate the magnitude of land requirement, Ground Level Plans of one Typical elevated station and underground station are put up at Figure-1 & Figure-2 to this appendix.

Figure - 4.5 Typical Elevated Station Layout

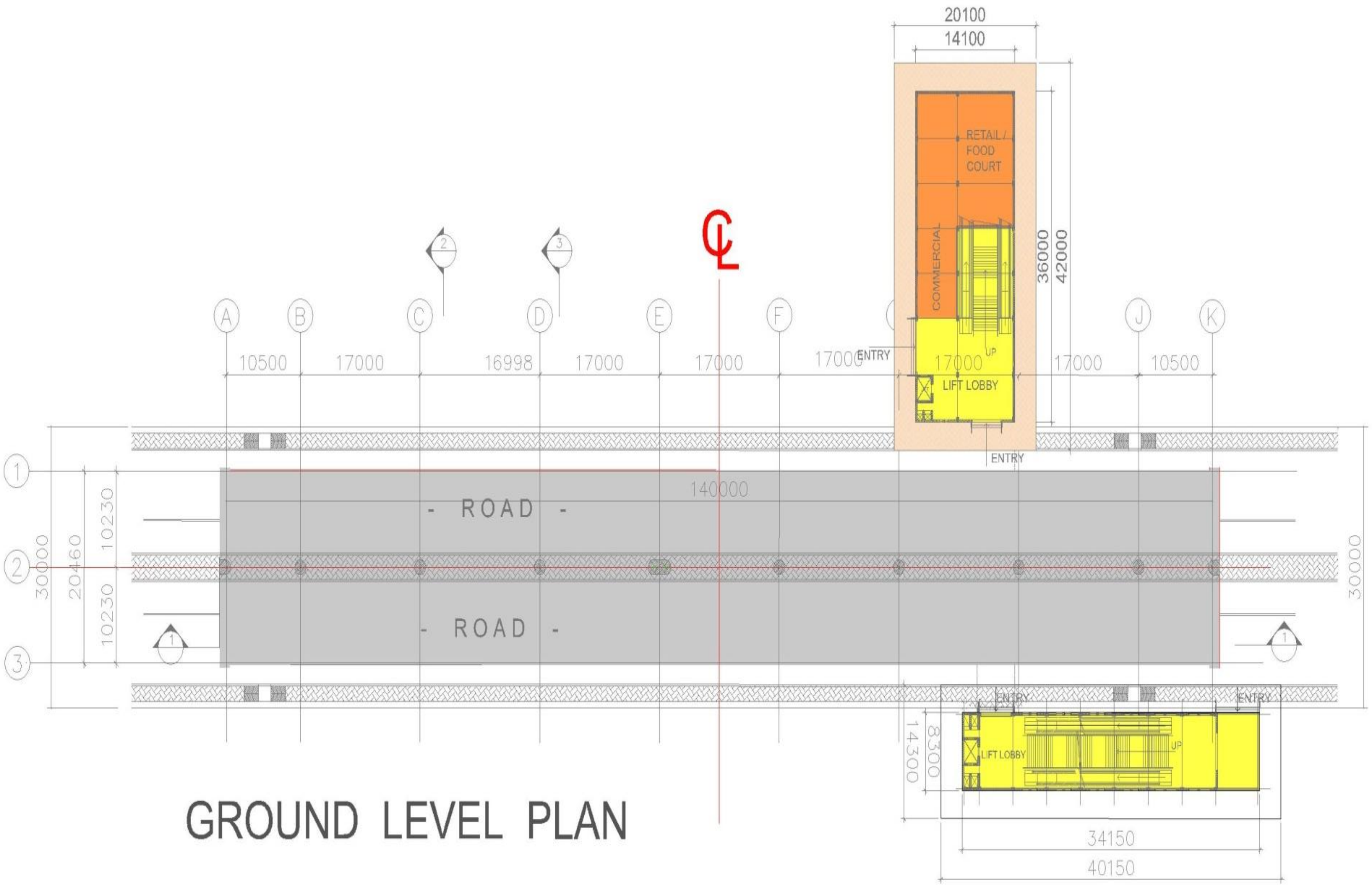
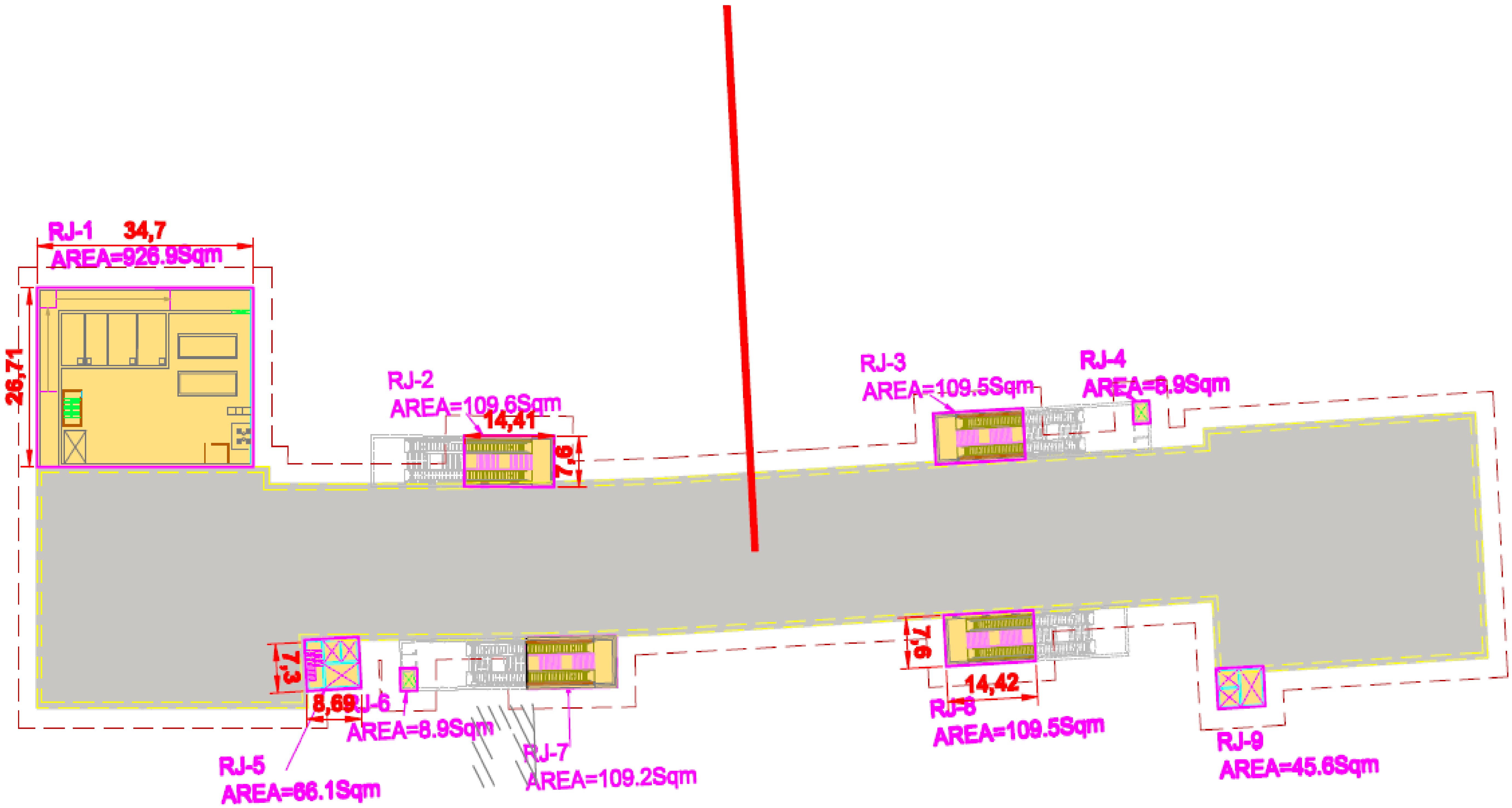
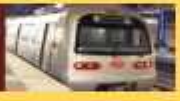


Figure-4.6 Typical Underground Station Layout

Ground Level Plan





CHAPTER 5- CIVIL ENGINEERING

CHAPTER - 5

CIVIL ENGINEERING

5.1 GENERAL

This chapter deals with civil structure, geotechnical investigation, construction methods, land requirements, utility services and traffic diversion during construction etc.

5.2 CIVIL STRUCTURE

5.2.1 Viaduct – Elevated Structure

Choice of Superstructure

The choice of superstructure has been made keeping in view of the factors like ease in construction, standardization of formwork, Optimum utilization of form work for wide spans etc.

Generally four types of Superstructure are used for construction of elevated section of Metro Corridor, i.e. (i) Segmental Box Girder, (ii) Segmental U Girder, (iii) I Girder and (iv) Double U Girder, depending upon characteristic of the corridor such as traffic congestion on roads, available working space, etc.

A. Double U Girder

Following are the merits of Double U-Girder:

- It is an efficient and economical method.
- Its construction permits a reduction of construction time as it may be manufactured while substructure work proceeds and assembled rapidly thereafter.
- This method of construction protects the environment as only space required for foundation and sub-station is required at site. The superstructure is manufactured at a place away from busy areas and placement of superstructure is done at site.
- Girders are easy to stack in the casting yard/stacking yard in more than one layer, thereby saving in requirement of space.
- Interference to the traffic during construction is significantly reduced.
- It contributes towards aesthetically pleasing structures and good finishes.
- The overall labour requirement is less than that for conventional methods.
- Better quality control is possible in the casting yard.
- During construction, the technique shows an exceptionally high record of safety.

B. Pre-cast Segmental Box Girder using External Unbounded Tendons.

This essentially consists of precast segmental construction with external pre-stressing with proper jointing technique and hence considered most preferred technique in fast track projects. In this construction, the pre-stressing tendons are placed outside the structural concrete (inside the box section) and protected with high density polyethylene tubes, which are grouted with special wax or cement. The match-cast joints at the interface of two segments are provided with shear keys.

The main advantages of externally pre-stressed precast segmental construction are as follows:-

- Simplification of all post-tensioning operations, especially in installation of tendons.
- Reduction in the thickness of structural concrete, as no space is occupied by the tendons inside the concrete.
- Good protection from the corrosion, as the tendons are covered with polyethylene ducts. The grout inspection is easier and leaks if any, can be identified during the grouting process.
- Simplified segment casting, as there is no concern about alignment of tendons.
- Increased speed of construction.
- Replacement of tendons can be done in safe and convenient manner in case of distress.
- Possible for inspection and monitoring of tendons, throughout the life of structure.

However, there are few disadvantages also in this type of construction, like:

i) Parapets are to be provided separately after launching of box guider is completed. This takes some extra time in the construction.

ii) Rail level is about 1 m higher as compared to U-girder.

In view of above, it is recommended to use Segmental Box Girder for the section having road width upto 30m and for the section having road width more than 30m, it is recommended to use Double U-Girder upto radius 300m. For Radius less than 300 m and at locations where point and crossing are to be provided, it is suggested to use I-Girder.

5.3 CONSTRUCTION METHODOLOGY

5.3.1 Pre-Cast Construction

5.3.1.1 Casting of Girders

It requires a casting yard for pre-casting Double U-Girders/ Box Girders for viaducts. The construction depot will have facilities for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 2.0 ha to 2.5 ha is required for each construction depot.

The girders are cast in casting moulds with pre-tensioning. The girders are water cured for a period of 14 days from the date of casting.

5.3.1.2 Erection of U-Girder

The U-girders are transported from stacking yard to erection point with the means of Hydraulic Multi Axle trailers.

The erection of precast U-Girder is done by means of two mobile cranes of capacity not less than 300 MT each. After erection of U-Girder, bearing pedestal will be concreted for placement of bearing.

5.3.1.3 Launching Scheme of Box Girder

Launching girder is specially designed for launching of segments. The suggested launching scheme is designed in such a way that initially the launching girder is erected on pier head at one end of the work. The segments are lifted in sequence and when the lifting is over, they are dry matched while hanging from the launching girder. After dry matching, the Segments are glued with epoxy and pre-stressed from one end. The girder is lowered on the temporary / permanent bearings after pre-stressing. The launching girder then moves over the launched span, to the next span and the sequence continues.

5.3.2 Structural System of Viaduct

5.3.2.1Superstructure

The superstructure of a large part of the viaduct comprises of simply supported spans. However at major crossing over or along existing bridge, special steel or continuous unit will be provided. These details will be worked out at detailed design stage.

A. Double U Girder

Normally two U-Girders having a soffit width of about 3.8 m (approx) each, accommodates two tracks situated at 4.7 m center to center (c/c). The U-Girder superstructure for almost all the simply supported standard spans will be constructed by precast pre-stressed construction.

The standard length (c/c of piers) of simply supported spans, constructed by precast construction technique, has been proposed as 28.0m. The standard length of U-Girder will be around 28m and usually up-to 35m length can be managed with the help of extended pier cap. For shorter span or at sharper curves (less than 300m), I-Girders will be used.

For major crossings having span greater than 35 m, special continuous units (normally of 3 span construction or steel girders) have been envisaged. All these continuous units (in case provided at obligatory location) will be constructed by cast-in-situ balanced cantilever construction technique.

B. Segmental Box Girder

A Box Girder having a soffit width of about 4 mts (approx.) normally accommodates the two tracks situated at 4.2m center to center (c/c). The superstructure with Box Girder for all simply supported standard spans will be constructed by 'precast pre-stressed segmental construction method' with epoxy bonded joints.

The standard Spans with center to center piers of simply supported spans constructed by precast segmental construction technique has been proposed as 28.0m. The usual segments shall be 3.0m in length except the Diaphragm segments, which shall be 2.0m each. The other spans (c/c of pier) comprises of 31.0 m, 25.0 m, 22.0 m, 19.0 m & 16.0 m, which shall be made by removing/adding usual segments of 3.0 m each from the center of the span.

The pier segment will be finalized based on simply supported span of 31.0m and the same will also be kept for all standard spans of simply supported. For major crossing having spans greater than 31.0m, special continuous units of normally 3 m span construction or steel girders are envisaged. All these continuous units (in case provided at obligatory location) will be constructed cast-in-situ by 'balanced cantilever construction technique'.

5.3.2.2 Substructure

The superstructure of the viaduct will be supported on single cast-in-place RC pier. The shape of the pier follows the flow of forces. For the standard spans, the pier gradually widens at the top to support the bearing under the soffit of the girder. At the preliminary design stage, the size of pier is found to be limited to 1.8m to 2.0 m diameter of circular shape for most of its height, so that it occupies the minimum space at ground level where the alignment often follows the central verge of existing roads.

To prevent the direct collision of vehicle to pier, a Jersey Shaped crash barrier of 1.0 m height above existing road level has been provided all around the pier. A gap of 25 mm has also been provided in between the crash barrier and outer face of pier. The shape of upper part of pier has been so dimensioned that a required clearance of 5.5 m is always available on road side beyond vertical plane drawn on outer face of crash barrier. In such a situation, the minimum height of rail above the existing road is about 8.5m.

The longitudinal center to center spacing of elastomeric/pot bearing over a pier would be about 1.8 m. The space between the elastomeric bearings will be utilized for placing the lifting jack required for the replacement of elastomeric bearing. An outward slope of 1:200 will be provided at pier top for the drainage due to spilling of rainwater, if any.

The transverse spacing between bearings would be about 3.2 m (however its exact dimension to be decided by the DDC).

The orientation and dimensions of the piers for the continuous units or steel girder (simply supported span) have to be carefully selected to ensure minimum occupation at ground level. Since the vertical and horizontal loads will vary from pier to pier, this will be catered to by selecting the appropriate structural dimensions.

5.3.3 Construction of Stations

At all locations, it is proposed to construct 'the elevated stations' over the road without concourse to reduce the cost. To keep the rail level low, it is proposed not to take viaduct through the stations. Thus, a separate structural configuration is required to be proposed, although this may necessitate a break in the launching operations at each station location.

Sub-structure for the station portion will also be similar to that of viaduct and will be carried out in the similar manner. However, in the cross section there will be single viaduct column in the station area, which will be located on the median/footpath and supporting the station girders by a cantilever arm to eliminate the columns in the right of way.

5.3.4 Grade of Concrete

It is proposed to carry out construction work with 'Design mix concrete' through computerized automatic Batching Plants with following grades of concrete for various members considering the design requirements and durability.

i)	Piles	-	M -35
ii)	Pile cap and open foundation	-	M -35
iii)	Piers	-	M -40
iv)	All precast element for viaduct and station	-	M -45
v)	Cantilever piers and portals	-	M -45/M -60
vi)	Other miscellaneous structure	-	M -30

For all the main structures, permeability test on concrete sample is recommended to ensure impermeable concrete.

5.3.5 Reinforcement and pre-stressed Steel

It is proposed to use HYSD 500 or TMT steel as reinforcement bars. For pre-stressing work, low relaxation high tensile steel strands with the configuration 12 K 15 and or 19 K 15 is recommended (confirming to IS:14268).

5.3.6 Road width required during construction

As most of the construction is to be carried out in the middle of the road, central two lanes including median will be required for construction activities. During piling and open foundation work, a width of about 9 m will be required for construction and the same will be barricaded. It is proposed that two lanes are provided for traffic on either side during construction by widening of roads, if necessary. In certain cases, one way traffic may be resorted to.

All these actions will require a minimum period of about 4 to 6 months. During this period, the implementing agency can go ahead with the following preliminary works:

i) Preliminary action for diversion of utility and preparation of estimates thereof.

ii) Reservation of land along the corridor, identification and survey for acquisition.

5.4 GEO-TECHNICAL INVESTIGATION

Fresh Geotechnical Investigation has not been carried out for this corridor. The geotechnical data available in the DPR prepared in 2009 for this corridor has been reproduced.

5.4.1 Details of Bore Holes

Investigation Works

Geotechnical investigation work at site was carried out to determine the existing subsoil strata, proposed type & depth of foundations and safe bearing capacity of foundations required for the proposed Metro Corridors in Jaipur City based on the results of 25 boreholes.

Boring in Soil and Rock

Core drilling was carried out by using rotary type of boring machine with diamond bits of N_X size. Casing of 100/150 mm dia. was advanced up to the firm strata as per IS1892 (1979). The description of bore logs for bore holes drilled as per IS -5313. The bore logs are as under:

Table 5.1: Borehole Details

S. No.	Specified Locations	Bore Hole No.	Depth below ground level (m)
1	Near India Gate Sita Pura (Tonk Road,)	BH -1	30.00 m
2	Near Old Toll Gate Sita Pura (Tonk Road,)	BH -2	30.00 m
3	At Hindustan Petrol Pump, Pratap Nagar, (Tonk Road)	BH-3	30.00 m
4	Gayatri Vihar (Tonk Road)	BH-4	30.00 m
5	Near Sanganer Bridge (Tonk Road)	BH-5	30.00 m
6	Near Flight View Airport Boundary, (Tonk Road)	BH-6	30.00 m
7	At Pink City Garden, (Tonk Road)	BH-7	30.00 m
8	Near City Plax, (Tonk Road)	BH -8	30.00 m
9	At Durgapura Under const. Fly Over	BRTS BH - 1	39.70 m
10	At Durgapura Under const. Fly Over	BRTS BH – 3	39.70 m
11	At Durgapura Under const. Fly Over	BRTS BH – 5	36.25 m
12	At Durgapura Under const. Fly Over	BRTS BH – 7	36.36 m
13	At Durgapura Under const. Fly Over	BRTS BH - 9	36.33 m
14	Near Pawana Restaurant (Tonk Road)	Rev.BH - 1	30.00 m
15	Near City Square Building	Rev.BH –2	30.00 m
16	Near Chankya IAS Academy	Rev.BH - 3	30.00 m
17	Post Office Gandhi Nagar, (Tonk Road)	BH -8	30.00 m
18	Rambagh Circle, (Tonk Road)	BH -9	30.00 m
19	At Central Park, (Tonk Road)	BH -10	30.00 m

S. No.	Specified Locations	Bore Hole No.	Depth below ground level (m)
20	Opp. Gokhale Hostel, (Tonk Road)	BH -11	30.00 m
21	Near Shiv Temple, (Ajmeri Gate Tonk Road)	BH -12	30.00 m
22	Opp. Sanganeri Gate	BH -13	30.00 m
23	Pani Petch Tiraha Bani Park Bani Park	BH - 1	30.00 m
24	Panch Batti Circle MI Road	BH - 3	30.00 m
25	Peetal Factory Bani Park	BH - 2	30.00 m

5.4.2 Field & Laboratory Tests

Standard Penetration Tests

The Standard Penetration Tests were conducted in exploratory bore hole at different depths as per the procedure stipulated in IS: 2131. Number of blows required for each 15 cm penetration up to 45 cm were recorded and the number of blows for later 30 cm penetration were counted as Standard Penetration Value (N).

Grain Size Analysis

The Grain Size Analysis of different samples collected from boreholes were done as per IS: 2720(part IV).

Atterberg's Limits

The liquid limit and plastic limit were conducted as per IS: 2720(part V) on soil samples.

Field Content Density and Moisture

The Undisturbed Soil Samples were tested for field density and moisture content as per IS: 2720(part II).

Specific Gravity

The soil samples were tested for specific gravity as per IS: 2720(part III).

Direct Shear Test

The undisturbed soil samples were tested for direct shear tests.

Chemical Analysis of Soil

Chemical analysis of soil samples were conducted for PH, Sulphates (ppm) and for Chloride (ppm).

Chemical Analysis of Water

Chemical analysis of soil samples were conducted for PH, Sulphates (ppm) and for Chloride (ppm).

Rock Test Analysis

Rock samples were collected from the bore holes and tested for water absorption, porosity, dry density and compressed strength (kg/cm^2).

5.4.3 RECOMMENDATIONS

The top soil is generally silty sand with gravels having variable thickness.

Sub soil/ Rock Profile:
Profile was drawn for each bore hole covered in the scope of geotechnical investigation. Based on sub soil profile pile foundation have been considered for piers.

Foundation in soil:
A foundation must have an adequate depth to avoid adverse environmental influence.

Allowable Bearing pressure:
Considering the proposed structure and taking in to account "N" values are allowable settlement of 25 mm has been adopted.

5.5 UTILITY IDENTIFICATION

5.5.1 Introduction

Besides the details of various aspects e.g. transport demand analysis, route alignment, station locations, system design, viaduct structure, geo-technical investigations etc., there are a number of other engineering issues, which are required to be considered in sufficient details before really deciding on taking up any infrastructure project of such magnitude.

Large number of sub-surface, surface and over head utility services viz. sewers, water mains, storm water drains, telephone cables, O.H electrical transmission lines, electric poles, traffic signals, etc. are existing along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions or by supporting in position. Since these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance. Meticulous planning therefore will have to be taken in tackling the issue of protection/diversion of these utility services. Accordingly, the following engineering items have been studied and described below:

i) Existing utilities and planning for their diversion during construction, if necessary.

5.5.2 Utilities and Services

Affected Utilities as indicated hereunder are notional, actual investigation is required before commencement of the field work. Organizations/Departments with concerned utility services in Jaipur are mentioned in **Table 5.2.**

Table 5.2: Organizations Responsible for Utilities and Services

S. No.	Organization/Deptt.	Utility Services
1	Jaipur Nagar Nigam/ Jaipur Development Authority	Surface water drains, nallahs, Sewerage and drainage conduits, sewerage treatment plants, pumping stations, etc.

S. No.	Organization/Deptt.	Utility Services
2	PHED Jaipur	Water mains and their service lines, including hydrants, water treatment plants, pumping stations, Gardens, etc.
3	Public Works Dept. (PWD) and JDA Jaipur	Road construction & maintenance of State highways, Municipals Roads etc.
4	Bharat Sanchar Nigam Ltd. (BSNL), Airtel, Tata Indicom, Reliance, MTS, Vodaphone Idea.	Telecommunication cables, junction boxes, telephone posts, O.H. lines, etc.
5	Office of Traffic Commissioner of Police, Jaipur, Rajasthan	Traffic signal posts, junction boxes and cable connections, etc.
6	District Revenue Office	Land Development & Housing etc.
7	Railway	Railway crossings, signals, railway bridges, etc.
8	RVVNL Jaipur	OH & Under Ground Electric cables and Electric poles

5.5.3 Details of Above Ground Utilities

Affected above ground utilities have been identified based on topographical survey maps. The details have been placed in the following tables;

Table No. 5.3: Other Affected Services

S. No	Description	Number
1	Lamp Post	554
2	Electric Pole	37
3	Manhole	66
4	Optical Fiber Cable	9
5	Signal Pole	70
6	Telephone Pole	20

5.5.4 Details of Underground Utilities

While planning for diversion of underground utility services viz. sewer lines, water pipelines, cables etc., during construction of Metro Rail alignment, following guidelines have been adopted:

Utility services have to be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.

Sewer lines and water supply lines are mainly affected in underground cut and cover construction. These services are proposed to be maintained by temporarily replacing them with CI/Steel pipelines and supporting them during construction, these will be encased in reinforced cement after completion of construction and retained as permanent lines.

Where permanent diversion of the affected utility is not found feasible, especially at the station locations, temporary diversion with CI/Steel pipes without manholes is proposed during construction. After completion of construction, these will be replaced with conventional pipes and manholes. During execution, trail pits shall be taken, number & type of exact utilities shall be ascertained. Protection could be taken by having structural piles away from the paver block area (containing all the utilities) & construction done not simultaneously, but in phases for viaduct & station locations respectively.

The elevated viaduct does not pose much of a difficulty in negotiating the underground utility services, especially those running across the alignment. The utilities infringing at pier location can be easily diverted away from the pile cap location.

In case a major utility is running along/across the alignment which cannot be diverted or the diversion of which is difficult, time consuming and uneconomical, the spanning arrangement of the viaduct and layout of piles in the foundation may be suitably adjusted to ensure that no foundation needs be constructed at the location, where utility is crossing the proposed alignment. The utility service can also be encased within the foundation piles. Also portal way of designing could be also proposed as an alternative option.

Sewer Lines, Strom Water Drains and Water Lines: The sewer/drainage lines generally exist in the service lanes i.e. away from main carriageway. However, in certain stretches, these have come near the central verge or under main carriageway, as a result of subsequent road widening. The major sewer/drainage lines and water mains running across the alignment and likely to be affected due to location of column foundations are proposed to be taken care of by relocating on column supports of viaduct by change in span or by suitably adjusting the layout of pile foundations. Where, this is not feasible, lines will be suitably diverted. Provision has been made in the project cost estimate towards diversion of utility services lines.

5.6 LAND ACQUISITION

5.6.1 Land

In order to minimise land acquisitions and to provide good accessibility from either directions, the metro alignments are located mostly along the road, which lie on the corridor. But, at some locations the geometrics of the roads especially at road turnings may not match with geometric parameters required for metro rail systems. In such cases, either the alignment will be off the road or some properties abutting the road would get affected. Further, some land is required for various purposes as detailed below.

Land Requirement for following Major Components

- MRTS Structure (including Route Alignment), Station Building, Platforms, Entry/Exit Structures, Traffic Integration Facilities, Depots, etc.
- Receiving/Traction Sub-stations
- Radio Towers
- Temporary Construction Depots and work sites.
- Staff quarters, office complex and operation control center(OCC)

5.6.2 Land Requirement for Elevated Stretches:

For elevated section, single pier as well as portal structure supporting the viaduct will be located on road. Accordingly, necessary permission for using such right-of-way will have to be obtained from the concerned authorities. Elevated station is proposed with FOB instead of concourse so the land will be required only for locating the entry/exit structures. Traffic integration facilities are provided wherever the same are required and, but no land is proposed for acquisition.

The normal viaduct structure of elevated Metro with double U-girder is about 9.9 m (edge to edge) wide. However, for reasons of safety a clean marginal distance/set back of about 5 m is necessary from either edge of the viaduct (or 10 m on both sides of the centre line) wherein no structures are to be located. This is necessary as the traction system as proposed is overhead 25 KV AC system with masts fixed on the parapets. Also, it ensures road access and working space all along the viaduct for working of emergency equipment and fire brigade. In stretches, where the elevated alignment has to be located away from road, a strip of 20-m width is proposed for acquisition.

All the stations in elevated stretch including terminal station are planned with single side discharge platforms. Normally, the width required for stations is 21 m. The staircases giving access to station area from ground have been proposed as per site conditions and constraints. Nevertheless it is not possible to find open space at all the locations therefore acquisition of certain private structures is inevitable.

5.6.3 Land for Traffic Integration

At most of the stations no open government land is available and private land has not been proposed for this purpose. Physical identification of land parcels for traffic integration /parking may be done by the project implementation authority at the time of implementation.

5.6.4 Land for Depot

Depot for this Corridor has been proposed on land identified at Sitapura Industrial Area on the bank of Dravyavati River. Hence an area of 27 ha Pvt. Land has been earmarked.

5.6.5 Land for Traction and Receiving Substation and Radio Towers

One new RSS at Sitapura Depot and existing RSS at Sindhi Camp to be augmented to cater the loads of this Corridor. Since new RSS is proposed inside Sitapura Depot, thus no additional land is proposed to be acquired for it. No additional land proposed for locating radio towers. These will be accommodated in the land already acquired.

5.6.6 Land Requirement for Stations & Running section

As indicated earlier, the ROW of most the roads along which the alignment is planned is sufficiently wide and hence no land is required for acquisition as long as the alignment is straight and in the centre/footpath of the road. However, at curved portions, the alignment could not be kept in the centre of the road and land acquisition at such locations is inevitable in spite of introduction of sharper curves.

To the extent possible the Entry and Exit points of stations were planned out of ROW of Road. Details of land permanently required for stations and running sections are indicated in Table 5.4 and 5.5.

Table 5.4 RUNNING SECTION

S. No.	PLOT NO	AREA PROPOSED TO BE ACQUIRED (Sqm.)	OWNERSHIP	TYPE
1	RS-1	20900 + 16146	Pvt.	Agriculture + Res.
2	RS-2	15700 + 4400 + 11962	Pvt. + Govt. + Pvt.	Res.
3	RS-3	4850	Pvt.	Res.
4	RS-4	2598	Pvt.	Res.
5	RS-5	964	Pvt.	Com.
6	RS-6	1234	Pvt.	Com.
7	RS-7	1643	Pvt.	Com.
8	RS-8	1358	Pvt.	Com.
9	RS-9	1571	Pvt.	Res.
10	RS-10	615	Pvt.	Res.
11	RS-11	4797	Govt.	Res.
12	RS-12	1438	Govt.	Res.
13	RS-13	108	Govt.	Res.
14	RS-14	3068	Govt.	Res.
TOTAL = 93352m^2 (13811 Govt. and 79541 Pvt.)				

Table 5.5 LAND REQUIRED FOR STATIONS

S. NO.	PLOT NO.	AREA (sq. m.)	OWNERSHIP	TYPE
1	SS-1	2026	Govt.	Res.
2	B2B-1	52	Govt.	Com.
3	DP-1	122	Pvt.	Com.
4	GP-1	158	Pvt.	Com.
5	RBC-1	143	Pvt.	Com.
6	SMSH-1	64	Govt.	Com.
7	GH-1	94	Pvt.	Com.
8	GH-2	100	Govt.	Com.
9	CP-1	29	Pvt.	Com.
10	CP-2	8	Pvt.	Com.
11	CT-1	105	Pvt.	Com.
12	SN-1	3	Govt.	Com.

S. NO.	PLOT NO.	AREA (sq. m.)	OWNERSHIP	TYPE
13	PP-1	62	Govt.	Com.
14	PP-2	58	Govt.	Com.
15	PP-3	1741	Govt.	Com.
16	AB-1	23	Govt.	Com.
TOTAL = 4788m^2 (4,129 Govt. and 659 Pvt.)				

5.6.7 Land for Staff Quarters, office complex and operation control centre (OCC)

A large number of officers and staff will be required to be deployed permanently to take care of project implementation and post construction operational activities. Moreover, Metro Office Complex and Operation Control Centre (OCC) will also be required, but since they are already there for the existing corridor thus no additional land is required for the same. It is proposed to construct staff quarters inside Sitapura Depot thus no additional land is required for the same. Any further changes may be decided at the time of project implementation.

5.6.8 Temporary office accommodation

During construction period, huge quantities of construction materials like reinforcing bars, cement, steel sections, shutters, pre-cast segments etc. are to be stored and sufficient land is required for storage of these materials. The areas may be identified based on availability as vacant on date nearer to the corridors. At the time of construction, depending up-on the need, the location and size can be reassessed and temporary land acquisitions can be made accordingly.

Since the area of land being acquired permanently at most of the stations is bare minimum, the land required for construction depots purpose has been considered throughout the corridor @ 2000 m^2 at every 5 km. These sites will be obtained on lease temporarily for the construction period. After completion of construction, these will be handed over back to the land owning agency.

Table 5.6 Details of Temporary Land office accommodation

S. No.	Corridor	AREA (m^2)	OWNER-SHIP
1	India Gate (SIA) to Ambabari	8000	Government
	Total	**8000**	

5.6.9 Casting Yard

Pre-cast girders are required for construction of elevated structures for which a large open area is required for setting up of casting yard. As far as possible, this area should be close to the site, easily accessible and away from habitation. Considering the various factors, it is proposed to setup **four** casting yards for the proposed corridor. Accordingly a provision of **8 ha** land has been proposed on temporary basis considering 2.0 ha of land for each casting yard for a period of four years.

5.6.10 Summary of Land Requirements

Abstract of land requirements for different components of this corridor is given in **Table 5.7 and 5.8**.

Table 5.7 Summary of Permanent Land Requirement (All figures in Sq. m)

S. No.	Description	Govt.	Pvt.	Total
1	Stations	4129	659	4788
2	Running Section	13811	79541	93352
3	Depot	0	270000	270000
4	Staff Quarter	0	0	0
5	Office Complex and OCC	0	0	0
6	RSS	0	0	0
	Total	**17940**	**350200**	**368140**

Total Permanent Land	**=**	**36.814 ha**
Permanent Land (Govt.)	**=**	**1.794 ha**
Permanent Land (Pvt.)	**=**	**35.02 ha**

Table 5.8 - Summary of Temporary Land Requirement

S. No.	Description	AREA (m^2)	OWNER-SHIP
1	Temporary Office/ Site Office	8000	Government
2	Segment Casting Yard	80000	Government
	Total	**88000**	

Total land required for temporary acquisition is **8.8ha,** which is assumed that it will be government land.

5.7 SAFETY & SECURITY SYSTEMS

5.7.1 General

This section lays down the standards and requirements for safety & security, arising out of fire and unauthorized entry into premises. The system will be designed and installed for safe transportation of passengers & premises safety in Metro Railway System.

Requirements

i. The System shall protect the passengers against the fire in train services and at the premises of Metro Railway.

ii. The system shall protect vulnerable premises from fire.

iii. The system shall be able to detect the unauthorized entry and exit at nominated places.

iv. The system shall include

- Fire alarm system.
- Fire Hydrant and Sprinkler System.
- Fire Extinguishers.
- Closed circuit television with video analytics.
- Security Gates – Metal Detector.
- Baggage Scanner.

5.7.2 Fire Alarm System:

5.7.2.1 General

The Fire Alarm System is a fully integrated, Fire Detection & Alarm System. It includes alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, power supplies, and wiring. Its installation is restricted to designated areas. In Metro railway this system shall be provided at the following locations:

i. At Station Control Room (SCR).
ii. Station security services center.
iii. At Operational Control Centre.
iv. At Depot, in depot controller room.
v. Escalator landing and inside elevators.
vi. Evacuation routes.
vii. Cash transfer routes on the station.
viii. Equipment room.
ix. Store room.
x. Any other place required.

5.7.2.2 Scope

The system comprises of Main Addressable Intelligent fire alarm panel, smoke sensors, and smoke laser sensors, smoke optical sensors, heat sensors, audio visual indicators, isolator modules, monitor control and relay modules connected by interconnecting with Fire Retardant Low Smoke (FRLS) copper armored cable.

The main panel shall be located in security / control room. All the sensors and devices shall be connected to main panel. The panel shall operate with UPS power, 210 AC and shall have its in-built battery backup with battery charger.

A smoke detector is a device that detects the presence of smoke. It will be provided in commercial, industrial, and residential complexes and also closed and limited open space areas. Provision of smoke detector at equipment/store room shall be mandatory.

5.7.2.3 System Components

Fire Alarm Control Panel

The main Fire alarm control panel, forms the heart of the fire detection system which gives command to peripheral device like detectors & to sub-systems. It shall consist of microprocessor based Central Processing Unit (CPU).

The CPU communicates with control panel installed, for the system to function effectively. The system comprises of:

i. Addressable pull stations – Manual Call Point.
ii. Intelligent photo electric smoke, thermal detector.
iii. Addressable control model.
iv. Isolated modules.

5.7.2.4 Addressable Pull Stations (Manual Call Point):

Addressable pull station is an active fire protection device, usually wall-mounted. When activated, it initiates an alarm on a fire alarm system. In its simplest form, the user activates the alarm by pulling the handle down, which completes a circuit and locks the handle in the activated position, sending an alarm to the fire alarm control panel. After operation, fire alarm pull station must be restored to the ready position using a special tool or key in order to de-activate the alarm sequence and return the system to normal.

5.7.2.5 Intelligent Photo - Electric Smoke Detector:

This Smoke detector works on photoelectric (light-scattering) principal to measure smoke density and on command, from the control panel, sends data to the panel representing the analog level of smoke density. However, the detectors do not respond to refrigerant gas.

5.7.2.6 Addressable Control Module:

Addressable control modules will be used to operate dry contacts for door holders, air handling unit, shut down or other similar functions. Optionally the module can be used to supervise wiring of the output load power supply. If the monitored voltage falls below threshold, then a fault condition shall be displayed.

5.7.2.7 Isolator Module:

The fault isolator module to be connected placed between groups of sensors on the loop wiring, to protect the loop, if a fault occurs in the event of short circuit. The two isolators located on either side of the short circuit fault, shall automatically sense the voltage drop, open their switches and remove the devices from the rest of the loop. If the line voltage rises above a fixed threshold, indicating that the short circuit fault is removed, then the isolator module shall automatically restore the power, to the isolated group of devices. The smooth functioning again shall be continued.

5.7.3 Fire Hydrant System:

5.7.3.1 General

Fire Hydrant System is a semi-automatic water based system. In this system a network of pipes is laid out, depending upon the risk, with hydrant valves placed at strategic places.

5.7.3.2 Scope

The entire pipeline shall be kept pressurized with water. When any of the hydrant valve opens, the pressure in the pipeline reduces drastically. Jockey pump set shall normally keep the complete system pressurized, and enables it to cope up with the system demand, which results in further fall in pressure. The fall in pressure is sensed by the designated pressure switch, which automatically starts the main fire pump set.

Depending upon the type and sensitivity of the risk, diesel-engine power pump set should be installed having 100% standby capacity.

Fire Hydrant System comprises of the following:

- Sufficiently large water reservoir
- Fire pump sets (Main and Standby)
- Jockey pump set
- Hydrant valves
- Fire fighting hoses
- Branch pipe with nozzles

Hydrant System is proposed to be installed at following Places

i. Building Stair Case area.
ii. Basement Area of Building.
iii. Restricted area of Yard / Car shed / Depot.

5.7.3.3 System Component

- Landing Valves
- Hoses
- Couplings
- Hose Reels
- Fire Brigade Connectors
- Branch Pipes & Nozzles

5.7.3.4 Landing Valve

It's a simple valve like water tap, whenever it is open, after connecting hose to that valve, water flow is targeted to extinguish fire.

5.7.3.5 Hoses

Hose is a flexible tube used to carry water

5.7.3.6 Hose Reel

A Hose Reel is a cylindrical spindle made of either metal, fiberglass, or plastic used for storing a hose. The most common style of hose reels are spring driven, hand crank, or motor driven. Hose reels are categorized by the diameter and length of the hose they hold, the pressure rating and the rewind method.

5.7.3.7 Coupling

Coupling is a short length of pipe or tube with a socket at both ends that allows two pipes or tubes to be connected together temporarily.

5.7.3.8 Fire Brigade Connector:

Approved fire brigade connection, shall consist of 4 nos. of 63 mm instantaneous inlets, in a glass fronted wall box, at a suitable position on the street at convenient location to make inlets accessible. The size of the wall box shall be adequate to allow hose to connect to the inlets, after breaking glass cover if need be.

5.7.4 Sprinkler System:

A fire sprinkler system is an active fire protection measure, consisting of a water supply system, with adequate pressure and flow rate to a water distribution piping system, onto which fire sprinklers are connected.

Each closed-head sprinkler is held by either a heat-sensitive glass bulb or a two-part metal link held together with fusible alloy. The glass bulb or link, applies pressure to a pipe cap which acts as a plug. This prevents water from flowing, until the ambient temperature around the sprinkler reaches the designed activation temperature of the individual sprinkler head. Each sprinkler activates independently, when the predetermined heat level is reached. The number of sprinklers that operate are limited to only those near the fire, thereby maximizing the available water pressure over the point of fire origin.

Sprinkler System is proposed to be installed at following places

i. Building Passages.
ii. Basement Area.
iii. OCC room.
iv. Equipment room.
v. Store room.

5.7.5 Fire Extinguishers:

5.7.5.1 General

Fire extinguishers form a first aid action against small and incipient fire before it develops into a major hazard.

5.7.5.2 Scope

Types of Extinguishers:

i. Carbon-di-oxide of 4.5 kg.
ii. ABC Type 5Kg.
iii. Water Container 9 ltr. capacity.

These extinguishers shall be installed in the entire public, as well as service areas where the security is necessary. These appliances should be distributed, over the entire area, so that its users do not have to travel more than 15 m to reach the appliance. These appliances can be mounted or hanged on the wall at desired location.

5.7.5.3 Description:

Carbon Di Oxide (CO2) Fire Extinguishers

The cylinder filled with carbon dioxide (CO2), when operated extinguishes fire without any residue. Carbon-di-oxide Extinguishers are recommended, as these have inert gas with no residue, which is electrically non-conductive and ideal to be used over electronics and electric appliances.

5.7.5.4 ABC Dry Powder - Fire Extinguishers

ABC Extinguishers are proposed for Class 'A' fire. These extinguishers are portable & can be handled by anyone / common person. These when operated, protect against the fire to flammable material, such as wooden articles, curtains etc.

- Type 'A' extinguisher shall be used for ordinary combustible articles such as cloth, wood, paper.
- Type 'B' extinguisher shall be used for flammable liquid fires, such as oil, gasoline, paints, lacquers, grease, and solvents.
- Type 'C' extinguisher shall be used for electrical fires, such as wiring, fuse boxes, energized electrical equipments and other electrical sources.
- Type 'D' extinguisher shall be used for metal fires such as magnesium, titanium and sodium.

5.7.5.5 Water Type Fire Extinguishers

Water Type Fire Extinguishers are recommended for all Class "A" type of Fires where unskilled staff / personnel exist and can operate these without much difficulty.

5.7.5.6 Glow Signs

Different types of signs like Exit, Fire and Emergency shall be provided to ensure passengers guidance and safety. The signs can glow in the dark specially. Exit Fire and Emergency Signs help passengers to find exit and help fire fighters to locate emergency equipment.

5.7.6 Closed Circuit Television

5.7.6.1 General

The objective of CCTV System is to provide High degree of Electronic surveillance system to the entire premises. It is essential to have recorded images to be stored at least for 30 days of all critical area's to facilitate investigations of reported cases. CCTV provision facilitates effective management.

Strategically placed video surveillance cameras help to enhance security by providing motion based / continuous monitoring of all corners / areas of premises.

CCTV monitoring shall cover the following areas:

i. Station Control Room (SCR)
ii. Station security services
iii. Platform Supervisor Booth
iv. Operational Control Centre and Traffic Controller (TC)
v. Depot controller (DC) in Depot.
vi. Escalator landing and inside elevators
vii. Evacuation routes
viii. Cash transfer routes at the station

5.7.6.2 Description:

CCTV comprises of the following components:

i. Integrated Port Camera (IP Cameras)

ii. Computer
iii. Software

5.7.6.3 Integrated Port Cameras:

For operation of IP Cameras, no external supply connection is needed. However, Power Over Ethernet (PoE) shall be attached to an Uninterruptible Power Supply (UPS) and sized to maintain camera operations. PoE technology, enables a system to pass electrical power, along with data, on Ethernet cabling. Standard version of PoE specify Category 5 cable or higher to be used for the system.

Two types of IP Cameras Shall be used:

*Fix Camera– Use of this camera is restricted to 20 m range.
*PTZ Camera– Pan/Tilt/Zoom Camera is used for range from 20 m to 100 m.

5.7.6.4 Computer

Images, when recorded by cameras, are transmitted to computer. When computer is on, images are displayed on its monitor instantly. These images are also stored in memory device.

Storing of images occurs automatically, even when computer is in off position.

5.7.6.5 Software

Software installed in computer enables coding & decoding of data for functioning of the system enforced.

5.7.6.6 Server Software:

Software covers MS-SQL 2005, or better based Main Archive Server for audio and video, Main directory, Failover directory, Failover recording, Digital Virtual Matrix, Incident Reports, Alarm Management, Network Management System and Watchdog modules.

Server maintains a catalog of settings for all clients. It also encodes & decodes of stored information through I P cameras.

Software enables the client to dynamically create connections between Cameras and workstations and view live or recorded video on the digital monitors (Audio, video, serial ports and digital I/Os)

5.7.6.7 Client Software:

Client software includes of Administrator Tool application, Monitoring application, Archive Player application, Sync archive player application, Map creation application etc. All the relevant software licenses work on concurrent basis and no restriction of its use for specific work station is classified.

Client software performs the following applications simultaneously without interfering with any of the Archive Server operations (Recording, Alarms, etc.):

- Live display of cameras and audio

- Live display of camera sequences, panoramic camera views.
- Playback of archived video
- Instant replays of Video and Audio
- Display and control of Maps
- Audio announcements
- Alarm management

Client application provides, management and control over the system, using a standard PC mouse, keyboard or CCTV keyboard. Standard scroll mouse moves the camera by merely clicking on the extremes of the picture, in all directions and zoom function by scroll button, to avoid the use of joystick keyboard while maintaining easiness of the control.

Client application is to control pan-tilt-zoom, iris, focus, presets and dome patterns of the PTZ camera for correct functioning of the system.

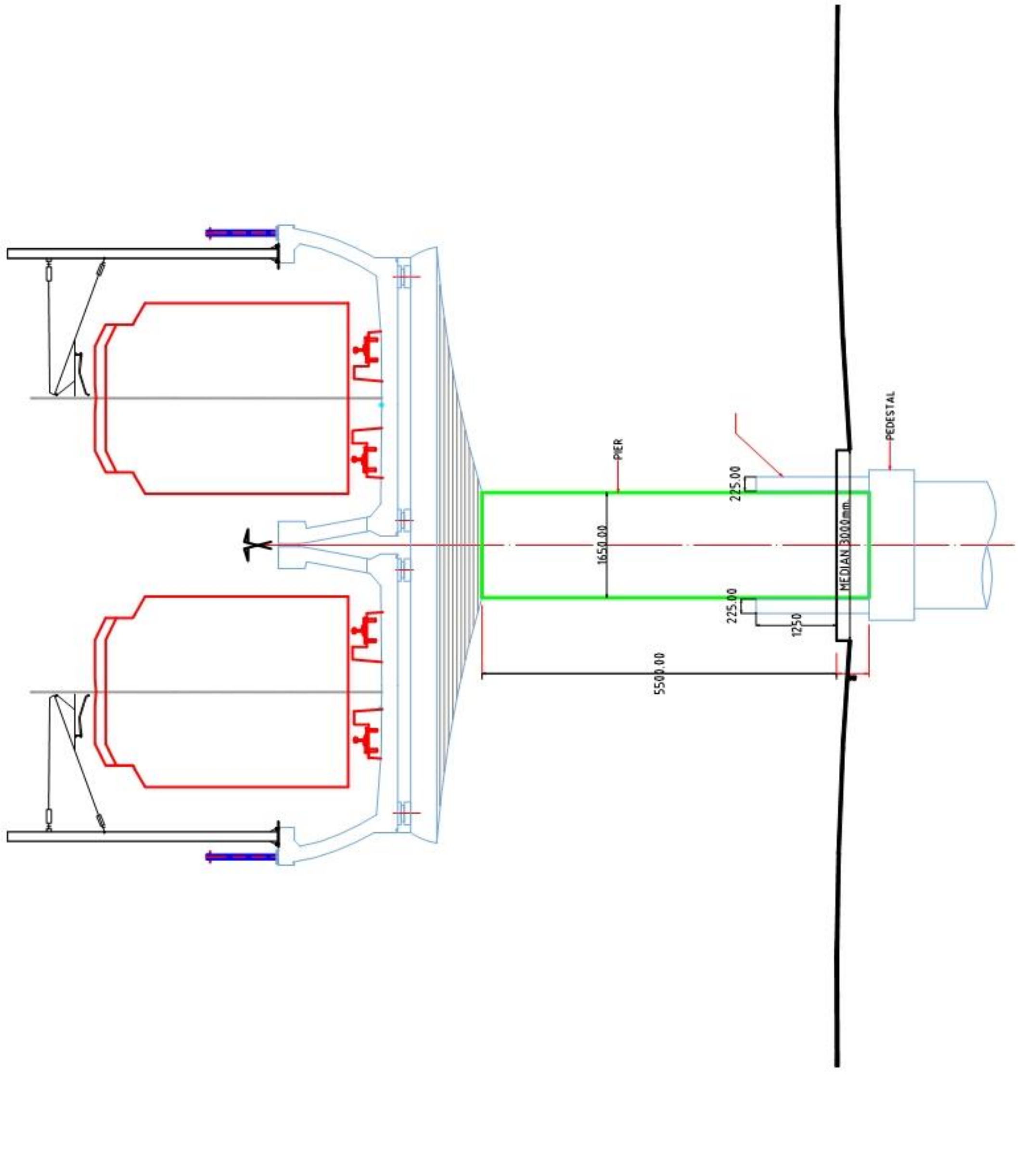
Software provides utility to play multiple exported clips simultaneously. It also provides the ability to play multiple clips in time sync with each other to understand the sequence of events occurred during an emergency.

5.7.6.8 Security in general has gained great importance during the last few years. It is a prime concern at the stations due to the large number of commuters who congregate there daily. Any short coming or lapse at the stations can cause a disaster. Security arrangement has been catered for at the stations and in the coaches. Cost of the same is included in the estimate.

The estimate for security may, however, need revision after level and quantum of security to be provided are known in greater detail.

Figure 5.1

TYPICAL CROSS SECTION OF THE VIADUCT WITH DOUBLE U GIRDER



SCALE:- NTS

Figure 5.2(a): Erection of Girder using Crane

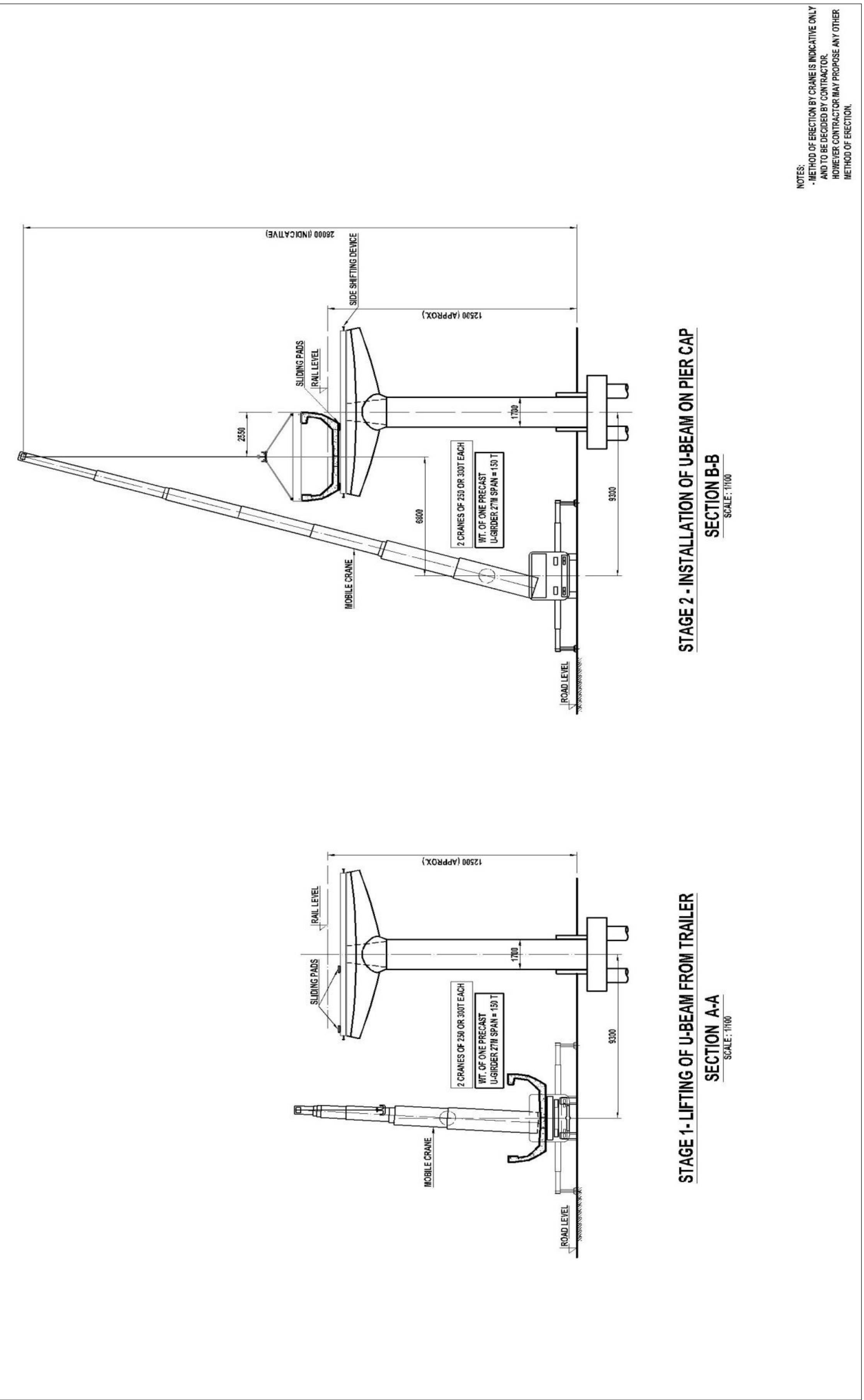
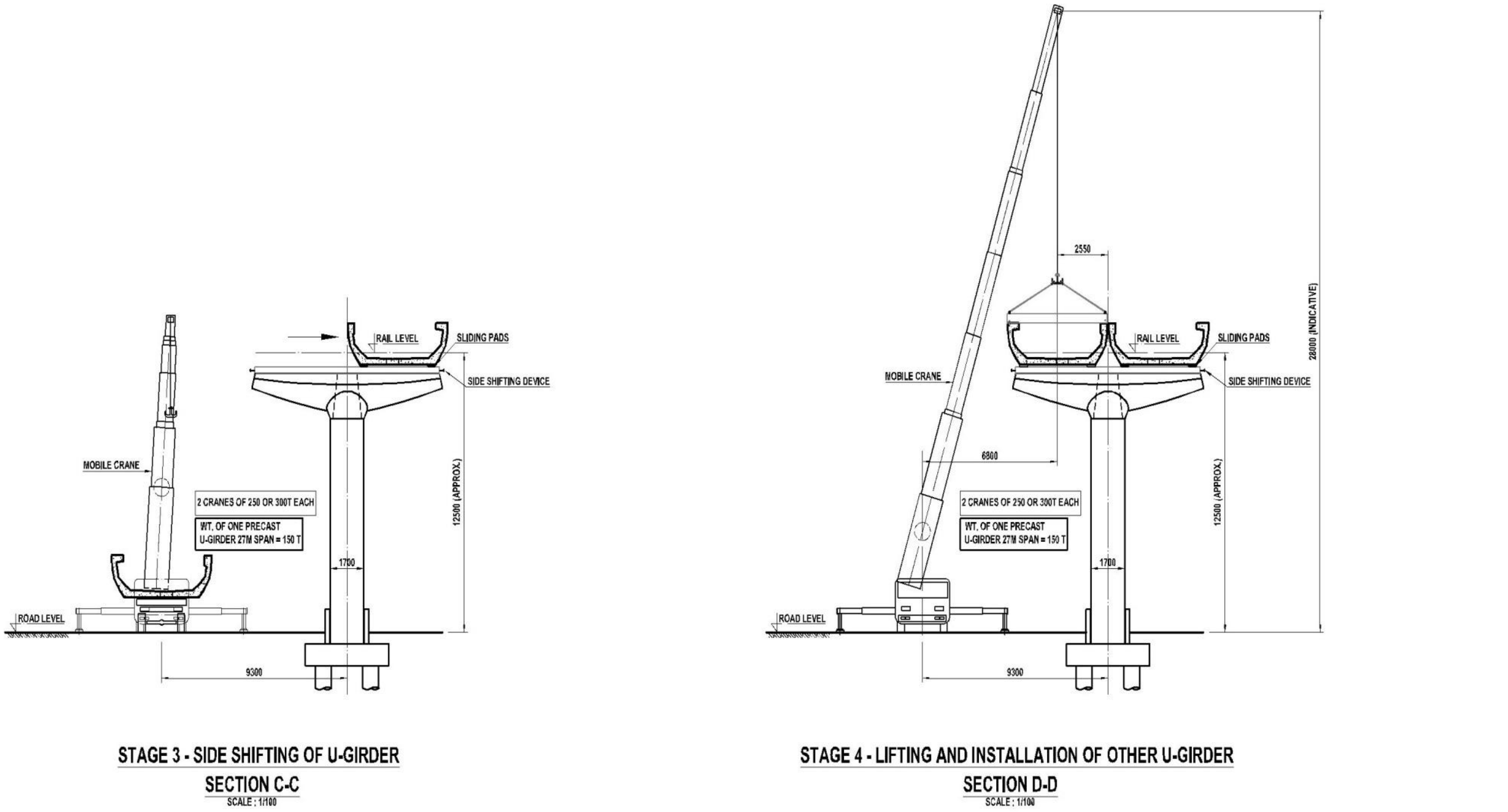


Figure 5.3(b): Erection of Girder using Crane



NOTES:
- METHOD OF ERECTION BY CRANE IS INDICATIVE ONLY AND TO BE DECIDED BY CONTRACTOR. HOWEVER CONTRACTOR MAY PROPOSE ANY OTHER METHOD OF ERECTION.

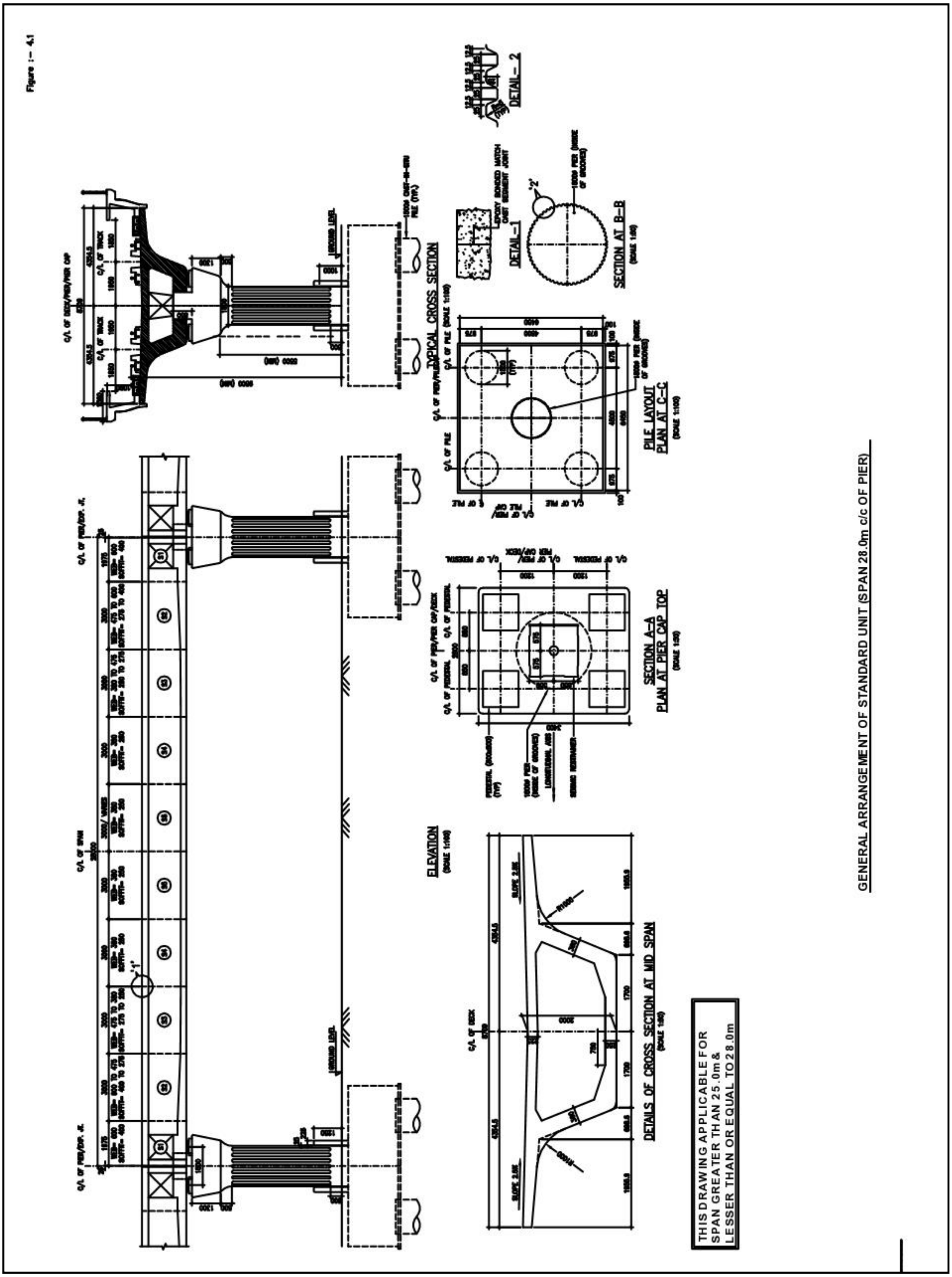
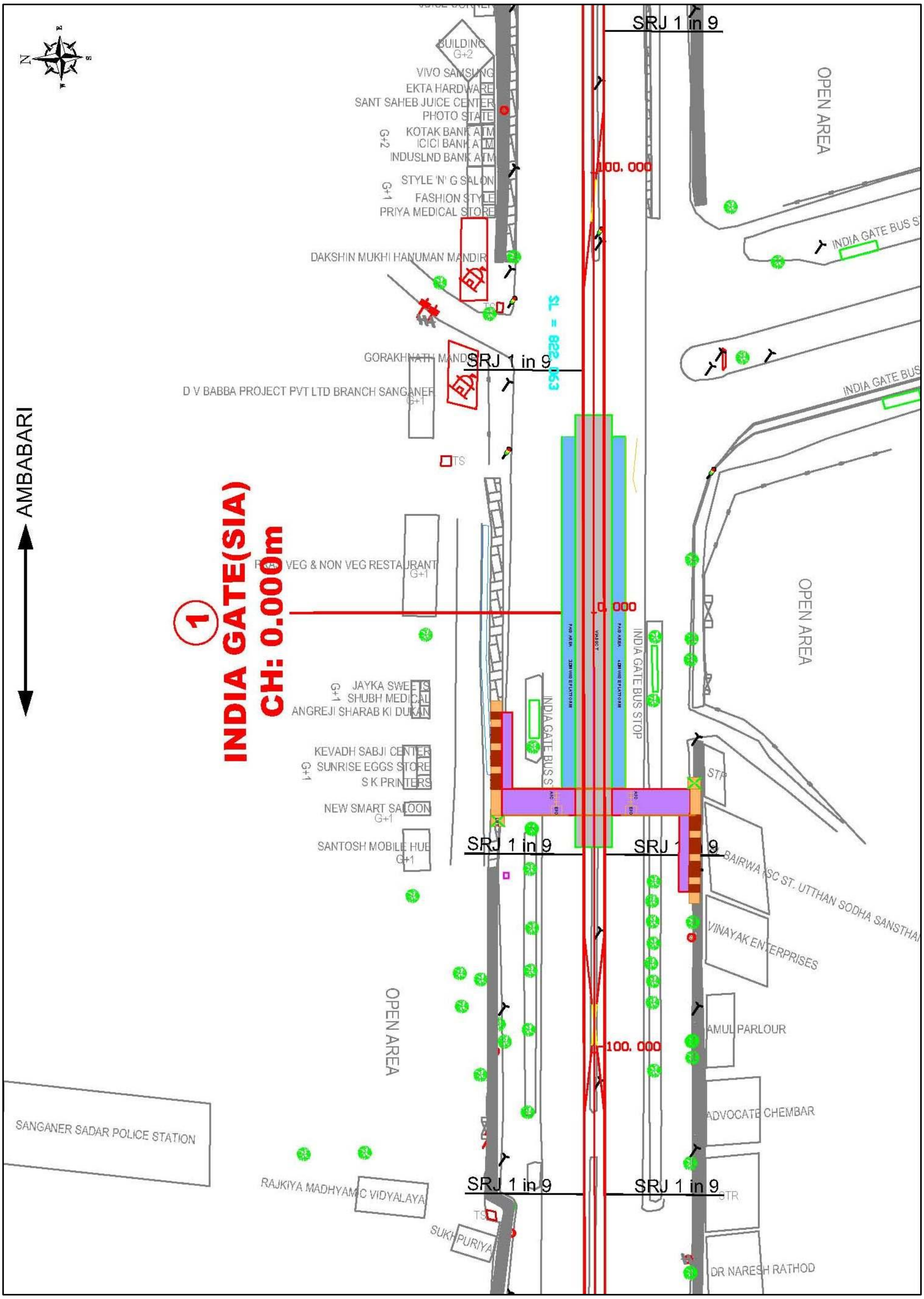
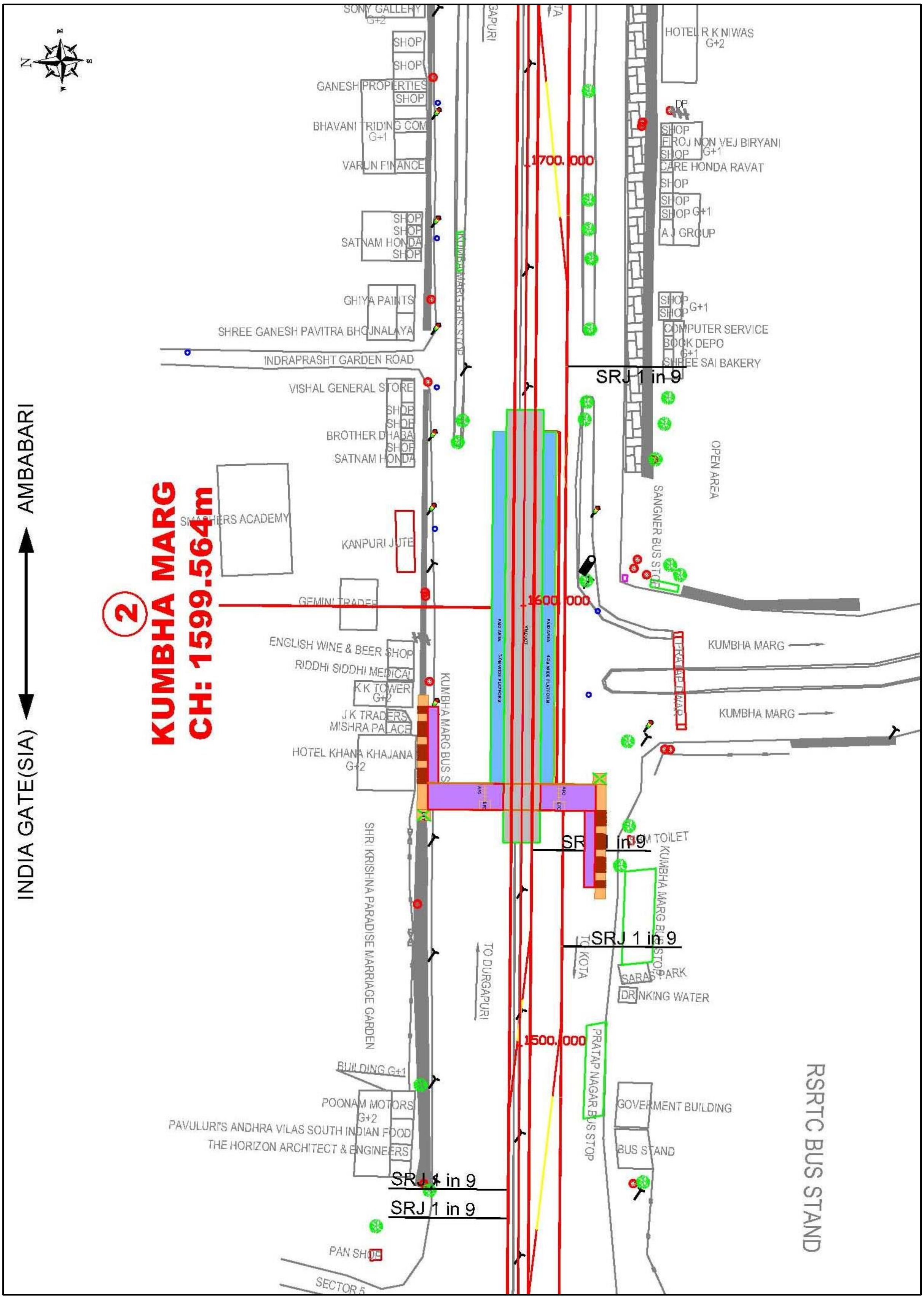
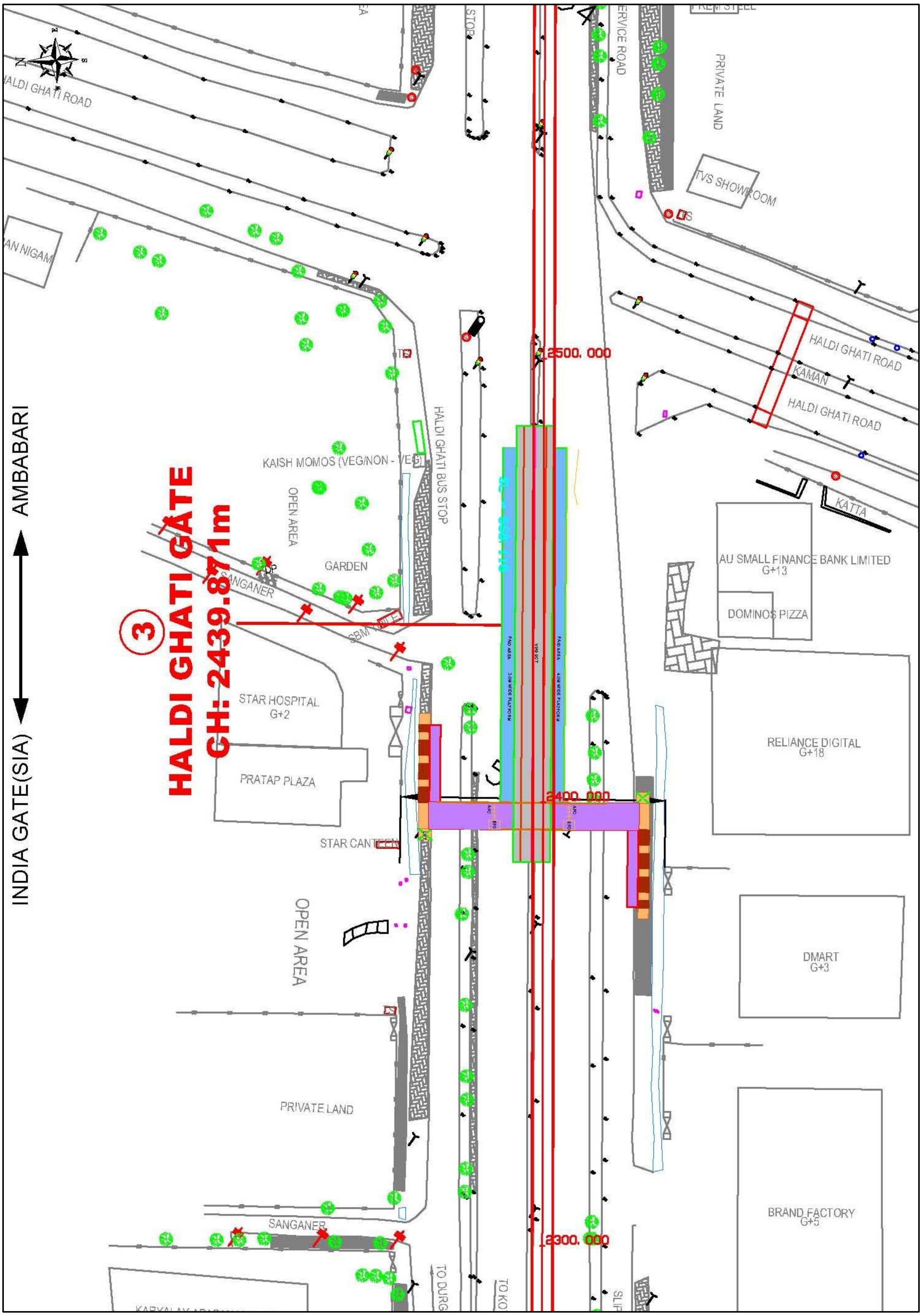
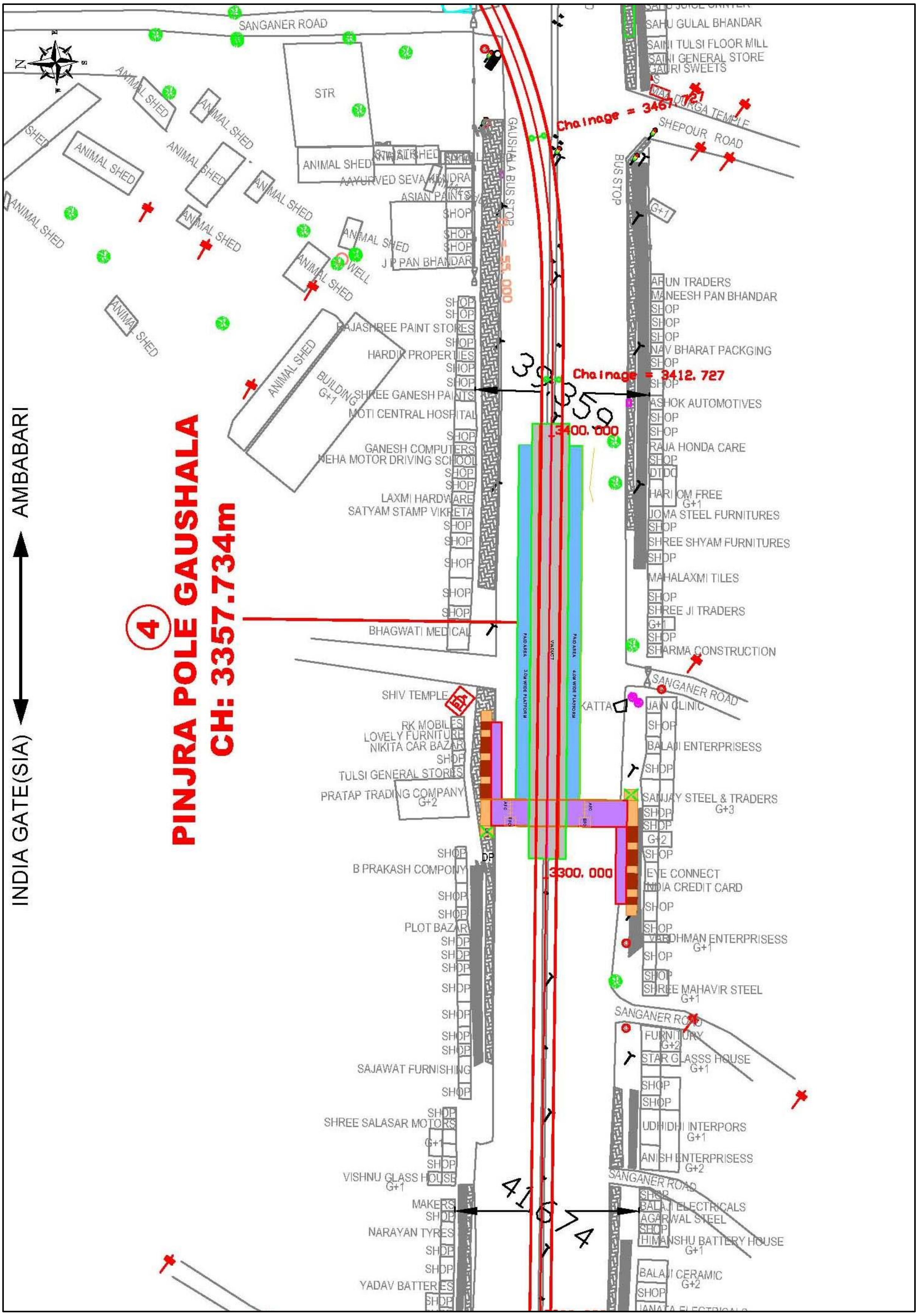


Figure :- 4.1
TYPICAL CROSS SECTION
DETAIL - 1
DETAIL - 2
SECTION AT B-B
ELEVATION
SECTION A-A
PLAN AT PIER CAP TOP
PILE LAYOUT
PLAN AT C-C
DETAILS OF CROSS SECTION AT MID SPAN
THIS DRAWING APPLICABLE FOR SPAN GREATER THAN 25.0m & LESSER THAN OR EQUAL TO 28.0m
GENERAL ARRANGEMENT OF STANDARD UNIT (SPAN 28.0m c/c OF PIER)

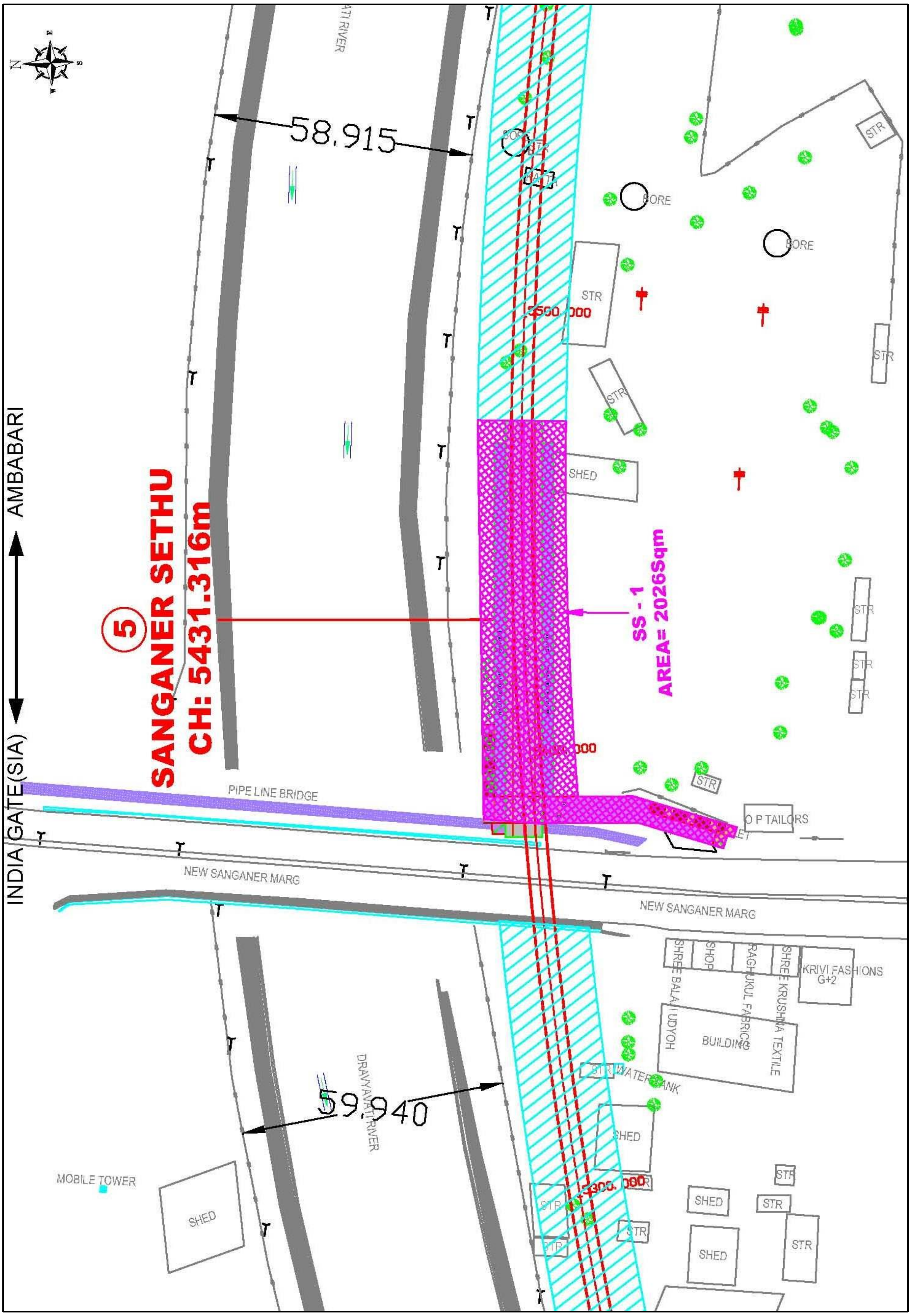

AMBABARI
INDIA GATE(SIA)
CH: 0.000m
1
SRJ 1 in 9
SL = 922.063
100. 000
0. 000
OPEN AREA
INDIA GATE BUS STOP
BUILDING G+2
VIVO SAMSUNG
EKTA HARDWARE
SANT SAHEB JUICE CENTER
PHOTO STATE
KOTAK BANK ATM
ICICI BANK ATM
INDUSLND BANK ATM
STYLE 'N' G SALON
FASHION STYLE
PRIYA MEDICAL STORE
DAKSHIN MUKHI HANUMAN MANDIR
GORAKHNATH MANDIR
D V BABBA PROJECT PVT LTD BRANCH SANGANER
VEG & NON VEG RESTAURANT
JAYKA SWEETS
SHUBH MEDICAL
ANGREJI SHARAB KI DUKAN
KEVADH SABJI CENTER
SUNRISE EGGS STORE
S K PRINTERS
NEW SMART SALOON
SANTOSH MOBILE HUB
SANGANER SADAR POLICE STATION
RAJKIYA MADHYAMIC VIDYALAYA
SUKHPURIYA
BAIRWA (SC ST. UTTHAN SODHA SANSTHAN
VINAYAK ENTERPRISES
AMUL PARLOUR
ADVOCATE CHEMBAR
DR NARESH RATHOD
INDIA GATE BUS STOP

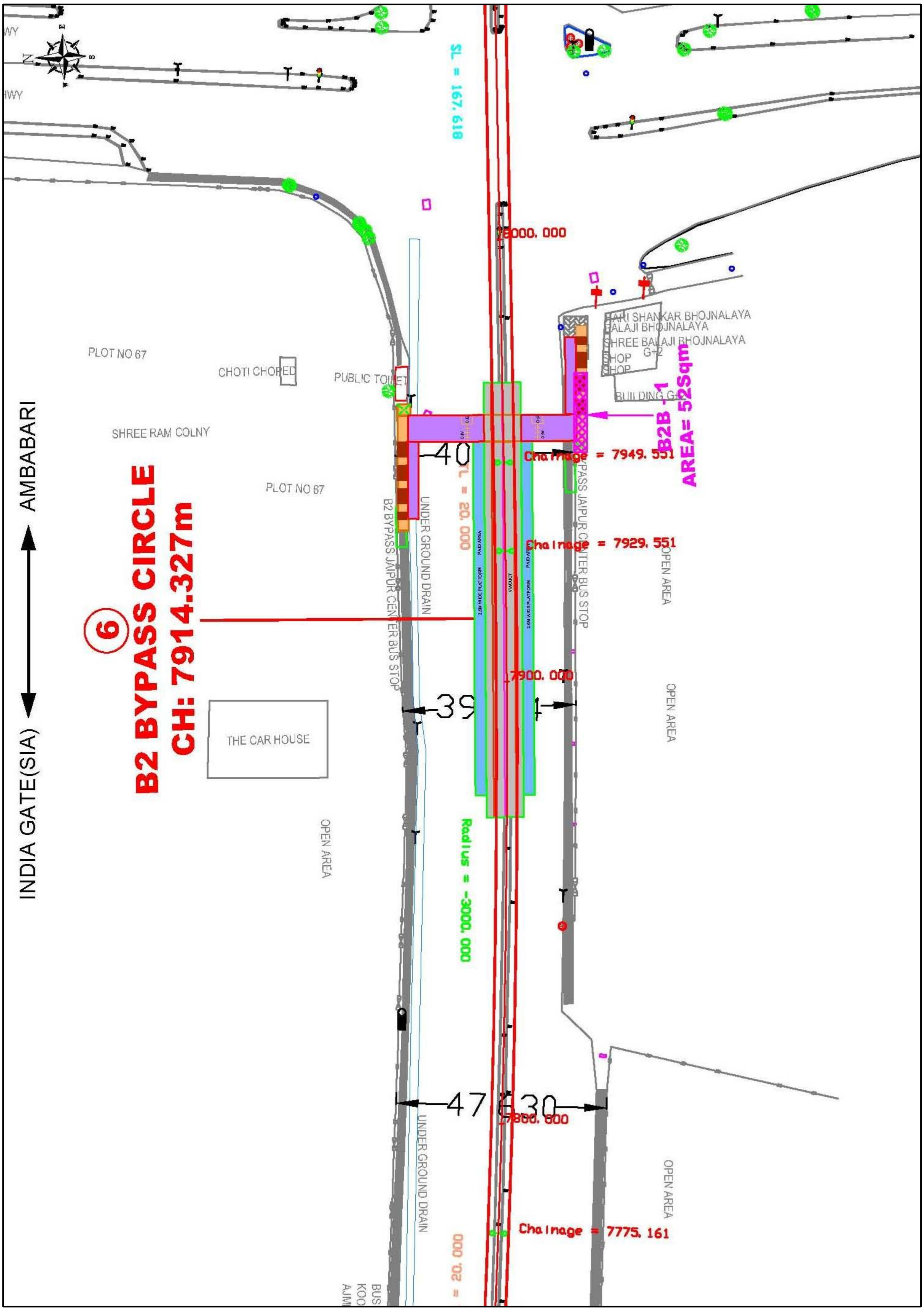

INDIA GATE(SIA)
AMBABARI
2
KUMBHA MARG
CH: 1599.564m
1700.000
1600.000
1500.000
SRJ 1 in 9
SRJ 1 in 9
SRJ 1 in 9
SRJ 1 in 9
KUMBHA MARG
KUMBHA MARG
RSRTC BUS STAND
INDRAPRASHT GARDEN ROAD
SHRI KRISHNA PARADISE MARRIAGE GARDEN
TO DURGAPURI
TO KOTA
SANGNER BUS STOP
PRATAP NAGAR BUS STOP
KUMBHA MARG BUS STOP
OPEN AREA
GOVERMENT BUILDING
BUS STAND
DRINKING WATER
HOTEL R K NIWAS
G+2
SHREE GANESH PAVITRA BHOJNALAYA
SMASHERS ACADEMY
KANPURI JUTE
GEMINI TRADER
ENGLISH WINE & BEER SHOP
RIDDHI SIDDHI MEDICAL
K K TOWER
J K TRADERS
MISHRA PALACE
HOTEL KHANA KHAJANA
POONAM MOTORS
PAVULURI'S ANDHRA VILAS SOUTH INDIAN FOOD
THE HORIZON ARCHITECT & ENGINEERS
PAN SHOP
SECTOR 5

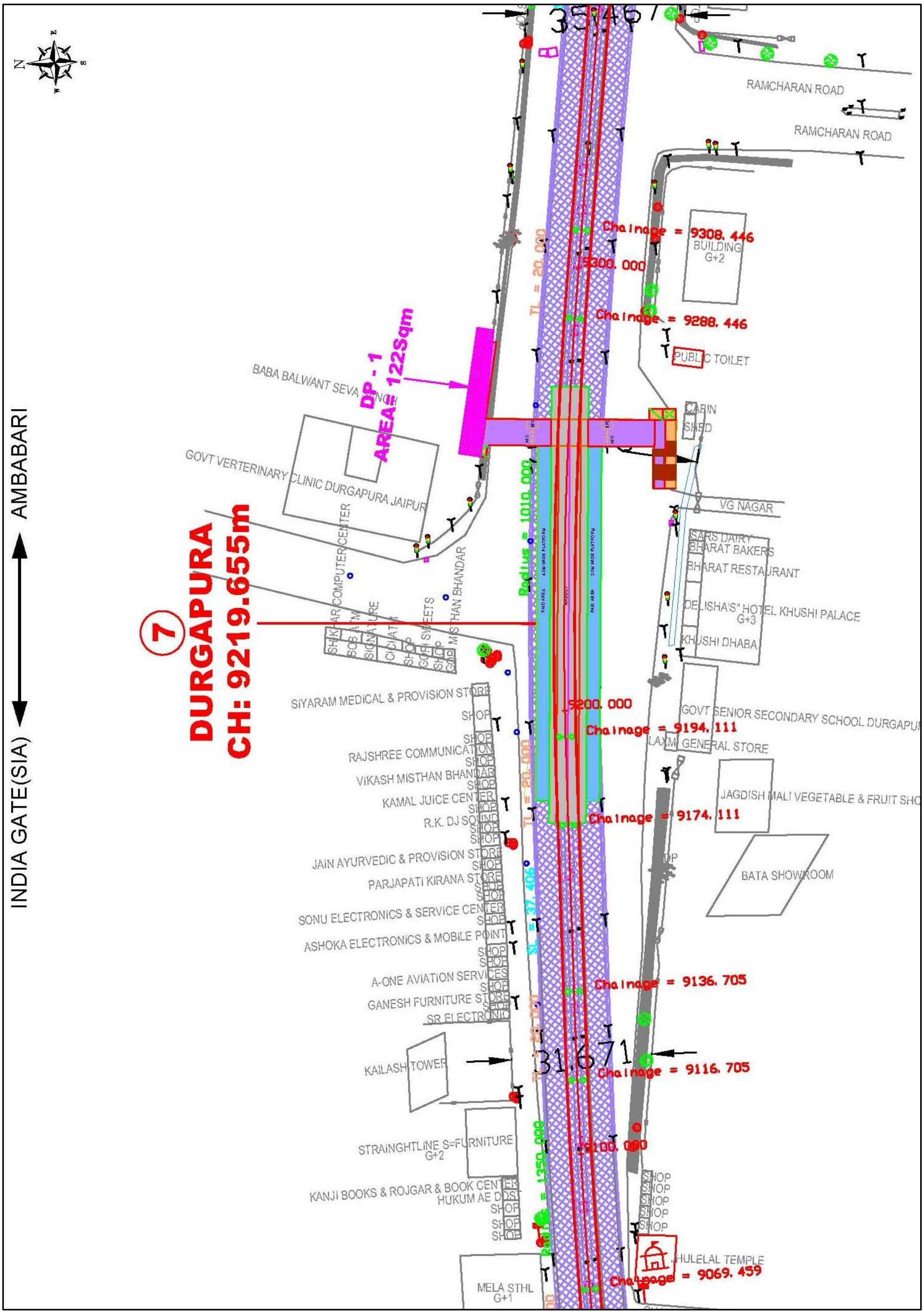

3
HALDI GHATI GATE
CH: 2439.871m
INDIA GATE(SIA)
AMBABARI
HALDI GHATI ROAD
KAISH MOMOS (VEG/NON - VEG)
OPEN AREA
GARDEN
SANGANER
STAR HOSPITAL
G+2
PRATAP PLAZA
STAR CANTEEN
PRIVATE LAND
HALDI GHATI BUS STOP
2500. 000
2400. 000
2300. 000
TVS SHOWROOM
PRIVATE LAND
KAMAN
KATTA
AU SMALL FINANCE BANK LIMITED
G+13
DOMINOS PIZZA
RELIANCE DIGITAL
G+18
DMART
G+3
BRAND FACTORY
G+5
TO DURG



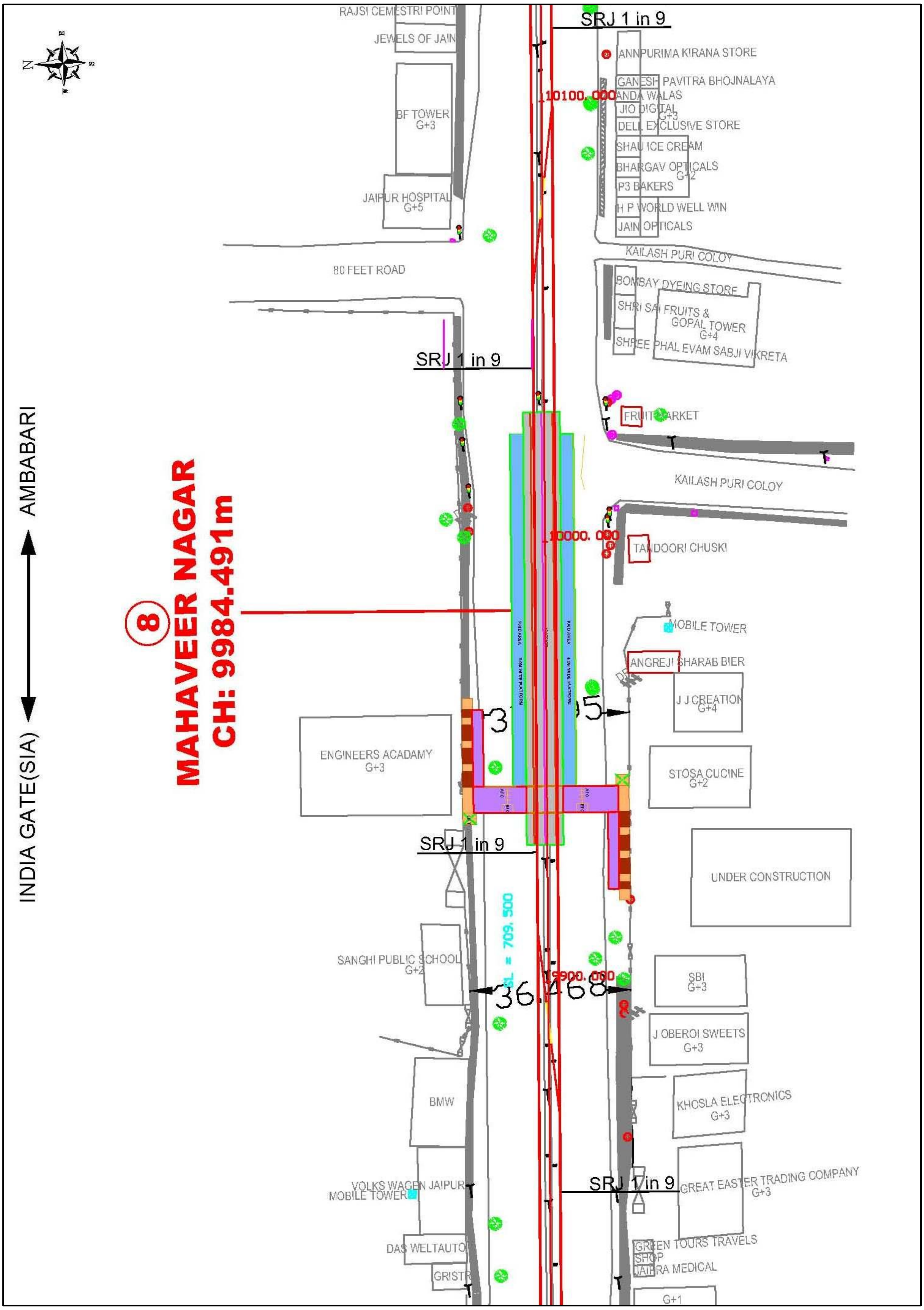
PINJRA POLE GAUSHALA
CH: 3357.734m
4
INDIA GATE(SIA)
AMBABARI
SANGANER ROAD
SHEPOUR ROAD
Chainage = 3412.727
3400.000
3300.000
ANIMAL SHED
STR
GAUSHALA BUS STOP
BUS STOP
ARUN TRADERS
MANEESH PAN BHANDAR
NAV BHARAT PACKGING
ASHOK AUTOMOTIVES
RAJA HONDA CARE
JOMA STEEL FURNITURES
SHREE SHYAM FURNITURES
MAHALAXMI TILES
SHREE JI TRADERS
SHARMA CONSTRUCTION
JAIN CLINIC
BALAJI ENTERPRISESS
SANJAY STEEL & TRADERS
EYE CONNECT
INDIA CREDIT CARD
SHREE MAHAVIR STEEL
STAR GLASSS HOUSE
ANISH ENTERPRISESS
BALAJI ELECTRICALS
AGARWAL STEEL
HIMANSHU BATTERY HOUSE
BALAJI CERAMIC
SAHU GULAL BHANDAR
SAINI TULSI FLOOR MILL
SAINI GENERAL STORE
GAURI SWEETS
RAJASHREE PAINT STORES
HARDIK PROPERTIES
SHREE GANESH PAINTS
MOTI CENTRAL HOSPITAL
GANESH COMPUTERS
NEHA MOTOR DRIVING SCHOOL
LAXMI HARDWARE
SATYAM STAMP VIKRETA
BHAGWATI MEDICAL
SHIV TEMPLE
RK MOBILES
LOVELY FURNITURE
NIKITA CAR BAZAR
TULSI GENERAL STORES
PRATAP TRADING COMPANY
B PRAKASH COMPONY
PLOT BAZAR
SAJAWAT FURNISHING
SHREE SALASAR MOTORS
VISHNU GLASS HOUSE
NARAYAN TYRES
YADAV BATTERIES
J P PAN BHANDAR
AAYURVED SEVA KENDRA
ASIAN PAINTS
WELL
SHOP


INDIA GATE(SIA)
AMBABARI
5
SANGANER SETHU
CH: 5431.316m
SS - 1
AREA= 2026Sqm
58.915
59.940
PIPE LINE BRIDGE
NEW SANGANER MARG
NEW SANGANER MARG
O P TAILORS
BORE
BORE
STR
SHED
SHREE BALAJI UDYOG
SHOP
RAGHUKUL FABRICS
SHREE KRUSHNA TEXTILE
KRIVI FASHIONS
G+2
BUILDING
WATER TANK
DRAVYAVATI RIVER
MOBILE TOWER

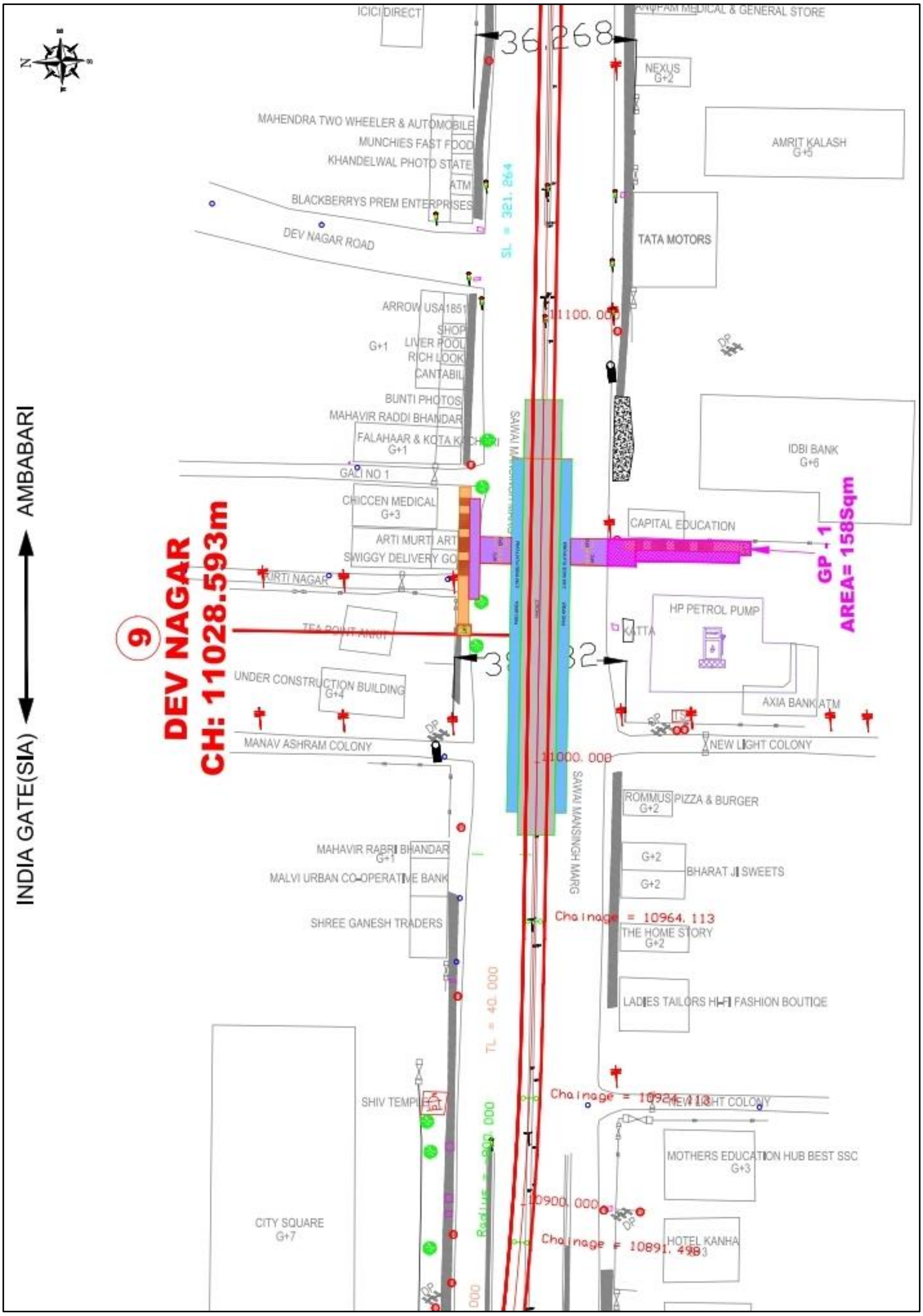

INDIA GATE(SIA)
AMBABARI
6
B2 BYPASS CIRCLE
CH: 7914.327m
B2B - 1
AREA= 52Sqm
Chainage = 7949.551
Chainage = 7929.551
Chainage = 7775.161
7900.000
7800.000
SL = 167.618
Radius = -3000.000
PLOT NO 67
CHOTI CHOPED
PUBLIC TOILET
SHREE RAM COLNY
THE CAR HOUSE
OPEN AREA
UNDER GROUND DRAIN
B2 BYPASS JAIPUR CENTER BUS STOP
HARI SHANKAR BHOJNALAYA
BALAJI BHOJNALAYA
SHREE BALAJI BHOJNALAYA
47.630



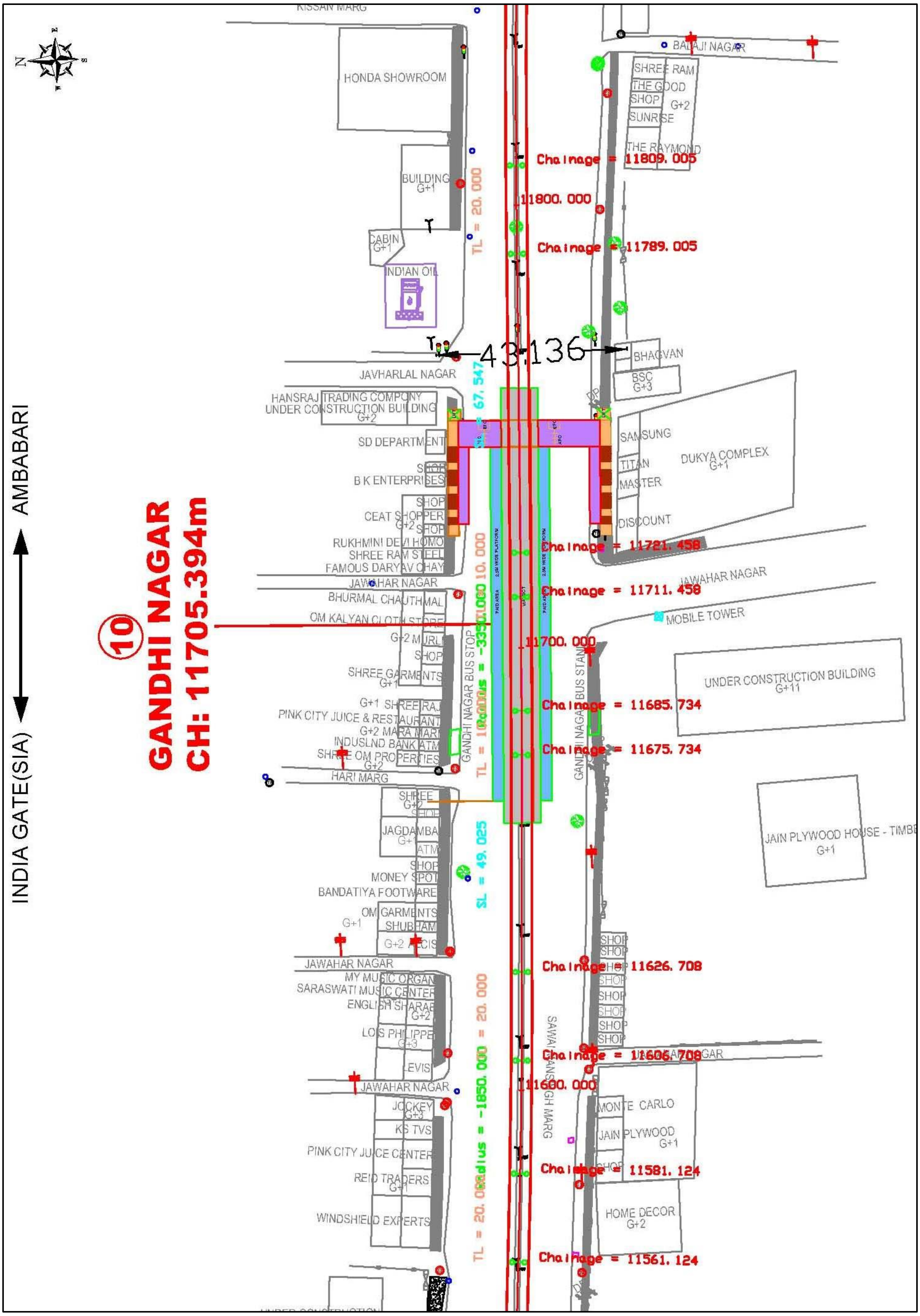
INDIA GATE(SIA)
AMBABARI
7
DURGAPURA
CH: 9219.655m
DP - 1
AREA= 122Sqm
RAMCHARAN ROAD
RAMCHARAN ROAD
Chainage = 9308.446
Chainage = 9288.446
Chainage = 9194.111
Chainage = 9174.111
Chainage = 9136.705
Chainage = 9116.705
Chainage = 9069.459
9300.000
9200.000
9100.000
BABA BALWANT SEVA
GOVT VERTERINARY CLINIC DURGAPURA JAIPUR
PUBLIC TOILET
VG NAGAR
BHARAT BAKERS
BHARAT RESTAURANT
KHUSHI DHABA
GOVT SENIOR SECONDARY SCHOOL DURGAPUR
LAXMI GENERAL STORE
JAGDISH MALI VEGETABLE & FRUIT SHO
BATA SHOWROOM
SIYARAM MEDICAL & PROVISION STORE
RAJSHREE COMMUNICATION
VIKASH MISTHAN BHANDAR
KAMAL JUICE CENTER
R.K. DJ SOUND
JAIN AYURVEDIC & PROVISION STORE
PARJAPATI KIRANA STORE
SONU ELECTRONICS & SERVICE CENTER
ASHOKA ELECTRONICS & MOBILE POINT
A-ONE AVIATION SERVICES
GANESH FURNITURE STORE
SR ELECTRONIC
KAILASH TOWER
STRAINGHTLINE S=FURNITURE
G+2
KANJI BOOKS & ROJGAR & BOOK CENTER
MELA STHL
G+1
JHULELAL TEMPLE
BUILDING
G+2



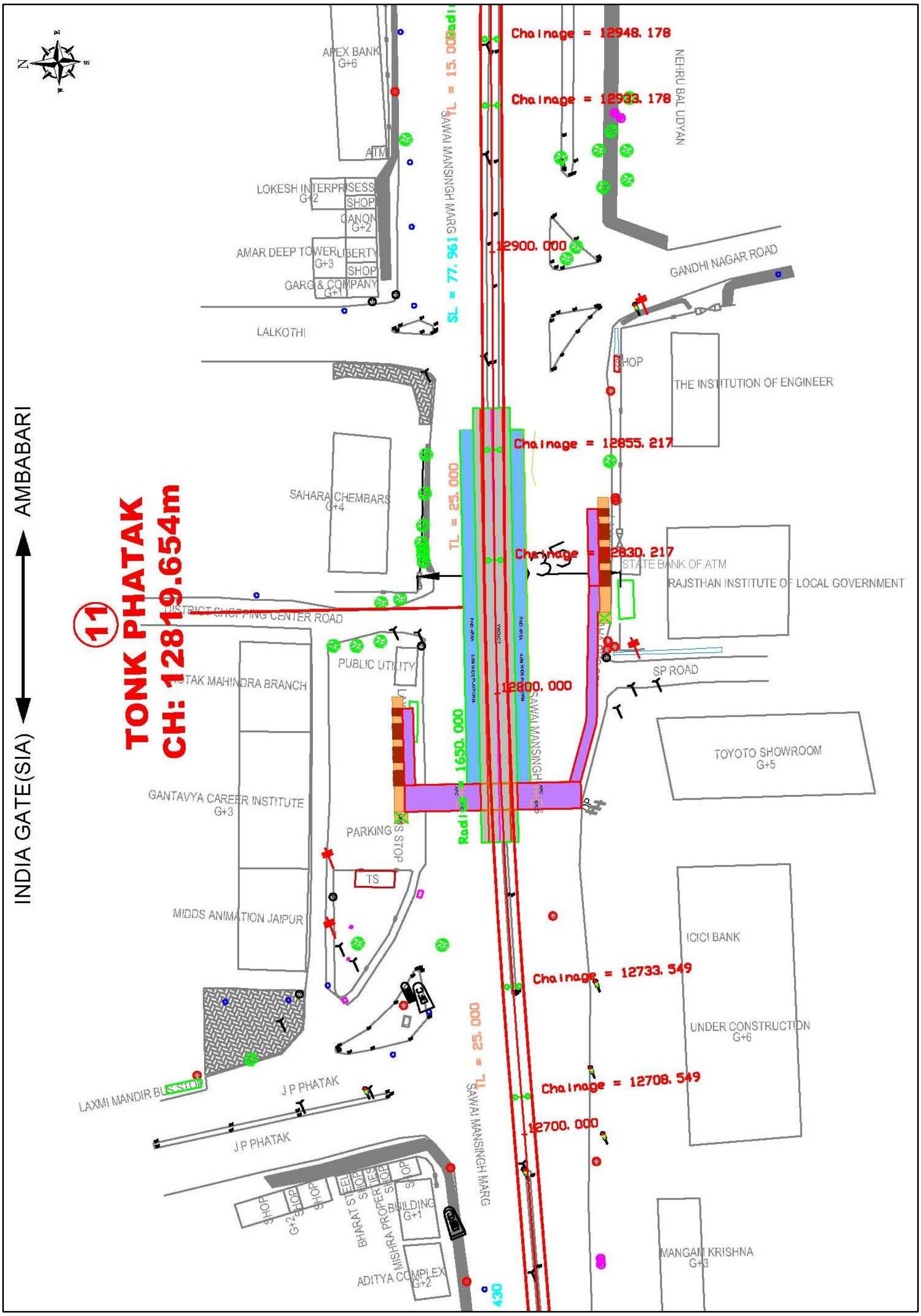
8
MAHAVEER NAGAR
CH: 9984.491m
INDIA GATE(SIA)
AMBABARI
SRJ 1 in 9
RAJSI CEMESTRI POINT
JEWELS OF JAIN
ANNPURIMA KIRANA STORE
GANESH PAVITRA BHOJNALAYA
ANDA WALAS
JIO DIGITAL
DELL EXCLUSIVE STORE
SHAU ICE CREAM
BHARGAV OPTICALS
P3 BAKERS
H P WORLD WELL WIN
JAIN OPTICALS
BF TOWER
G+3
JAIPUR HOSPITAL
G+5
80 FEET ROAD
KAILASH PURI COLOY
BOMBAY DYEING STORE
SHRI SAI FRUITS &
GOPAL TOWER
G+4
SHREE PHAL EVAM SABJI VIKRETA
FRUIT MARKET
TANDOORI CHUSKI
MOBILE TOWER
ANGREJI SHARAB BIER
J J CREATION
G+4
ENGINEERS ACADAMY
G+3
STOSA CUCINE
G+2
UNDER CONSTRUCTION
SANGHI PUBLIC SCHOOL
G+2
SBI
G+3
J OBEROI SWEETS
G+3
BMW
KHOSLA ELECTRONICS
G+3
VOLKS WAGEN JAIPUR
MOBILE TOWER
GREAT EASTER TRADING COMPANY
G+3
DAS WELTAUTO
GREEN TOURS TRAVELS
SHOP
JAIPRA MEDICAL
GRISTR
G+1
10100.000
10000.000
9900.000
36.468
RL = 709.500

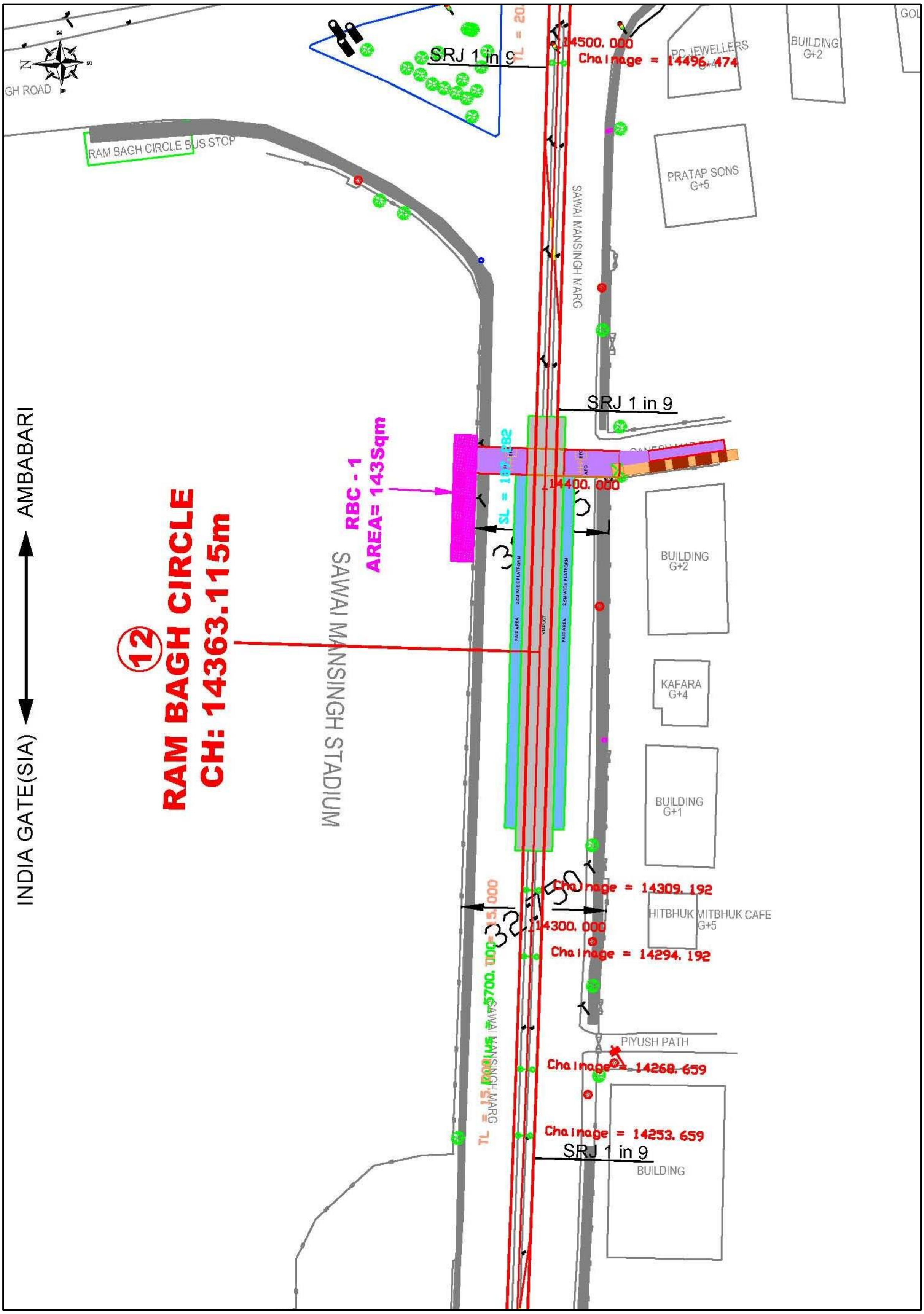


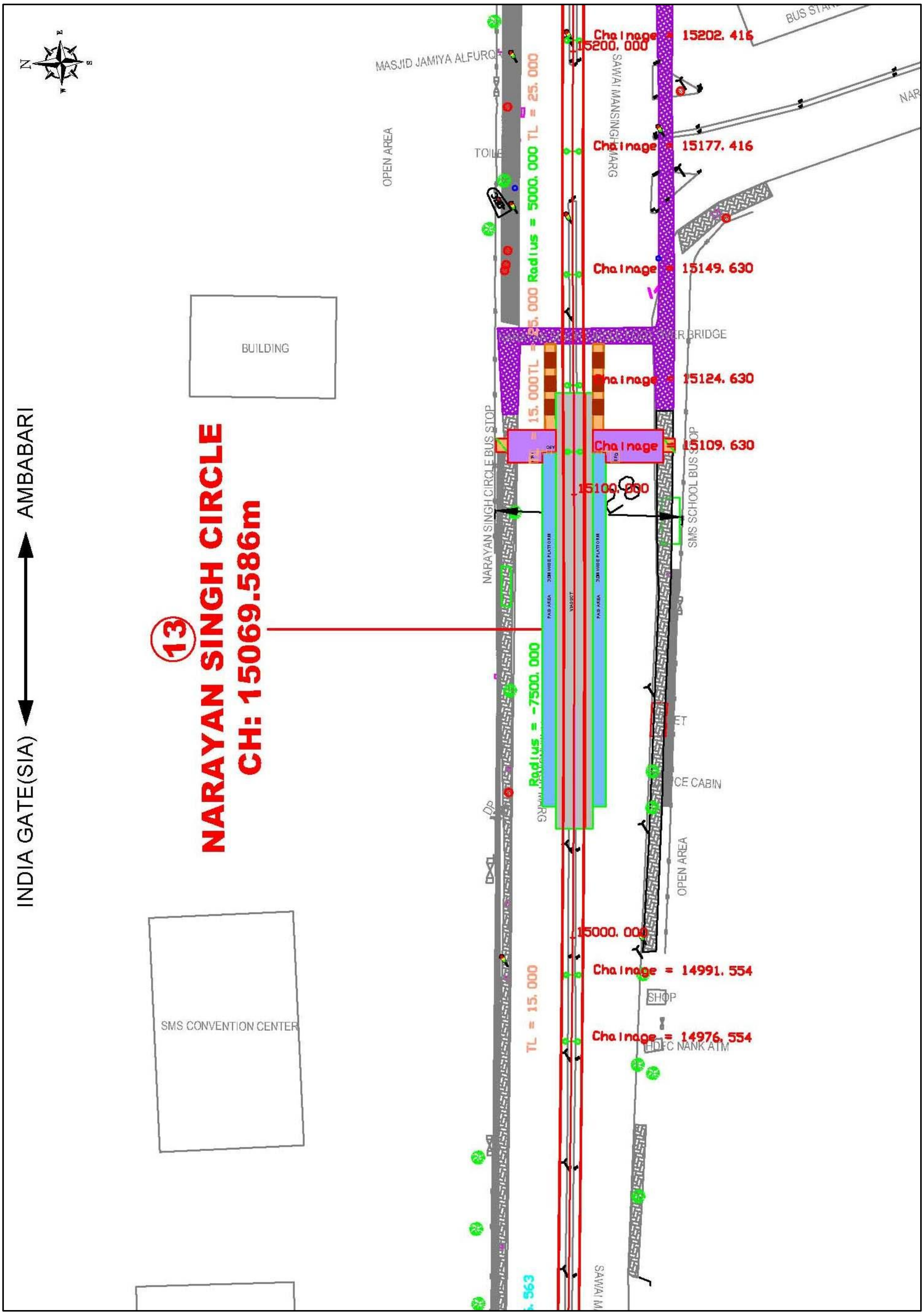
ICICI DIRECT
36.268
ANUPAM MEDICAL & GENERAL STORE
NEXUS G+2
MAHENDRA TWO WHEELER & AUTOMOBILE
MUNCHIES FAST FOOD
KHANDELWAL PHOTO STATE
ATM
BLACKBERRYS PREM ENTERPRISES
AMRIT KALASH G+5
SL = 321.264
DEV NAGAR ROAD
TATA MOTORS
ARROW USA1851
SHOP
G+1
LIVER POOL
RICH LOOK
CANTABIL
11100.000
BUNTI PHOTOS
MAHAVIR RADDI BHANDAR
FALAHAAR & KOTA KACHORI G+1
GALI NO 1
IDBI BANK G+6
CHICCEN MEDICAL G+3
ARTI MURTI ART
SWIGGY DELIVERY GO
CAPITAL EDUCATION
GP - 1
AREA= 158Sqm
KIRTI NAGAR
HP PETROL PUMP
TEA POINT ANKIT
KATTA
AMBABARI
INDIA GATE(SIA)
9
DEV NAGAR
CH: 11028.593m
UNDER CONSTRUCTION BUILDING G+4
AXIA BANK ATM
MANAV ASHRAM COLONY
NEW LIGHT COLONY
11000.000
SAWAI MANSINGH MARG
ROMMUS G+2
PIZZA & BURGER
MAHAVIR RABRI BHANDAR G+1
G+2
BHARAT JI SWEETS
MALVI URBAN CO-OPERATIVE BANK
G+2
Chainage = 10964.113
SHREE GANESH TRADERS
THE HOME STORY G+2
TL = 40.000
LADIES TAILORS HI-FI FASHION BOUTIQE
SHIV TEMPLE
NEW LIGHT COLONY
MOTHERS EDUCATION HUB BEST SSC G+3
10900.000
CITY SQUARE G+7
HOTEL KANHA

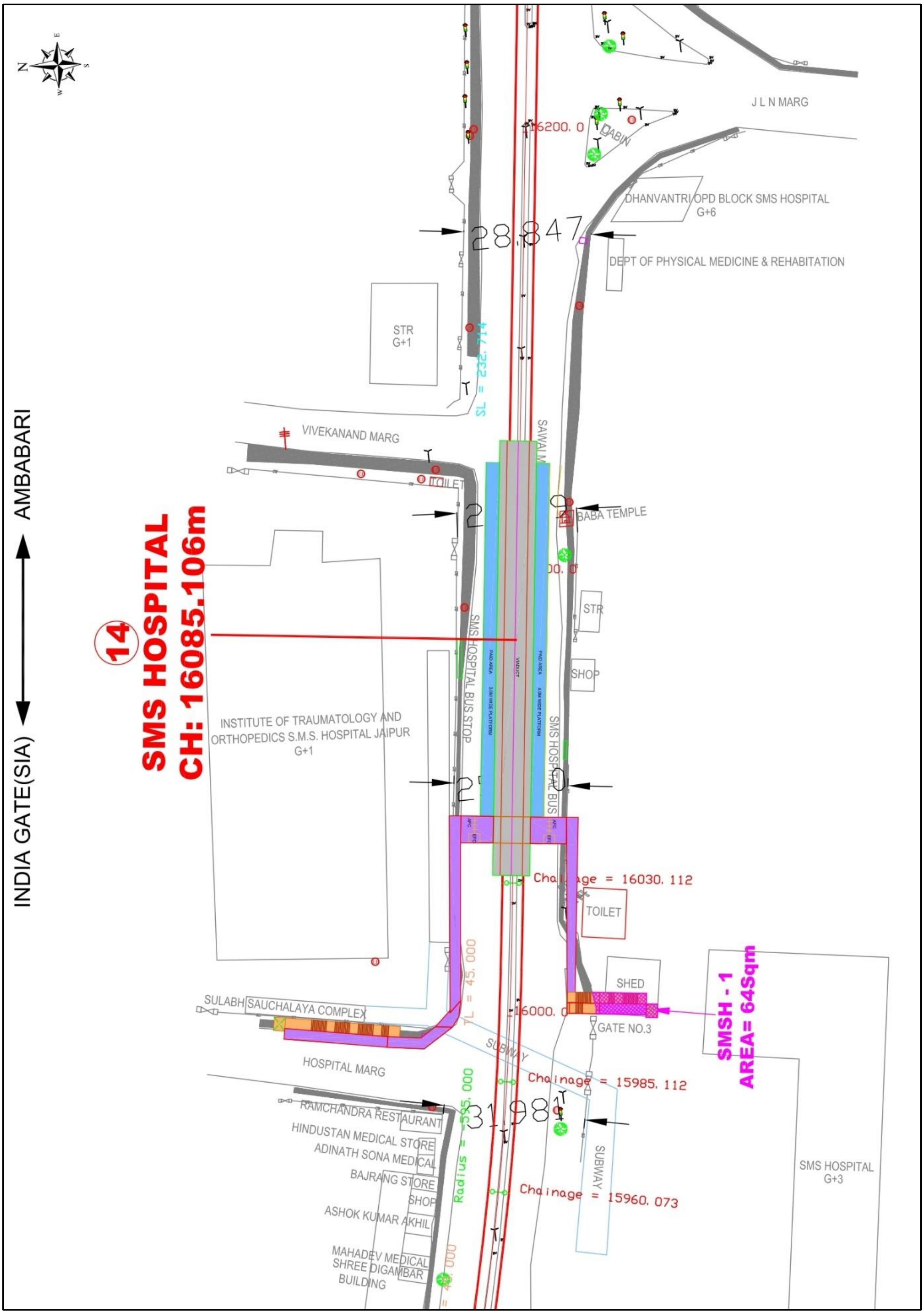


AMBABARI
INDIA GATE(SIA)
10
GANDHI NAGAR
CH: 11705.394m
KISSAN MARG
HONDA SHOWROOM
BUILDING G+1
CABIN G+1
INDIAN OIL
JAVHARLAL NAGAR
HANSRAJ TRADING COMPONY
UNDER CONSTRUCTION BUILDING G+2
SD DEPARTMENT
B K ENTERPRISES
CEAT SHOPPER G+2
RUKHMINI DEVI HOMO
SHREE RAM STEEL
FAMOUS DARYAV CHAY
JAWAHAR NAGAR
BHURMAL CHAUTHMAL
OM KALYAN CLOTH STORE
SHREE GARMENTS G+1
PINK CITY JUICE & RESTAURANT
INDUSLND BANK ATM
HARI MARG
GANDHI NAGAR BUS STOP
JAGDAMBA
MONEY SPOT
BANDATIYA FOOTWARE
OM GARMENTS
SHUBHAM
JAWAHAR NAGAR
MY MUSIC ORGAN
SARASWATI MUSIC CENTER
ENGLISH SHARAB G+2
LOIS PHILIPPE G+3
LEVIS
JAWAHAR NAGAR
JOCKEY G+3
KS TVS
PINK CITY JUICE CENTER
REID TRADERS G+1
WINDSHIELD EXPERTS
BALAJI NAGAR
SHREE RAM
THE GOOD SHOP G+2
SUNRISE
THE RAYMOND
Chainage = 11809.005
11800.000
Chainage = 11789.005
43.136
BHAGVAN
BSC G+3
SAMSUNG
TITAN
MASTER
DISCOUNT
DUKYA COMPLEX G+1
Chainage = 11721.458
Chainage = 11711.458
JAWAHAR NAGAR
MOBILE TOWER
11700.000
UNDER CONSTRUCTION BUILDING G+11
GANDHI NAGAR BUS STAND
Chainage = 11685.734
Chainage = 11675.734
JAIN PLYWOOD HOUSE - TIMBE G+1
Chainage = 11626.708
Chainage = 11606.708
SAWAI MANSINGH MARG
11600.000
MONTE CARLO
JAIN PLYWOOD G+1
Chainage = 11581.124
HOME DECOR G+2
Chainage = 11561.124
TL = 20.000
SL = 67.547
TL = 10.000
SL = 49.025
TL = 20.000


AMBABARI
INDIA GATE(SIA)
11
TONK PHATAK
CH: 12819.654m
Chainage = 12948.178
Chainage = 12933.178
12900.000
Chainage = 12855.217
Chainage = 12830.217
12800.000
Chainage = 12733.549
Chainage = 12708.549
12700.000
SL = 77.961
TL = 15.000
TL = 25.000
Radius = 1650.000
SAWAI MANSINGH MARG
NEHRU BAL UDYAN
GANDHI NAGAR ROAD
THE INSTITUTION OF ENGINEER
STATE BANK OF ATM
RAJSTHAN INSTITUTE OF LOCAL GOVERNMENT
SP ROAD
TOYOTO SHOWROOM
G+5
ICICI BANK
UNDER CONSTRUCTION
G+6
MANGAM KRISHNA
G+3
APEX BANK
G+6
ATM
LOKESH INTERPRISESS
G+2
SHOP
CANON
G+2
AMAR DEEP TOWER
G+3
LIBERTY
SHOP
GARG & COMPANY
G+1
LALKOTHI
SAHARA CHEMBARS
G+4
DISTRICT SHOPPING CENTER ROAD
PUBLIC UTILITY
KOTAK MAHINDRA BRANCH
GANTAVYA CAREER INSTITUTE
G+3
PARKING
BUS STOP
TS
MIDDS ANIMATION JAIPUR
LAXMI MANDIR BUS STOP
J P PHATAK
J P PHATAK
SHOP
BHARAT STEEL
MISHRA PROPERTIES
BUILDING
G+1
ADITYA COMPLEX
G+2
430


INDIA GATE(SIA)
AMBABARI
12
RAM BAGH CIRCLE
CH: 14363.115m
RBC - 1
AREA= 143Sqm
SAWAI MANSINGH STADIUM
SAWAI MANSINGH MARG
RAM BAGH CIRCLE BUS STOP
SRJ 1 in 9
SRJ 1 in 9
SRJ 1 in 9
14500. 000
Chainage = 14496. 474
PC JEWELLERS
BUILDING G+2
PRATAP SONS G+5
14400. 000
BUILDING G+2
KAFARA G+4
BUILDING G+1
Chainage = 14309. 192
14300. 000
HITBHUK MITBHUK CAFE G+5
Chainage = 14294. 192
PIYUSH PATH
Chainage = 14268. 659
Chainage = 14253. 659
BUILDING


INDIA GATE(SIA)
AMBABARI
13
NARAYAN SINGH CIRCLE
CH: 15069.586m
BUILDING
SMS CONVENTION CENTER
MASJID JAMIYA ALFURQ
OPEN AREA
NARAYAN SINGH CIRCLE BUS STOP
SMS SCHOOL BUS STOP
SAWAI MANSINGH MARG
Chainage = 15202.416
15200.000
Chainage = 15177.416
Chainage = 15149.630
Chainage = 15124.630
Chainage = 15109.630
15100.000
15000.000
Chainage = 14991.554
Chainage = 14976.554
SHOP
HDFC NANK ATM
Radius = 5000.000 TL = 25.000
TL = 15.000
Radius = -7500.000
BUS STAND


AMBABARI
INDIA GATE(SIA)
14
SMS HOSPITAL
CH: 16085.106m
J L N MARG
DHANVANTRI OPD BLOCK SMS HOSPITAL
G+6
DEPT OF PHYSICAL MEDICINE & REHABILITATION
16200. 0
28.847
STR
G+1
VIVEKANAND MARG
TOILET
BABA TEMPLE
STR
SHOP
SMS HOSPITAL BUS STOP
INSTITUTE OF TRAUMATOLOGY AND
ORTHOPEDICS S.M.S. HOSPITAL JAIPUR
G+1
Chainage = 16030. 112
TOILET
SHED
SMSH - 1
AREA= 64Sqm
16000. 0
GATE NO.3
SULABH SAUCHALAYA COMPLEX
HOSPITAL MARG
SUBWAY
Chainage = 15985. 112
31.981
RAMCHANDRA RESTAURANT
HINDUSTAN MEDICAL STORE
ADINATH SONA MEDICAL
BAJRANG STORE
SHOP
ASHOK KUMAR AKHIL
MAHADEV MEDICAL
SHREE DIGAMBAR
BUILDING
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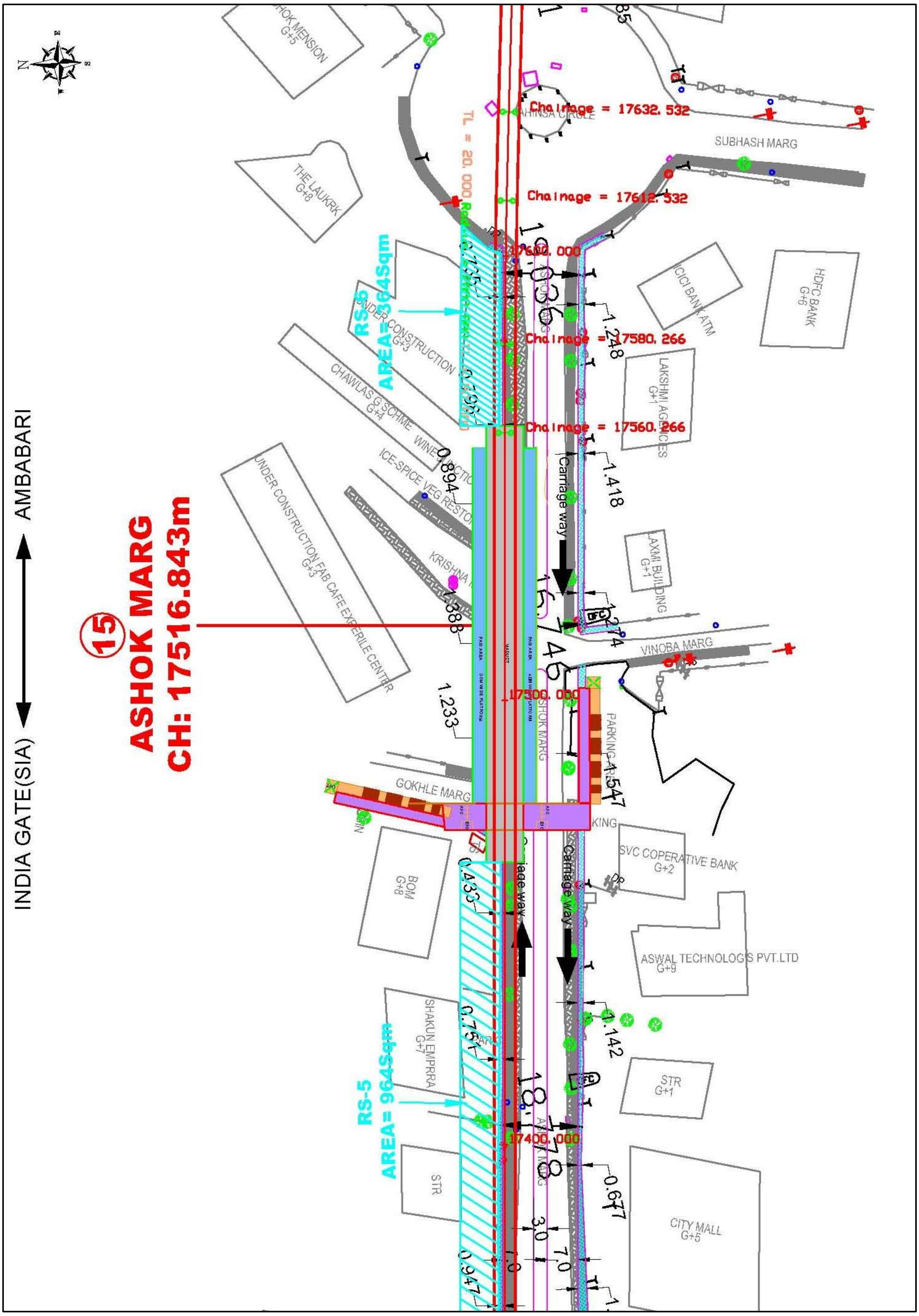
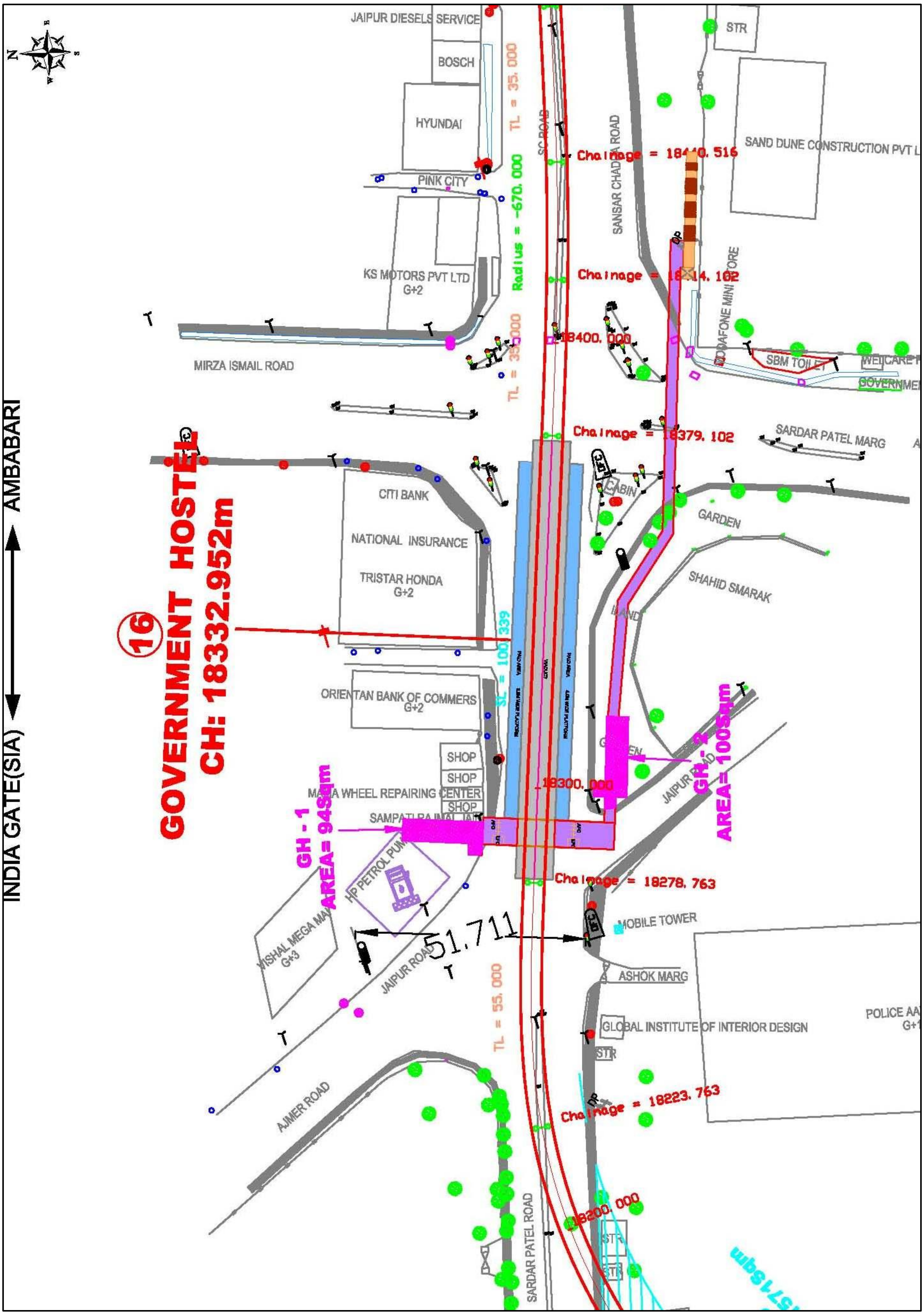
SUBWAY
SMS HOSPITAL
G+3


INDIA GATE(SIA)
AMBABARI
15
ASHOK MARG
CH: 17516.843m
RS-6
AREA=364Sqm
RS-5
AREA= 964Sqm
Chainage = 17632.532
Chainage = 17612.532
Chainage = 17580.266
Chainage = 17560.266
17600.000
17500.000
17400.000
SUBHASH MARG
VINOBA MARG
GOKHLE MARG
Carriage way
PARKING
SVC COPERATIVE BANK
G+2
ASWAL TECHNOLOGIS PVT.LTD
G+9
CITY MALL
G+5
STR
G+1
BOM
G+8
SHAKUN EMPRRA
G+7
HDFC BANK
G+6
ICICI BANK ATM
LAKSHMI AGENCIES
G+1
LAXMI BUILDING
G+1
THE LAUKRK
G+8
UNDER CONSTRUCTION
G+3
CHAWLAS G SCHME
G+4
ICE-SPICE VEG RESTO
UNDER CONSTRUCTION FAB CAFE EXPERILE CENTER
G+3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AMBABARI
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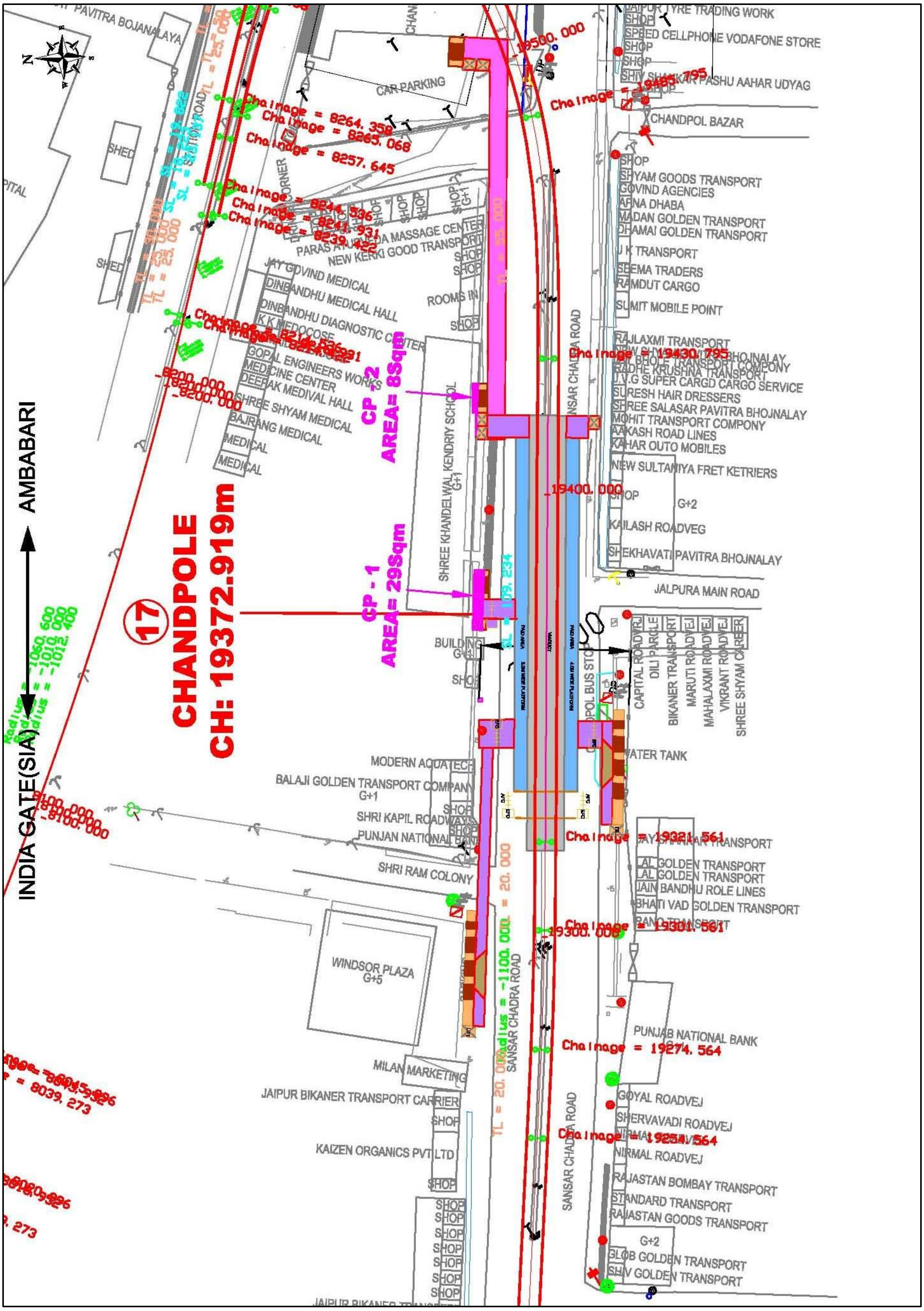
AREA= 945sqm
GH - 2
AREA= 1005sqm
Chainage = 18440.516
Chainage = 18414.102
18400.000
Chainage = 18379.102
18300.000
Chainage = 18278.763
Chainage = 18223.763
18200.000
TL = 35.000
TL = 55.000
Radius = -670.000
SL = 100.339
51.711
JAIPUR DIESELS SERVICE
BOSCH
HYUNDAI
PINK CITY
KS MOTORS PVT LTD
G+2
MIRZA ISMAIL ROAD
SC ROAD
SANSAR CHADRA ROAD
SAND DUNE CONSTRUCTION PVT L
STR
VODAFONE MINI STORE
SBM TOILET
SARDAR PATEL MARG
CABIN
GARDEN
SHAHID SMARAK
CITI BANK
NATIONAL INSURANCE
TRISTAR HONDA
G+2
ORIENTAN BANK OF COMMERS
G+2
SHOP
SHOP
SHOP
WHEEL REPAIRING CENTER
HP PETROL PUMP
VISHAL MEGA MA
G+3
JAIPUR ROAD
MOBILE TOWER
ASHOK MARG
GLOBAL INSTITUTE OF INTERIOR DESIGN
POLICE
AJMER ROAD
SARDAR PATEL ROAD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CP - 1
AREA= 29Sqm
CP - 2
AREA= 8Sqm
CHANDPOL BAZAR
JALPURA MAIN ROAD
SANSAR CHANDRA ROAD
WINDSOR PLAZA
G+5
CAR PARKING
WATER TANK
PUNJAB NATIONAL BANK
MILAN MARKETING
SHRI RAM COLONY
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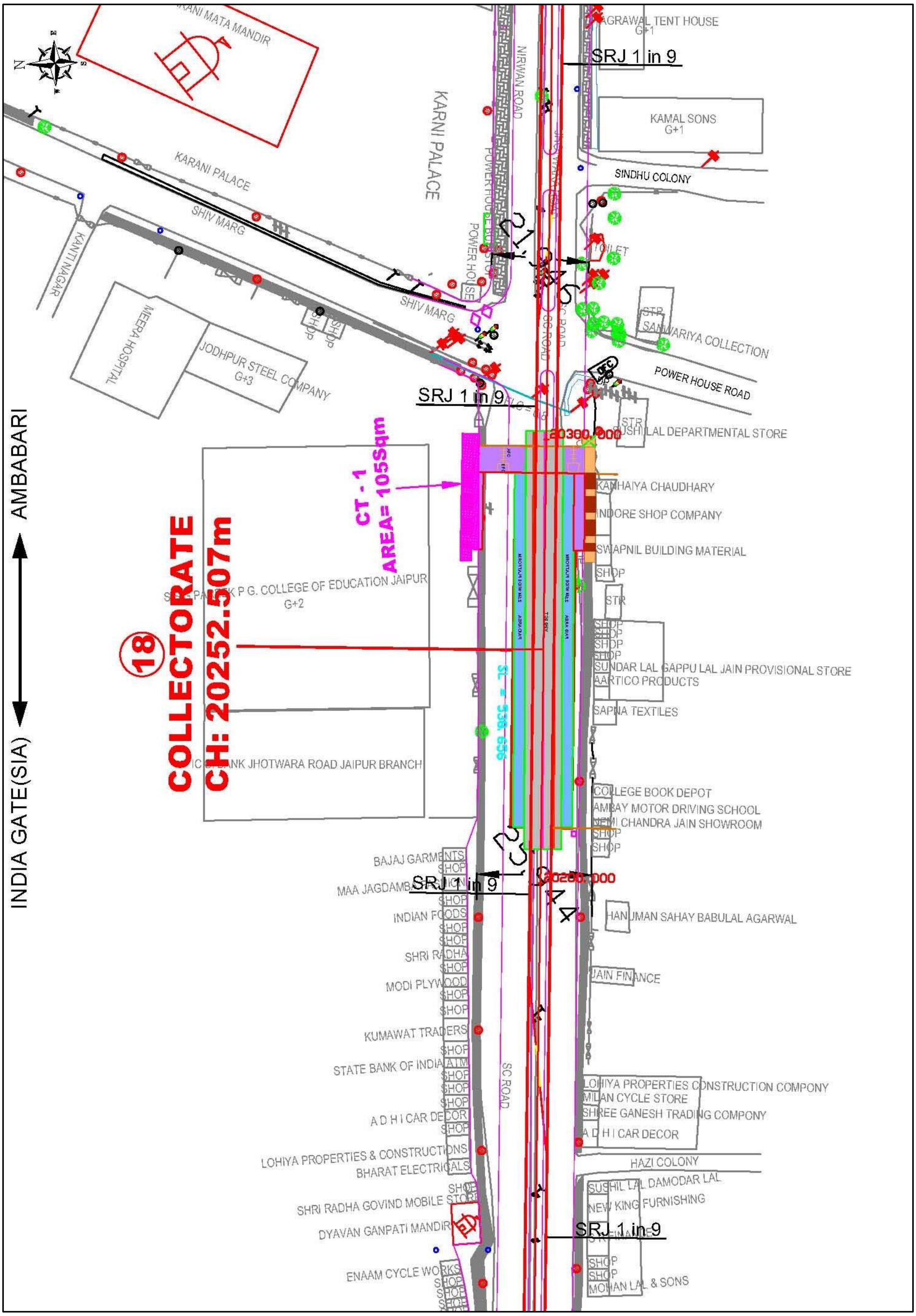
19500.000


AMBABARI
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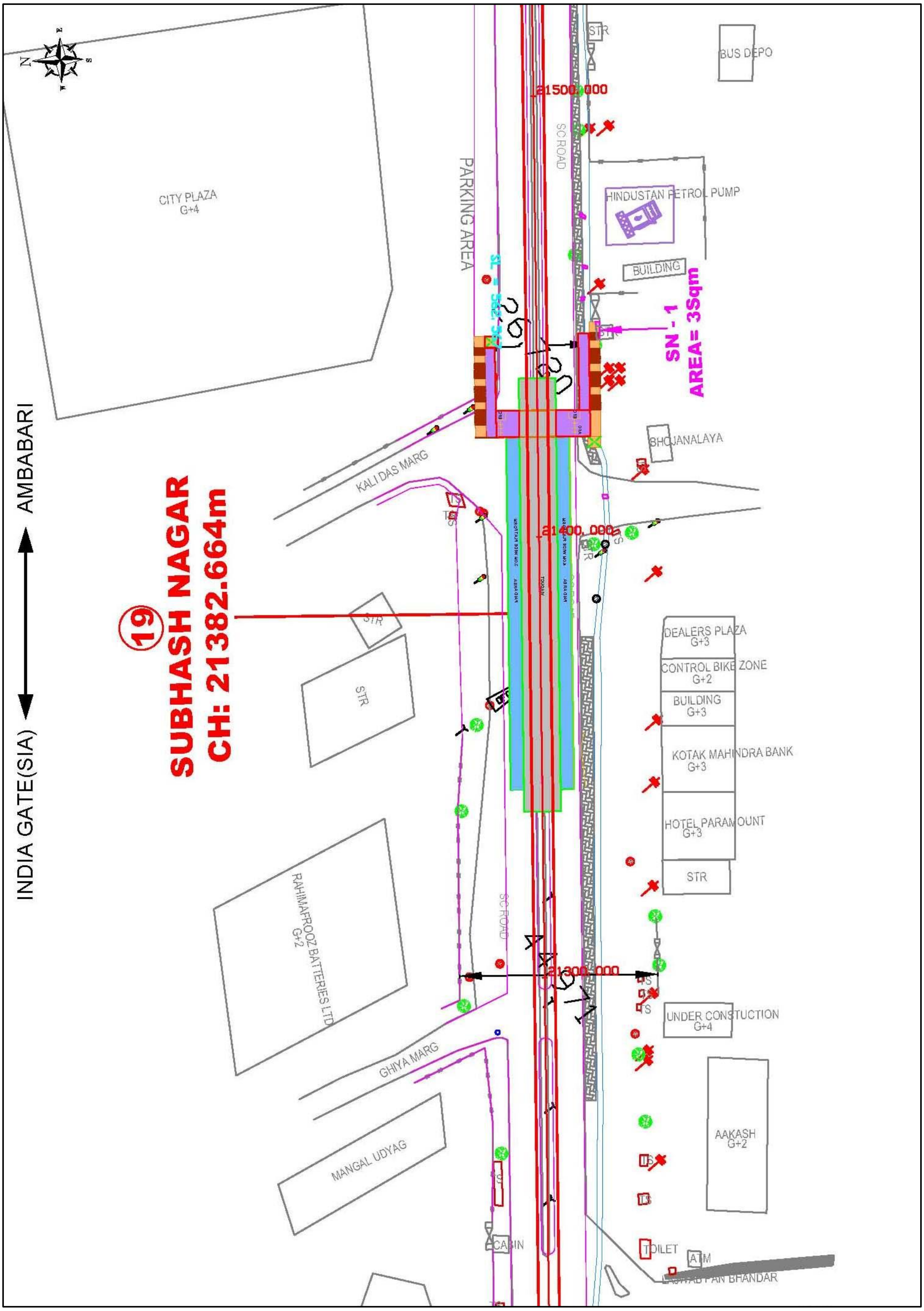
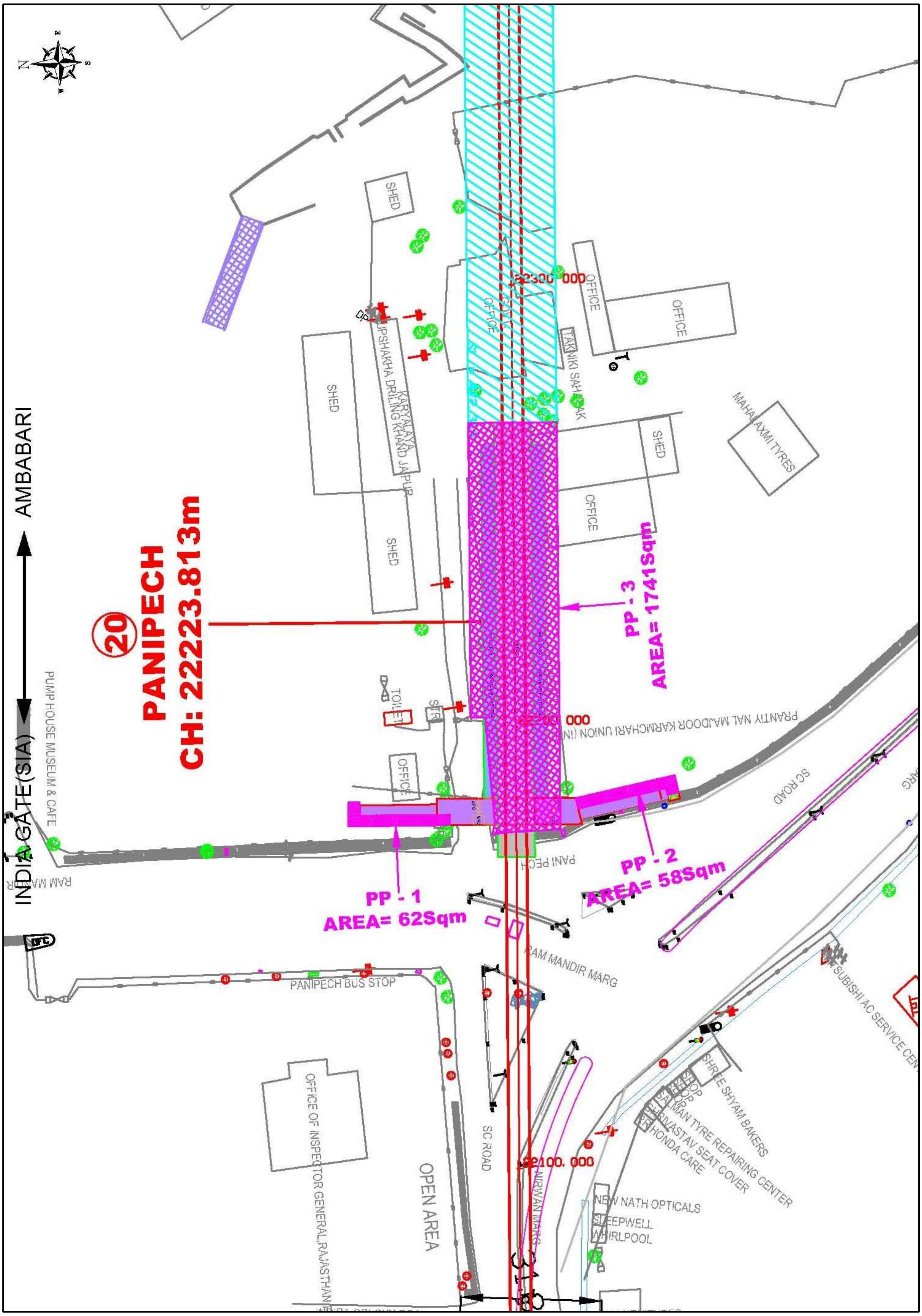
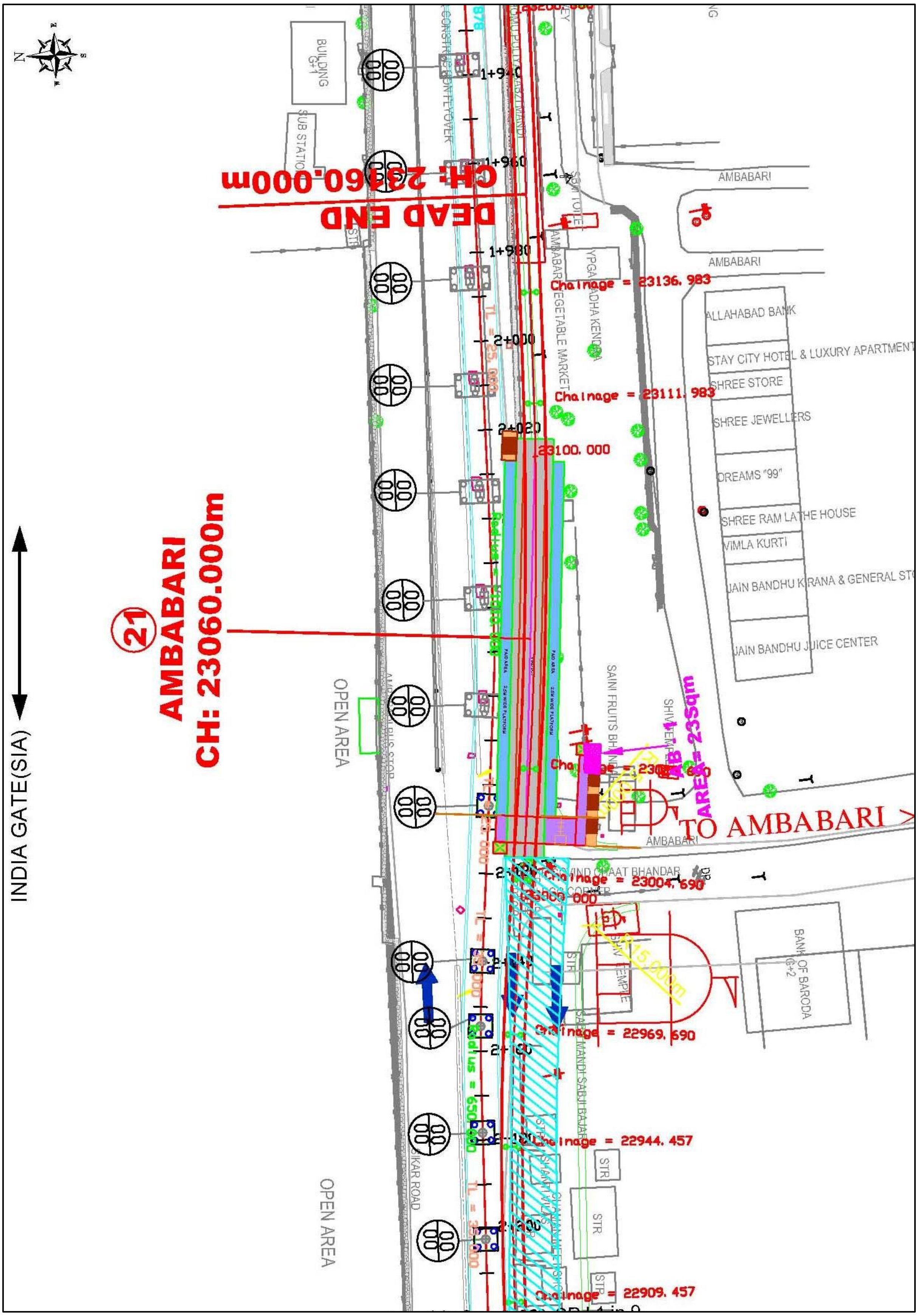
COLLECTORATE
CH: 20252.507m
CT - 1
AREA= 105Sqm
SRJ 1 in 9
SRJ 1 in 9
SRJ 1 in 9
SRJ 1 in 9
KARANI PALACE
SHIV MARG
KANTI NAGAR
MEERA HOSPITAL
JODHPUR STEEL COMPANY
G+3
KARNI PALACE
NIRWAN ROAD
POWER HOUSE ROAD
SC ROAD
AGRAWAL TENT HOUSE
G+1
KAMAL SONS
G+1
SINDHU COLONY
TOILET
SANWARIYA COLLECTION
STR
POWER HOUSE ROAD
SUSHIL LAL DEPARTMENTAL STORE
20300.000
KANHAIYA CHAUDHARY
INDORE SHOP COMPANY
SWAPNIL BUILDING MATERIAL
SHOP
SUNDAR LAL GAPPU LAL JAIN PROVISIONAL STORE
AARTICO PRODUCTS
SAPNA TEXTILES
COLLEGE BOOK DEPOT
AMBAY MOTOR DRIVING SCHOOL
HEMI CHANDRA JAIN SHOWROOM
20200.000
HANUMAN SAHAY BABULAL AGARWAL
JAIN FINANCE
LOHIYA PROPERTIES CONSTRUCTION COMPONY
MILAN CYCLE STORE
SHREE GANESH TRADING COMPONY
A D H I CAR DECOR
HAZI COLONY
SUSHIL LAL DAMODAR LAL
NEW KING FURNISHING
MOHAN LAL & SONS
ICICI BANK JHOTWARA ROAD JAIPUR BRANCH
P G. COLLEGE OF EDUCATION JAIPUR
G+2
SL = 538.656
BAJAJ GARMENTS
MAA JAGDAMBA
INDIAN FOODS
SHRI RADHA
MODI PLYWOOD
KUMAWAT TRADERS
STATE BANK OF INDIA ATM
A D H I CAR DECOR
LOHIYA PROPERTIES & CONSTRUCTIONS
BHARAT ELECTRICALS
SHRI RADHA GOVIND MOBILE STORE
DYAVAN GANPATI MANDIR
ENAAM CYCLE WORKS


INDIA GATE(SIA)
AMBABARI
SUBHASH NAGAR
CH: 21382.664m
19
SN - 1
AREA= 3Sqm
CITY PLAZA
G+4
PARKING AREA
SC ROAD
BUS DEPO
HINDUSTAN PETROL PUMP
BUILDING
BHOJANALAYA
KALI DAS MARG
DEALERS PLAZA
G+3
CONTROL BIKE ZONE
G+2
BUILDING
G+3
KOTAK MAHINDRA BANK
G+3
HOTEL PARAMOUNT
G+3
STR
RAHIMAFROOZ BATTERIES LTD
G+2
UNDER CONSTUCTION
G+4
GHIYA MARG
MANGAL UDYAG
AAKASH
G+2
CABIN
TOILET
ATM
21500.000
21400.000
21300.000


AMBABARI
INDIA GATE(SIA)
20
PANIPECH
CH: 22223.813m
PP - 3
AREA= 1741Sqm
PP - 1
AREA= 62Sqm
PP - 2
AREA= 58Sqm
PUMP HOUSE MUSEUM & CAFE
PANIPECH BUS STOP
RAM MANDIR MARG
SC ROAD
OPEN AREA
OFFICE OF INSPECTOR GENERAL,RAJASTHAN
SHED
OFFICE
MAHALAXMI TYRES
SHREE SHYAM BAKERS
HONDA CARE
NEW NATH OPTICALS


INDIA GATE(SIA)
21
AMBABARI
CH: 23060.000m
DEAD END
CH: 23160.000m
TO AMBABARI
OPEN AREA
AMBABARI
ALLAHABAD BANK
STAY CITY HOTEL & LUXURY APARTMENT
SHREE STORE
SHREE JEWELLERS
DREAMS "99"
SHREE RAM LATHE HOUSE
VIMLA KURTI
JAIN BANDHU KIRANA & GENERAL ST
JAIN BANDHU JUICE CENTER
BANK OF BARODA G+2
BUILDING G+1
Chainage = 23136.983
Chainage = 23111.983
23100.000
Chainage = 23004.690
Chainage = 22969.690
Chainage = 22944.457
Chainage = 22909.457

CHAPTER 6 – STATION PLANNING

6.1 General

6.2 Rail Levels and Alignment

6.3 Platforms

6.4 Sequence of Stations

6.5 Planning and Design Criteria for Stations

6.6 Passenger Amenities

CHAPTER - 6

STATION PLANNING

6.1 GENERAL

Stations on the Line

The proposed Corridor of Jaipur Metro Phase II has 21 Elevated stations covering a distance of 23.51km. Almost all the stations of this corridor are located on or beside the road. This Corridor comprises following 21 stations.

S.No.	Station Name
1	India Gate (SIA)
2	Kumbha Marg
3	Haldi Ghati Gate
4	Pinjra Pole Gaushala
5	Sanganer Sethu
6	B2 Bypass Circle
7	Durgapura
8	Mahaveer Nagar
9	Dev Nagar
10	Gandhi Nagar
11	Tonk Phatak
12	Ram Bagh Circle
13	Narayan Singh Circle
14	SMS Hospital
15	Ashok Marg
16	Government Hostel
17	Chandpole
18	Collectorate
19	Subhash Nagar
20	Panipech
21	Ambabari

The locations of stations are defined so as to serve passenger requirements and to enable convenient integration with other modes of transport. Efforts have been made to propose stations at a uniform inter-station distance wherever possible. Average inter-station distance is 1.153 km, though it varies from 0.677 km to 2.483 km due to land-use and topographic reasons.

Fig. 6.1: Jaipur Metro Rail Project (India Gate (SIA) To Ambabari Corridor)

6.2 RAIL LEVELS AND ALIGNMENT

The rail levels in the stations are decided to provide sufficient clearance (Headroom) for the traffic on the road. In this Elevated corridor, Rail Level is generally about 10.2m above the ground in order to maintain a clearance of 5.50 m between the Road and the Station Structure. The alignment is planned generally at the median of the road in order to keep the land acquisition to minimum, and a two-level station design has been proposed. Entry/exit structures to the proposed stations and Multimodal integration areas have been planned in the open spaces available beside the road.

6.3 PLATFORMS

Elevated station platforms are side platforms which are 3m. wide. These platforms are connected to Entry structures/FOB below viaduct by staircases at the ends. Overall station design is sleek in nature and virtually there is no concourse structure beneath the platforms. Only a connecting passage and system room space are planned beneath the viaduct. The stations have been planned with side platforms to avoid the viaduct structure from flaring in and out at stations, which obstructs the road traffic below. Care has been taken to locate stations on straight alignment.

6.4 SEQUENCE OF STATIONS

The sequence of stations along with their respective chainages, interstation distances and platform characteristics are presented in the Table 6.1.

Table 6.1: Station List

S. No.	Station Name	Chainage(m)	Inter-station Distance	REMARKS
	DEAD END	-350.000		
1	INDIA GATE(SIA)	0.000		SIDE PLATFORMS
2	KUMBHA MARG	1599.564	1599.564	SIDE PLATFORMS
3	HALDI GHATI GATE	2439.871	840.307	SIDE PLATFORMS
4	PINJRA POLE GAUSHALA	3357.734	917.863	SIDE PLATFORMS
5	SANGANER SETHU	5431.316	2073.582	SIDE PLATFORMS
6	B2 BYPASS CIRCLE	7914.327	2483.011	SIDE PLATFORMS
7	DURGAPURA	9219.655	1305.328	SIDE PLATFORMS
8	MAHAVEER NAGAR	9984.491	764.836	SIDE PLATFORMS
9	DEV NAGAR	11028.593	1044.102	SIDE PLATFORMS
10	GANDHI NAGAR	11705.394	676.801	SIDE PLATFORMS
11	TONK PHATAK	12819.654	1114.260	SIDE PLATFORMS
12	RAM BAGH CIRCLE	14363.115	1543.461	SIDE PLATFORMS
13	NARAYAN SINGH CIRCLE	15069.586	706.471	SIDE PLATFORMS
14	SMS HOSPITAL	16085.106	1015.520	SIDE PLATFORMS
15	ASHOK MARG	17516.843	1431.737	SIDE PLATFORMS
16	GOVERNMENT HOSTEL	18332.952	816.109	SIDE PLATFORMS
17	CHANDPOLE	19372.919	1039.967	SIDE PLATFORMS
18	COLLECTORATE	20252.507	879.588	SIDE PLATFORMS
19	SUBHASH NAGAR	21382.664	1130.157	SIDE PLATFORMS
20	PANIPECH	22223.813	841.149	SIDE PLATFORMS
21	AMBABARI	23060.000	836.187	SIDE PLATFORMS
	Dead End	23160.000		

6.5 PLANNING AND DESIGN CRITERIA FOR STATIONS

1. The stations can be divided into public and non-public areas (those areas where access is restricted). The public areas can be further subdivided into paid and unpaid areas.

2. The platform level has adequate assemble space for passengers for both normal operating conditions and a recognized abnormal scenario.

3. The platform level at elevated stations is determined by a critical clearance of 5.5m under the concourse above the road intersection, allowing 3.4m for the system rooms height, about 0.8m for concourse floor and 0.8 m for structure of tracks above the concourse. Further, the platforms are 1.09-m above the tracks. This would make the rail level in an elevated situation at least 10.2 meters above ground.

4. The mid level of the station provides FOB connection for the unpaid connectivity between both sides of the road. Automatic fare collection system is provided on the platform level which divides the platform in paid and unpaid areas. The “Unpaid Area” is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the “Paid Area” (here only platform area), which provides access to the train.

5. The arrangement of the concourse (here FOB and a small system room space) has easy access on these stations. Stairs, Ticket machines and AFC gates are positioned to minimize cross flows of passengers and provide adequate circulation space.

6. Sufficient space for queuing and passenger flow has been allowed at the AFC gates.

7. Station entrances are located with particular reference to passenger catchment points and physical site constraints allowing for required right-of-way in order to provide a minimum of lane width under the station building on either side of the median.

8. The DG set, Bore Well, Pump House and Underground Water Tanks would be located generally in one area on ground within the Entry / Exit structures.

9. The system is being designed to maximize its attraction to potential passengers and the following criteria have been observed:
   - Minimum distance of travel to and from the platform and between platforms for transfer between lines.
   - Adequate capacity for passenger movements.
   - Convenience, including good signage relating to circulation and orientation.
   - Safety and security, including a high level of protection against accidents.

10. Following requirements have been taken into account:
   - Minimum capital cost is incurred consistent with maximizing passenger attraction.
   - Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.
   - Flexibility of operation including the ability to adapt to different traffic conditions changes in fare collection methods and provision for the continuity of operation during any extended maintenance, repair period, etc.
   - Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.
   - Provision of display of passenger information and advertising.

11. The numbers and sizes of staircases/escalators are determined by checking the capacity against AM and PM peak flow rates for both normal and emergency conditions such as delayed train service, fire etc.

12. In order to transfer passengers efficiently from street to platforms and vice versa, station planning has been based on established principles of pedestrian flow and arranged to minimize unnecessary walking distances and cross-flows between incoming and outgoing passengers.

13. Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit).

6.5.1 Typical Elevated Station:

The stations are generally located on the road median. Total length of the station is ~80 m. All the stations are two-level stations. The Technical room area with unpaid FOB connection is planned at one side of the platform with staircases leading from either side of the road. The maximum width of the station at concourse is ~14.5-m. Passenger facilities like ticketing, information, etc as well as Technical room area is provided at the FOB level.

All the stations are at the median of the road except one station i.e. Ambabari which is at one side of the road. Minimum vertical clearance of 5.5-m has been provided under the concourse above the road. Platforms are at a level of about 11.2 meters from the road. To reduce physical and visual impact of the elevated station, stations have been designed as cantilevered structures with single column located at the central verge of the road.

With respect to its spatial quality, an elevated Metro structure makes a great impact on the viewer as compared to At-grade or underground station. The positive dimension of this impact has been accentuated to enhance the acceptability of an elevated station and the above ground section of tracks. Structures that afford maximum transparency and are light looking have been envisaged. A slim concrete form is proposed, as they would look both compatible and modern high-rise environment as well as the lesser-built, low-rise developments along some parts of the metro corridors.

Platform roofs, that can invariably make a structure look heavy, have been proposed to be of steel frame with sleek Galvalume Sheets to achieve a light look. Platforms would be protected from the heat and rains by providing slopped overhang of the roof and sidewalls are avoided, thereby enhancing the transparent character of the station building.

It is proposed to install solar panels on the station roof to reduce energy demand of the station and to recharge the entire Rain water of the station and the viaduct for recharging the Underground aquifers.

6.6 PASSENGER AMENITIES

Passenger amenities such as ticketing counters/automatic ticket vending machines are provided at the FOB level.

The requirement of the facilities actually varies from station to station. The same applies to provision of platform widths and staircase/escalators. Maximum capacity required at any station has been calculated and the most critical year for emergency operation has been adopted for all stations.

For this purpose, peak minute traffic is assumed to be 2% of the peak hour traffic. For checking the adequacy of platform area, stair widths and requirement additional of emergency evacuation stairs, a maximum accumulation of passengers in the station has been considered to be comprising waiting passengers at the platform (including two missed headways) and section load expected to be evacuated at the station in case of an emergency.

6.6.1 Concourse

Concourse forms the interface between street and platforms. Usually, in elevated stations, this is contained along the full length of the station. This is where all the passenger amenities are provided. The concourse contains automatic fare collection system in a manner that divides the concourse into distinct paid and unpaid areas. The 'unpaid area’ is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the 'paid area’, which includes access to the platforms.

In the stations of this corridor instead of full length only space for Technical rooms is provided with a connecting FOB for both entry structure along the road. Ticketing system is provided along the FOB besides the Technical room area.

6.6.2 Ticketing Gates (AFC Gates)

Ticketing gates’ requirement has been calculated taking the gate capacity as 30 persons per minute per gate. Passenger forecast for the horizon year 2051 has been used to compute the maximum design capacity. At least two ticketing gates (one for Normal passenger and one for Wheel chair bound passenger) shall be provided at any station even if the design requirement is satisfied with only one gate. Uniform space has been provided in all stations where gates can be installed as and when required.

6.6.3 Ticket Counters and Ticket Vending Machines.

It is proposed to deploy manual ticket issuing in the beginning of the operation of the line. At a later stage, automatic Ticket Vending Machines would be used for which space provision has been made in the concourse. Capacity of manual ticket vending counters is taken to be 5 passengers per minute and it is assumed that only 40% of the commuters would purchase tickets at the stations while performing the journey. The rest are expected to buy prepaid tickets or prepaid card, etc. Accordingly, the requirement of ticket counters has been calculated and the same provided for in the plans.

6.6.4 Platforms

A uniform platform width of 3.00m wide side platforms have been proposed in all Elevated stations. These platform widths also have been checked for holding capacity of the platform for worst-case scenario.

6.6.5 Stairs, Escalators and Lifts

Provision has been made for staircases in the station area from FOB level to platform level on each platform. No escalator has been proposed. Instead two staircases are provided of width of 2.4 m located on each platform connecting to the FOB level.

These stairs provide an escape capacity adequate to evacuate maximum accumulated passengers in emergency from platforms to concourse in 5.5 minutes. Lifts have been provided one each on either platform, to provide access for elderly and disabled.

6.6.6 Fire Fighting Measures

Firefighting provisions in Elevated and Underground metro stations are in accordance with the National Building Code of India 2016 (part IV, Fire and Life Safety) Fire protection Annexure J (Clause 6.4.4)

STATION LOCATION AND PROXIMITY

1.	**Station**	**:**	**India Gate (SIA)**
	Chainage	**:**	0.000 m
	Inter station Distance	**:**	1599.564 m from Kumbha Marg station
	Rail Level	**:**	375.000m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Goverdhan Nagar, Shri Yogendra Nagar residential areas and RIICO Industrial areas, which will be the main source of passengers to the station

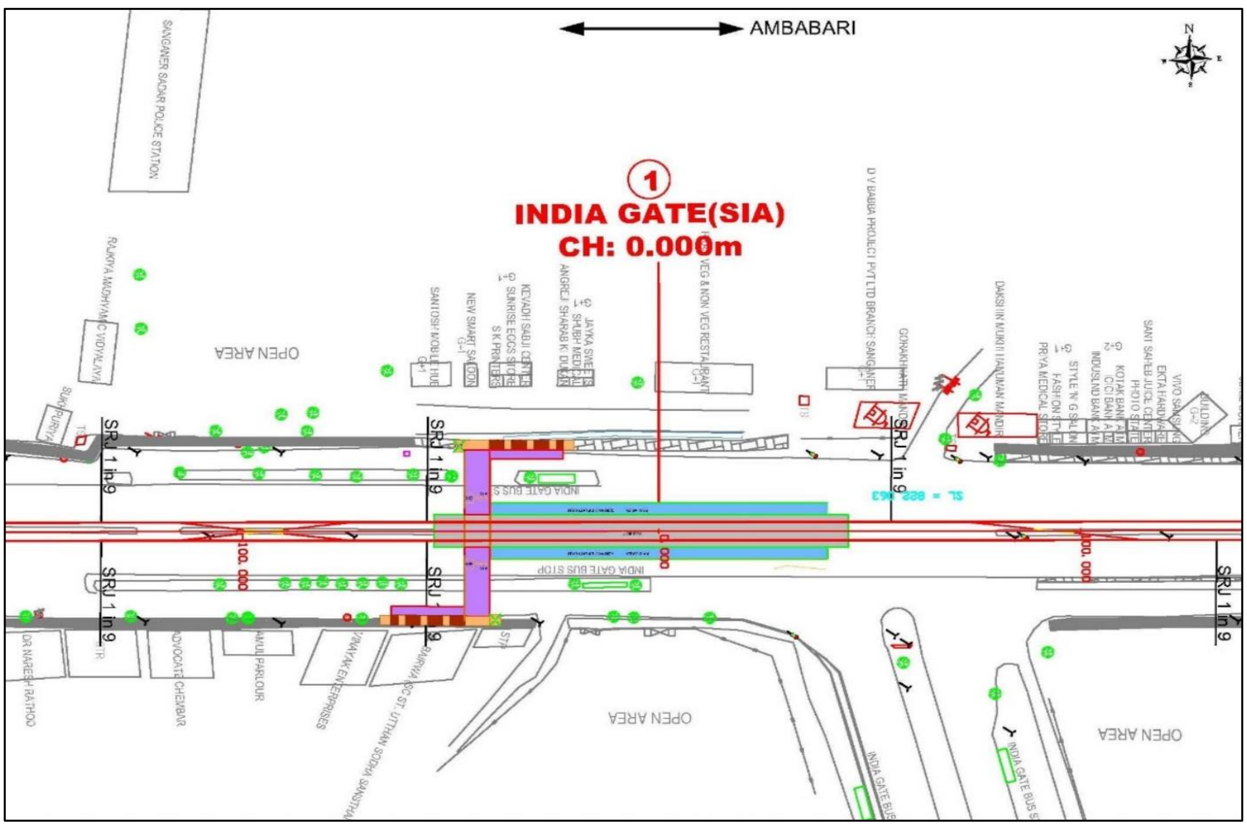


Figure 6.2: Site Conditions - India Gate (SIA)

2.	**Station**	**:**	**Kumbha Marg**
	Chainage	**:**	1599.564 m
	Inter station Distance	**:**	1599.564 m from India Gate(SIA) station
	Rail Level	**:**	378.700m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Sanganer and Pratap Nagar residential areas. Two big Hospitals NH and RUHS are also nearby. These will be the main source of passengers to the station.

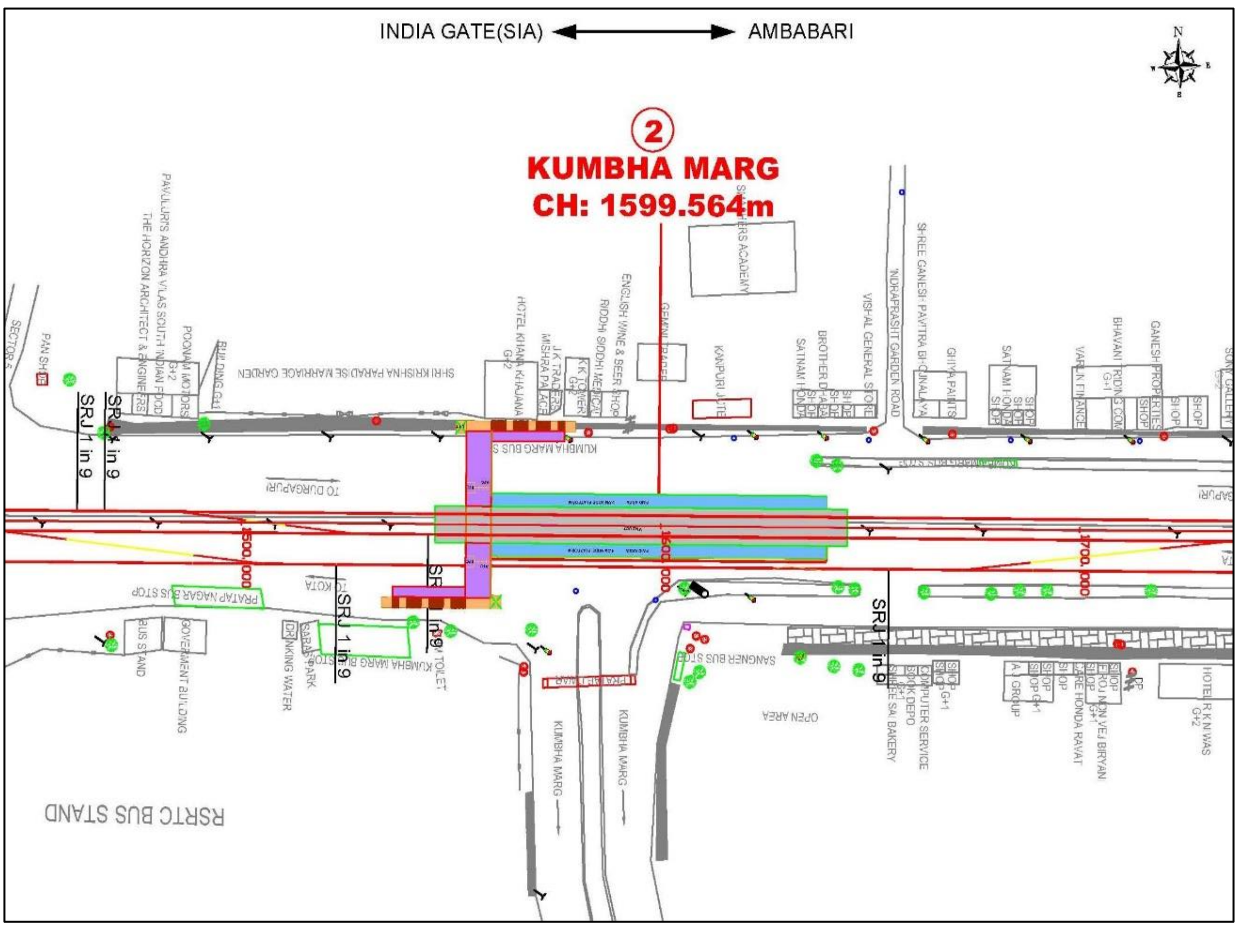


Figure 6.3: Site Conditions - Kumbha Marg

3.	**Station**	**:**	**Haldi Ghati Gate**
	Chainage	**:**	2439.871 m
	Inter station Distance	**:**	840.307m from Kumbha Marg station
	Rail Level	**:**	380.800 m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Sanganer sector-5, and Sanganer sector-8 residential areas which will be the main source of passengers to the station

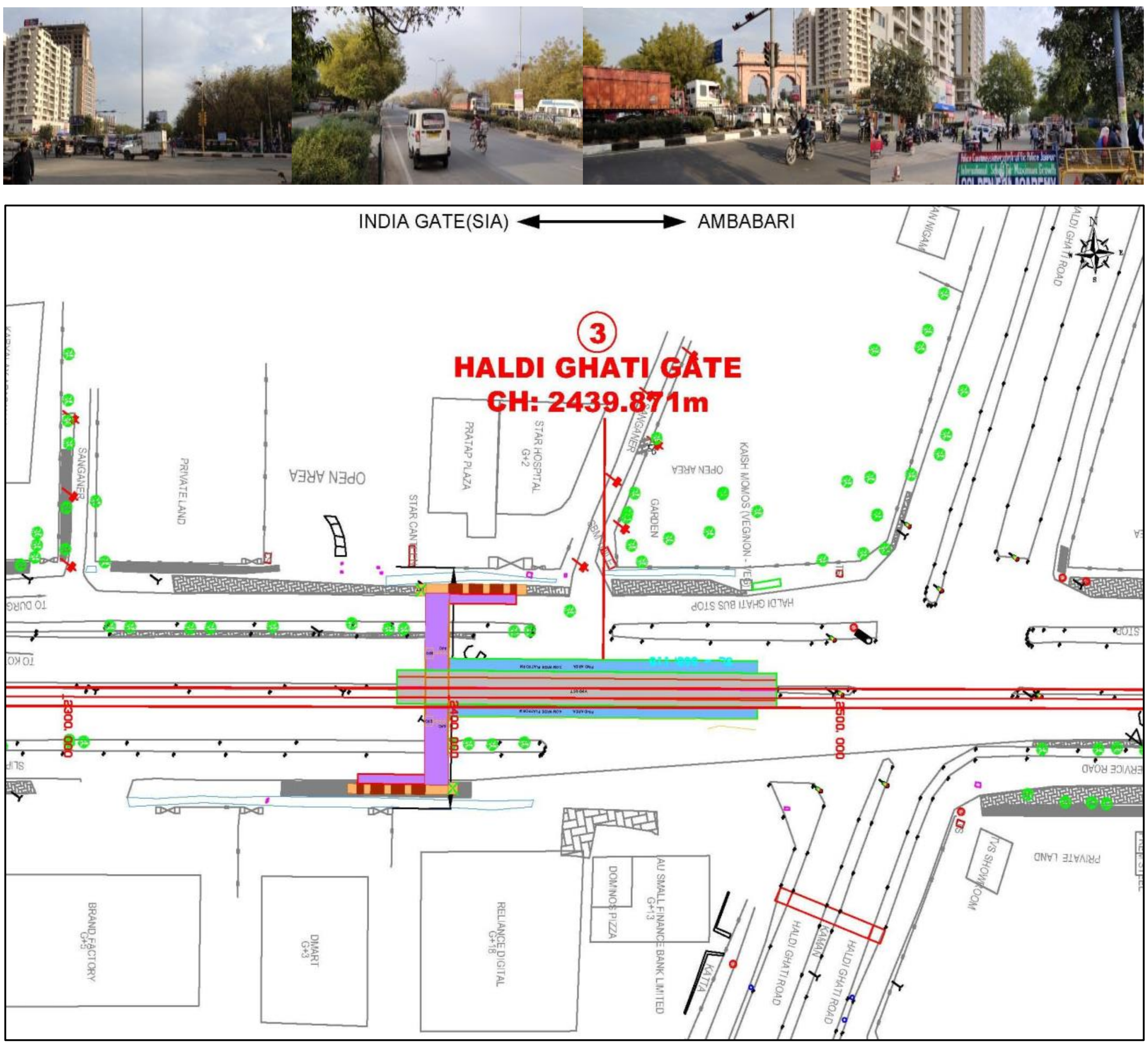


Figure 6.4: Site Conditions - Haldi Ghati Gate

4.	**Station**	**:**	**Pinjra Pole Gaushala**
	Chainage	**:**	3357.734 m
	Inter station Distance	**:**	917.863 m from Haldi Ghati Gate station
	Rail Level	**:**	385.700 m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Shiv Nagar, Azad Nagar, Maruti Nagar and Sanganer Residential areas which will be the main source of passengers to the station

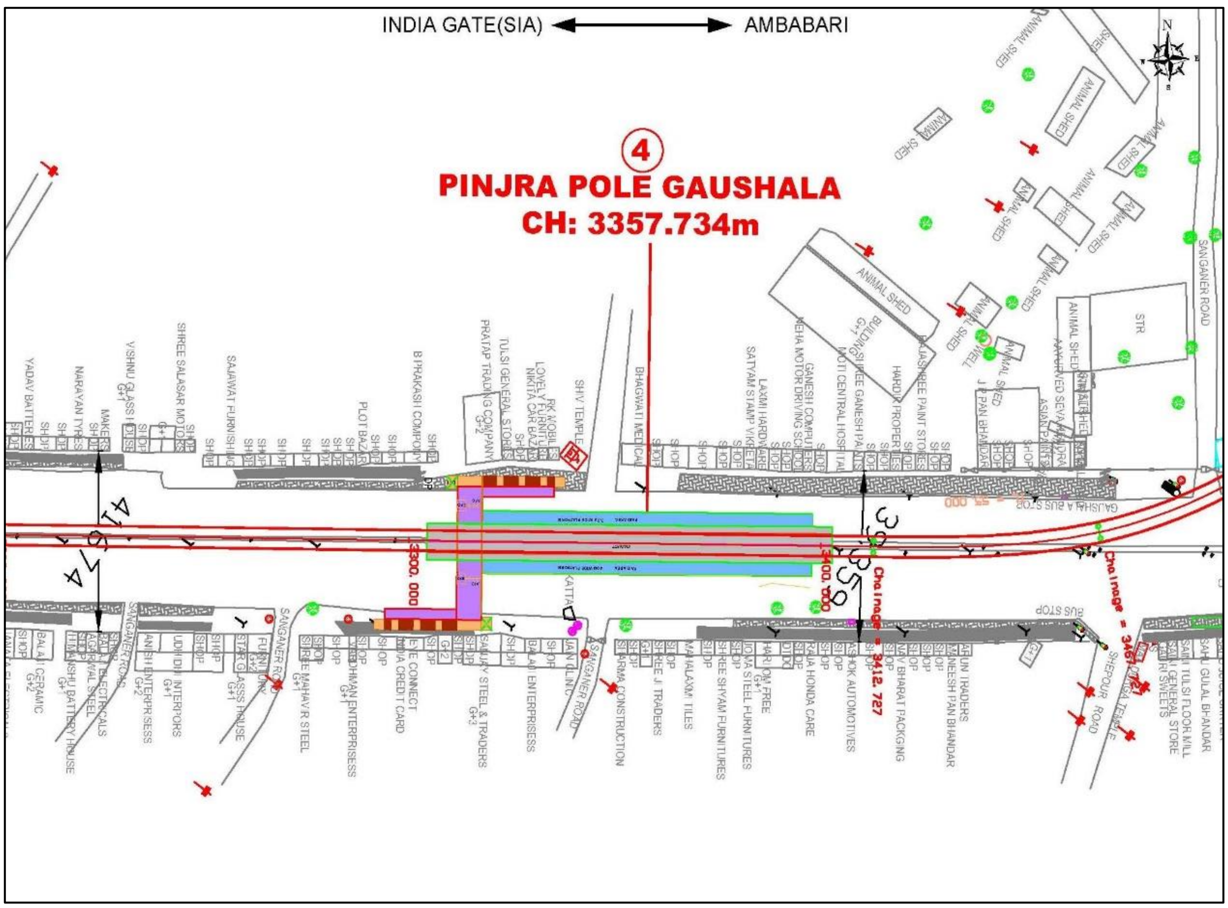


Figure 6.5: Site Conditions – Pinjra Pole Gaushala

5.	**Station**	**:**	**Sanganer Sethu**
	Chainage	**:**	5431.316 m
	Inter station Distance	**:**	2073.582 m from Pinjra Pole Gaushala station.
	Rail Level	**:**	385.700 m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Taru Chhaya Nagar, Khatri Nagar, GEM vihar colony and Kundan Nagar residential areas which will be the main source of passengers to the station

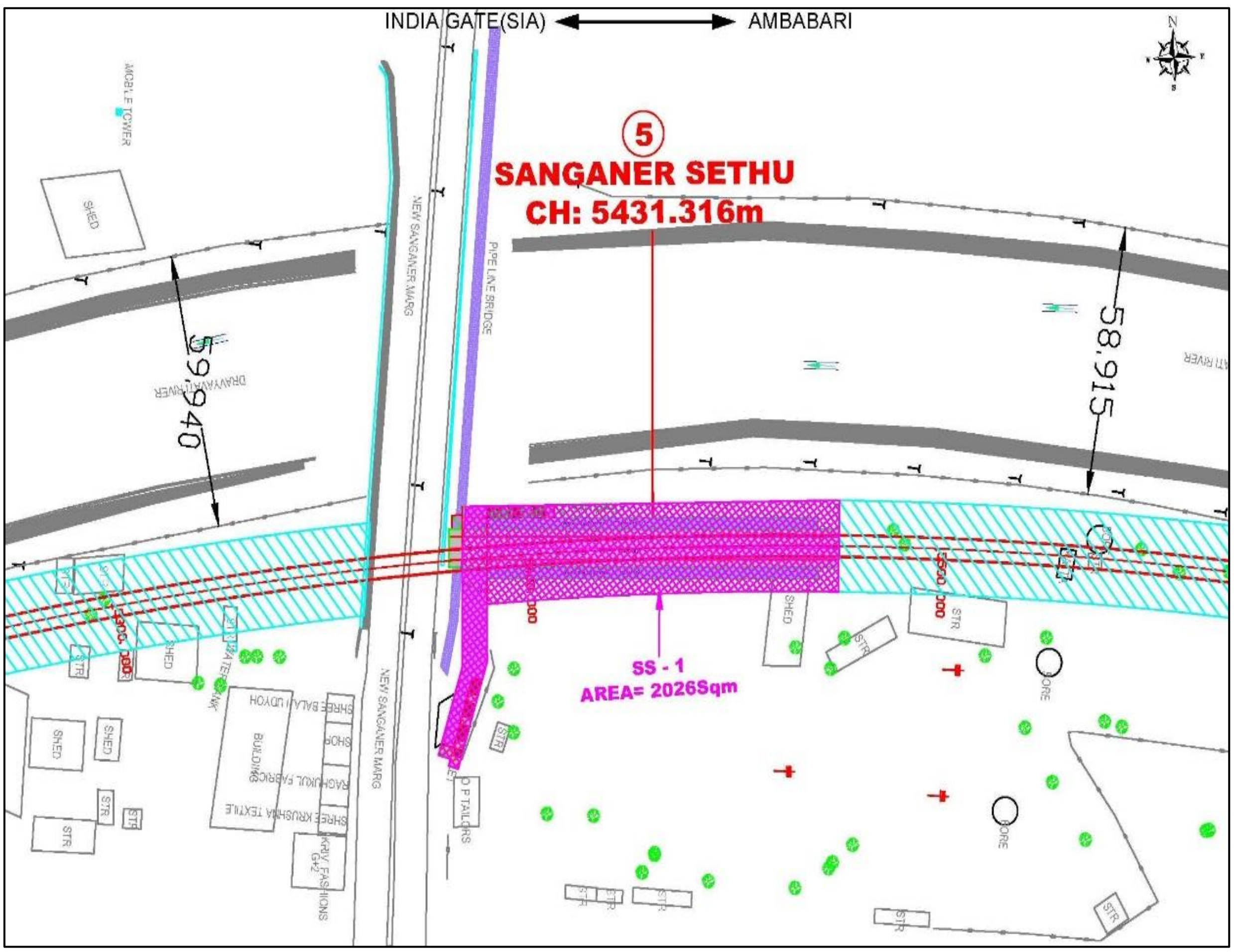


Figure 6.6: Site Conditions - Sanganer Sethu

6.	**Station**	**:**	**B2 Bypass Circle**
	Chainage	**:**	7914.327 m
	Inter station Distance	**:**	2483.011 m from Sanganer Sethu station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on Main Road.
	Catchment Area	**:**	The station is situated at Main Road surrounded by Shri Vihar, Taruchhaya nagar, Sita Bari residential areas. There is Jawahar Circle amusement place and Jaipur Airport is also in proximity. All of these elements will be the main source of passengers to the station.

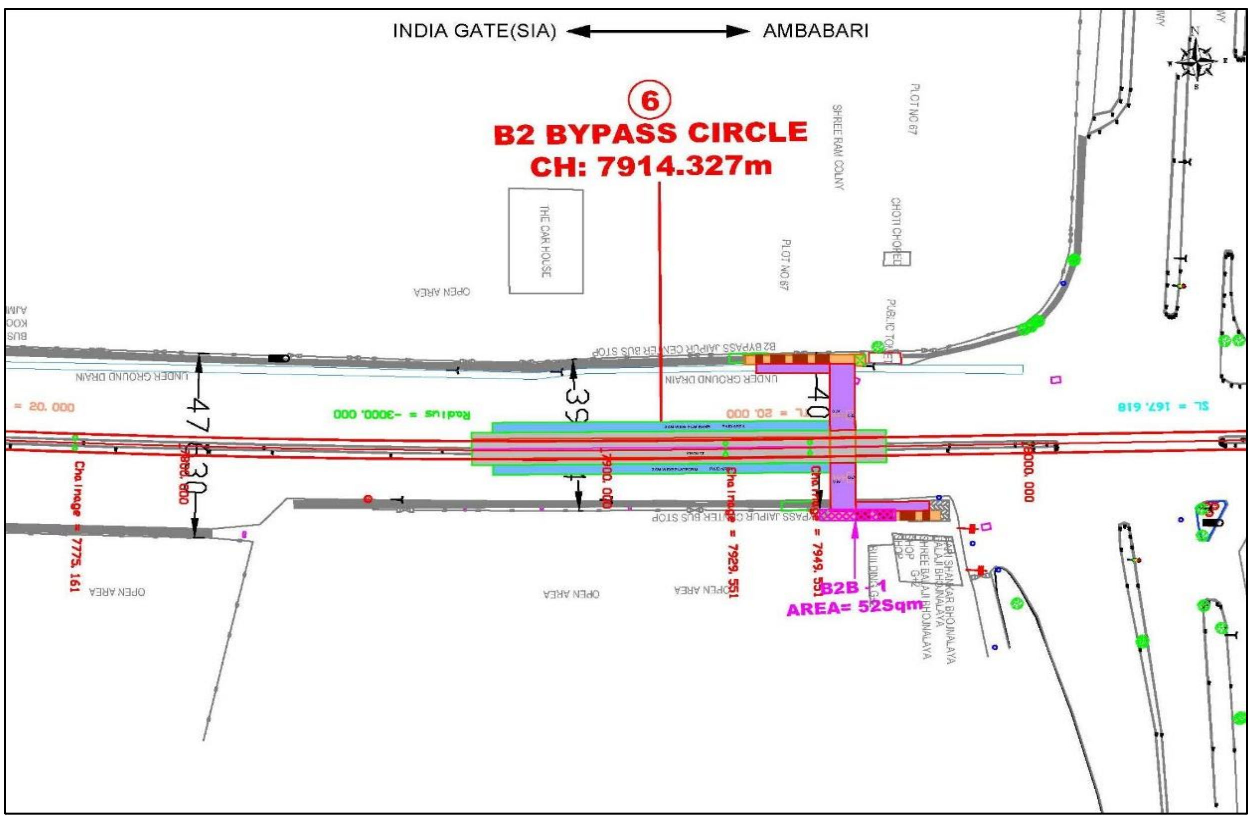


Figure 6.7: Site Conditions - B2 Bypass Circle Station

7.	**Station**	**:**	**Durgapura**
	Chainage	**:**	9219.655 m
	Inter station Distance	**:**	1305.328 m from B2 Bypass Circle station
	Rail Level	**:**	8.5 m above existing flyover
	Station type	**:**	Elevated station integrated with existing Flyover (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is designed, with integration of existing flyover above the main Road.
	Catchment Area	**:**	The station is surrounded by Mahaveer Nagar, Green Nagar and Durgapura residential areas which will be the main source of passengers to the station. There are two hospitals, namely AANCH and Jaipur Hospital are also in proximity.

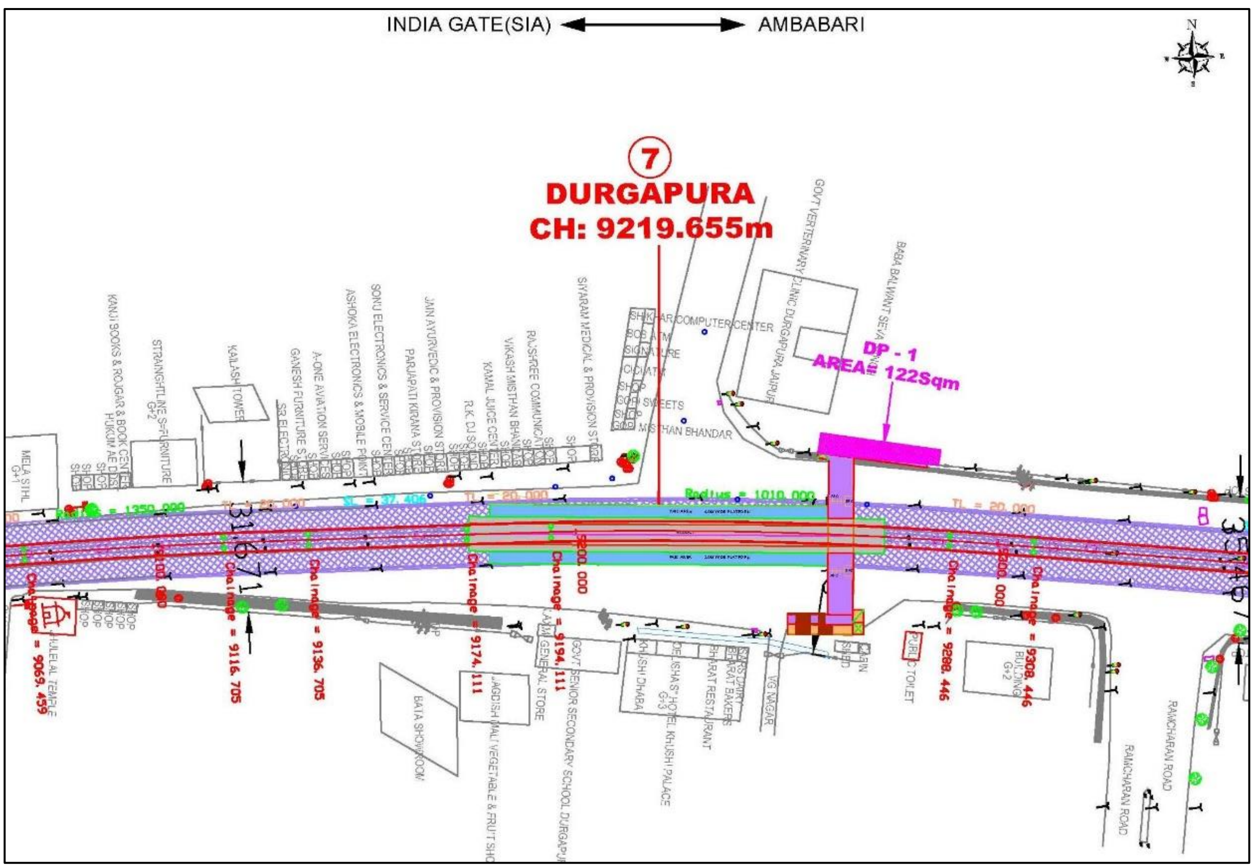


Figure 6.8: Site Conditions - Durgapura station

8.	**Station**	**:**	**Mahaveer Nagar**
	Chainage	**:**	9984.491 m
	Inter station Distance	**:**	764.836 m from Durgapura station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is situated on the Road surrounded by Mahaveer Nagar, Basant Vihar residential areas and Durgapura Railway Station which will be the main source of passengers to the station. This station is having proximity with Khandaka Hospital, Jaipur Hospital and Jaipuria Hospital & Medical College.

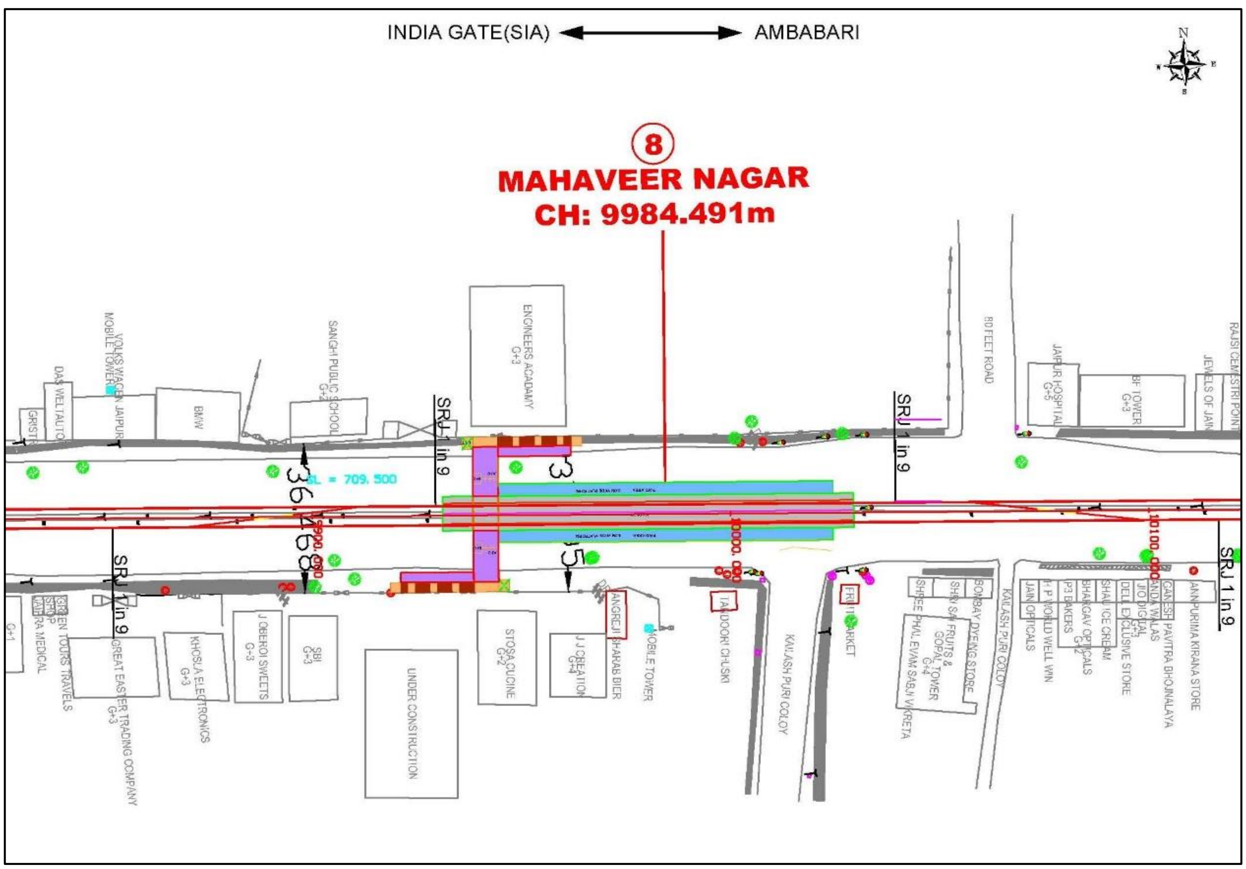


Figure 6.9: Site Conditions - Mahaveer Nagar station

9.	**Station**	**:**	**Dev Nagar**
	Chainage	**:**	11028.593 m
	Inter station Distance	**:**	1044.102 m from Mahaveer Nagar station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Jawahar Nagar colony, Dev Nagar, Bajaj Nagar and Himmat Nagar residential areas which will be the main source of passengers to the station. The station have proximity with Bhandari Hospital.

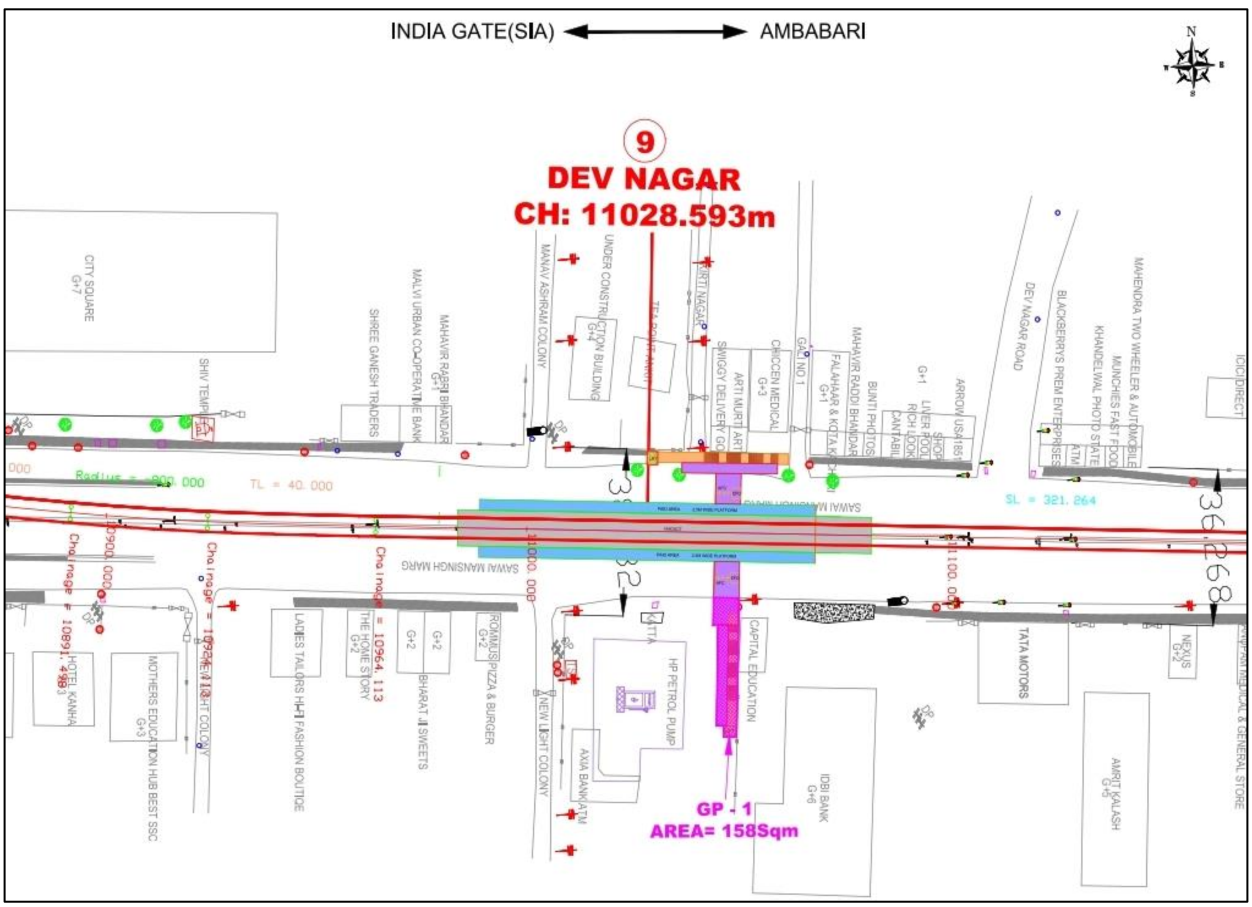


Figure 6.10: Site Conditions – Dev Nagar Station

10.	**Station**	**:**	**Gandhi Nagar**
	Chainage	**:**	11705.394 m
	Inter station Distance	**:**	676.801 m from Dev Nagar station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Shiv Colony and Dev Nagar residential areas. The station is situated near to Gandhi Nagar Railway station. The above elements are the main source of passengers to the station.

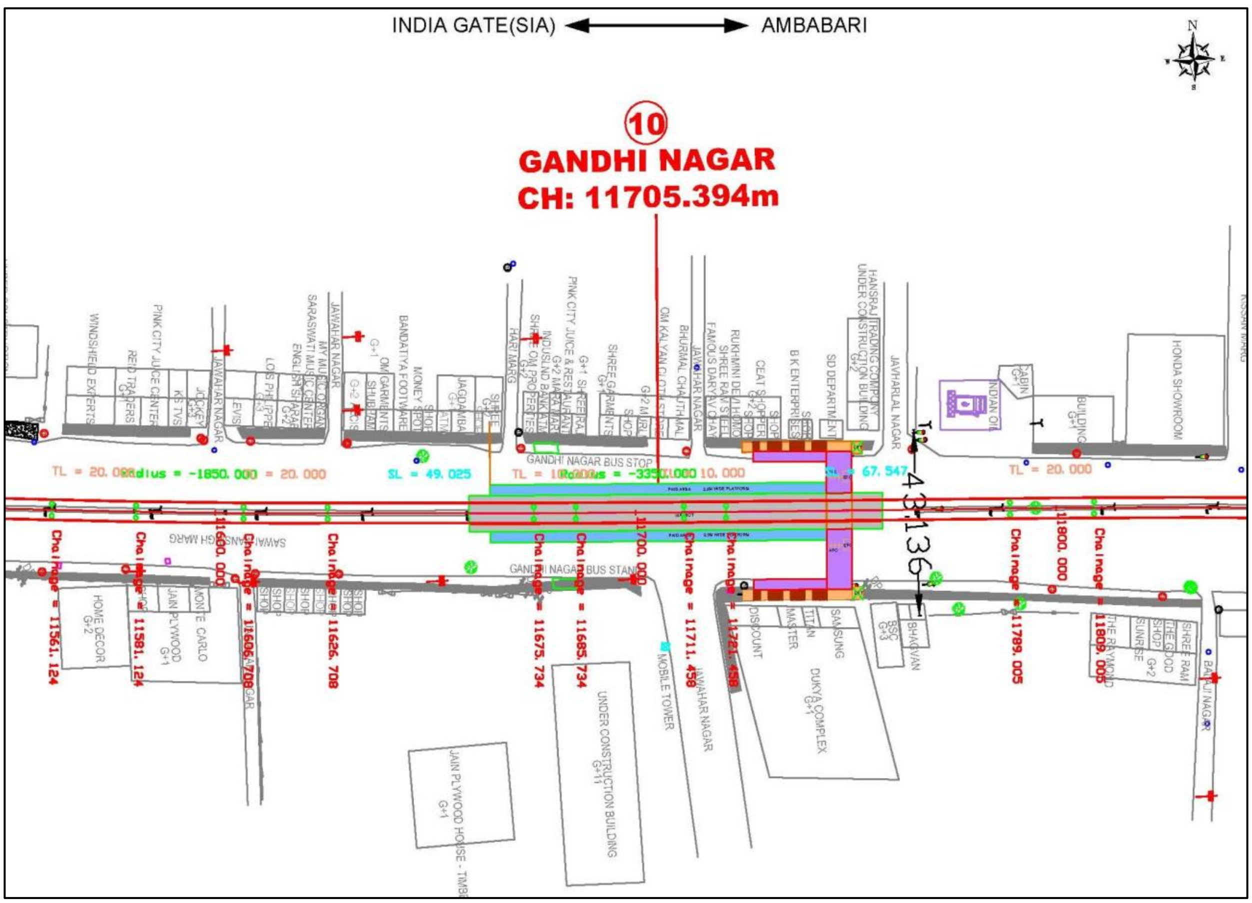


Figure 6.11: Site Conditions - Gandhi Nagar Station

11.	**Station**	**:**	**Tonk Phatak**
	Chainage	**:**	12819.654 m
	Inter station Distance	**:**	1114.260 m from Gandhi Nagar station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (U Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Janak Puri, Tonk Phatak, Bajaj Nagar and Gandhi Nagar residential areas which will be the main source of passengers to the station. Laxmi Mandir and Kendriya Vidyalaya are also nearby.

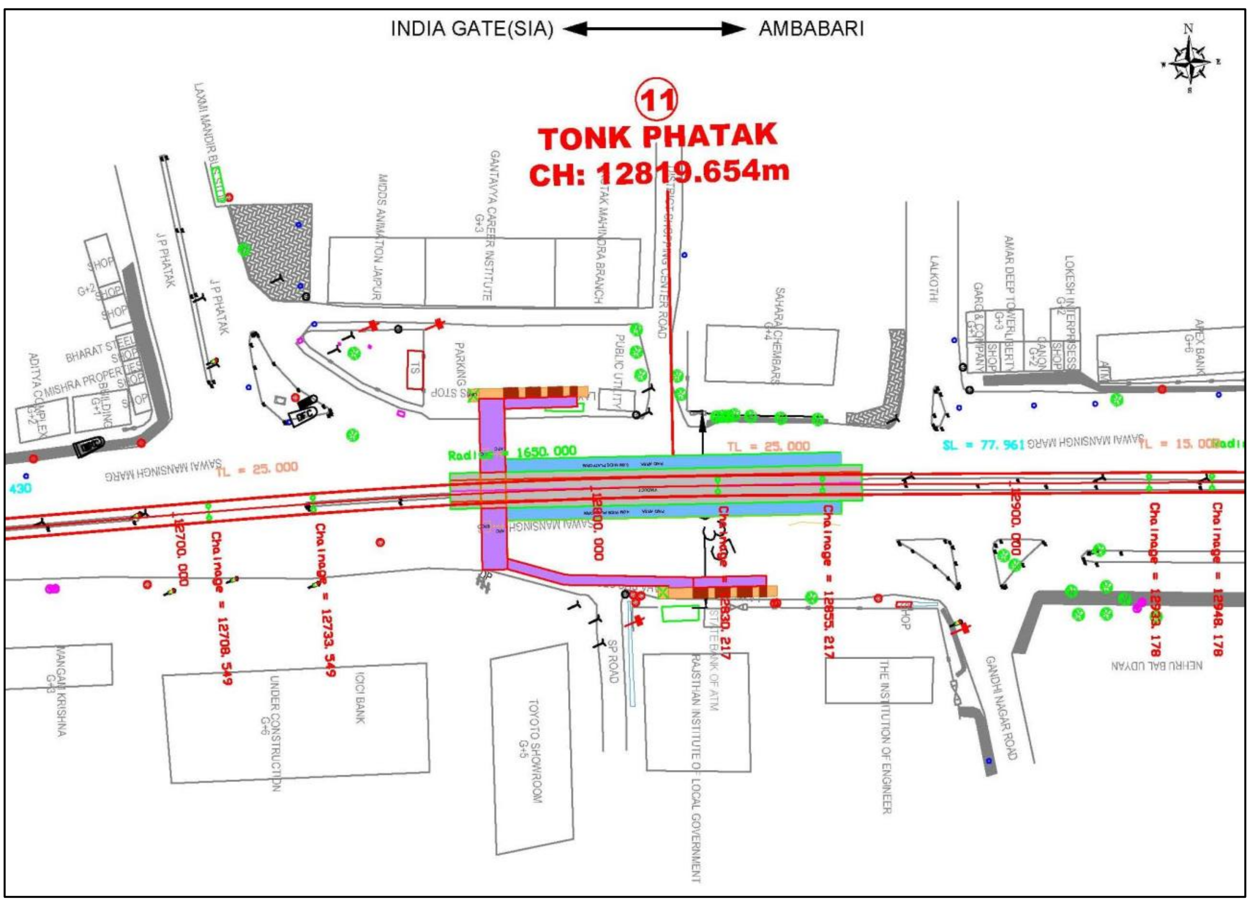


Figure 6.12: Site Conditions – Tonk Phatak

12.	Station	:	Ram Bagh Circle
	Chainage	:	14363.115 m
	Inter station Distance	:	1543.461 m from Tonk Phatak station
	Rail Level	:	10.2 m above Ground level
	Station type	:	Elevated station (U Girder Construction)
	Entry / Exit	:	Proposed on both sides of the Road
	Location	:	The station is located on the main Road.
	Catchment Area	:	The station is surrounded by Bapu Nagar residential area. Santokba Durlabhji Memorial Hospital, JDA Office and SMS Stadium are nearby. These will be the main source of passengers to the station.

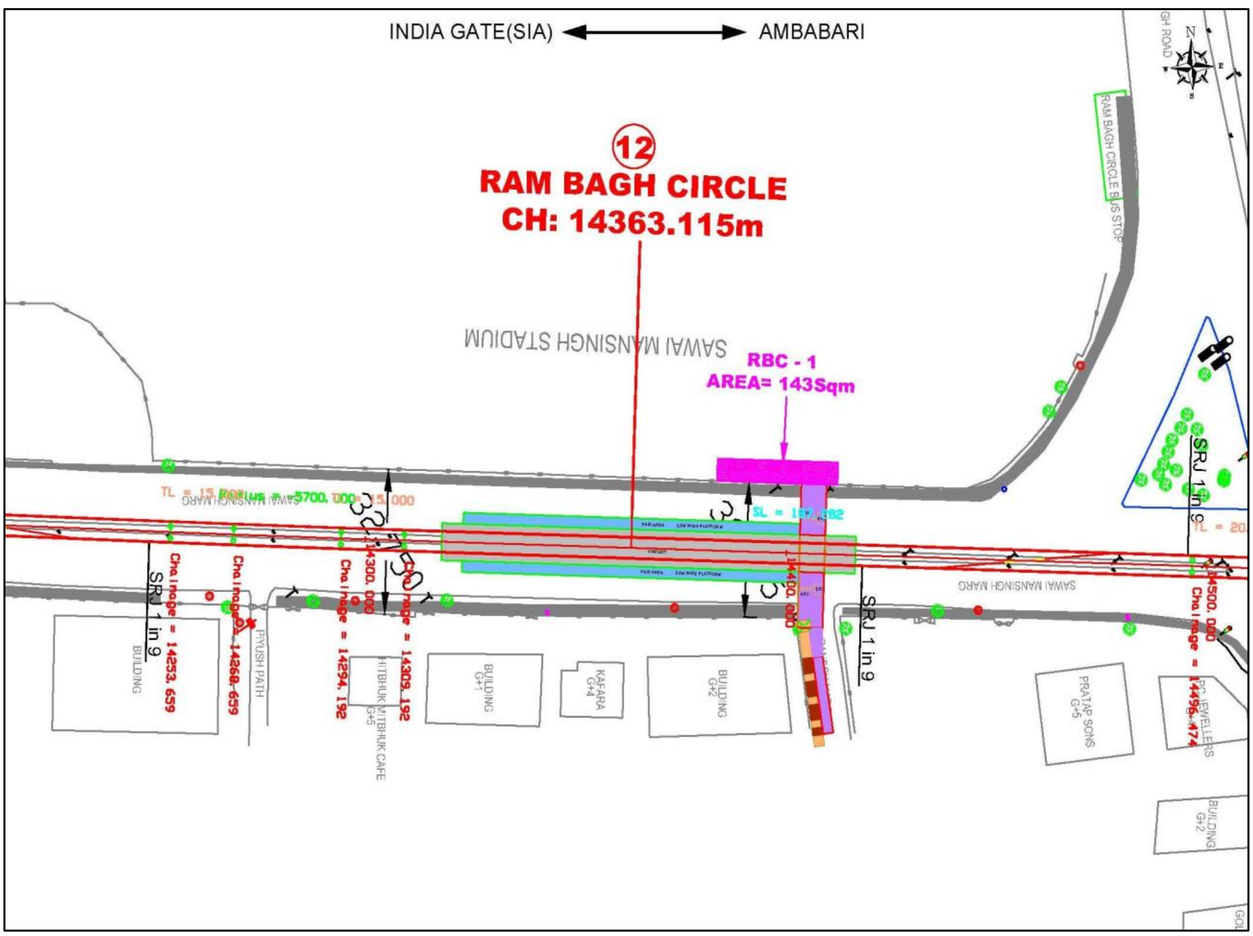


Figure 6.13: Site Conditions - Ram Bagh Circle

13.	Station	:	Narayan Singh Circle
	Chainage	:	15069.586 m
	Inter station Distance	:	706.471 m from Ram Bagh Circle station
	Rail Level	:	10.2 m above Ground level
	Station type	:	Elevated station (U Girder Construction)
	Entry / Exit	:	Proposed on both sides of the Road
	Location	:	The station is located on the main Road.
	Catchment Area	:	The station is situated on Road surrounded by Anand Puri, Gurunanak Pura and Raja Park Residential areas which will be the main source of passengers to the station

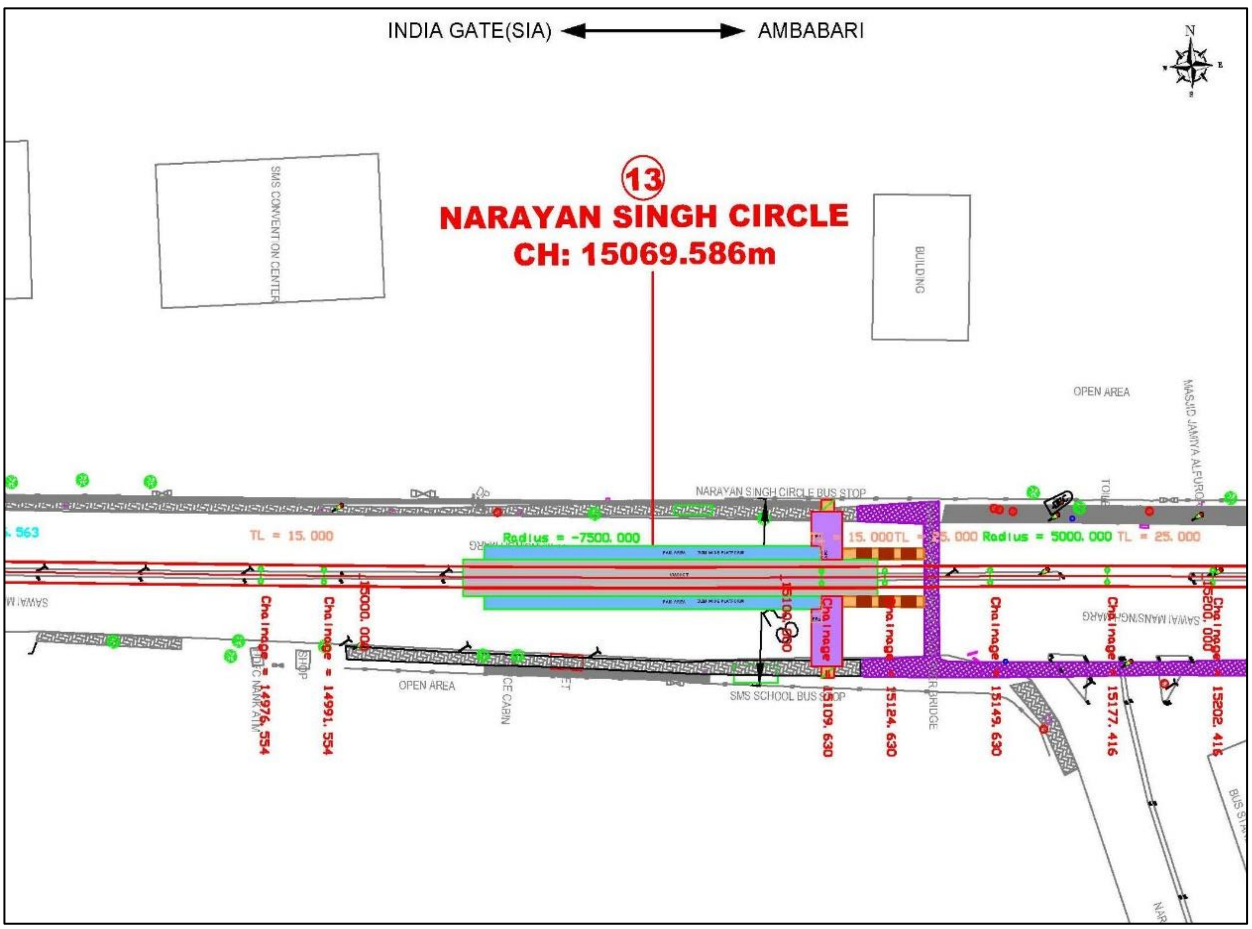


Figure 6.14: Site Conditions - Narayan Singh Circle Station

14.	Station	:	SMS Hospital
	Chainage	:	16085.106 m
	Inter station Distance	:	1015.520 m from Narayan Singh Circle station
	Rail Level	:	10.2 m above Ground level
	Station type	:	Elevated station (U Girder Construction)
	Entry / Exit	:	Proposed on both sides of the Station
	Location	:	The station is located on the main Road.
	Catchment Area	:	The station is surrounded by Bardia Colony residential area, SMS Hospital, University area and Maharaja College areas which will be the main source of passengers to the station

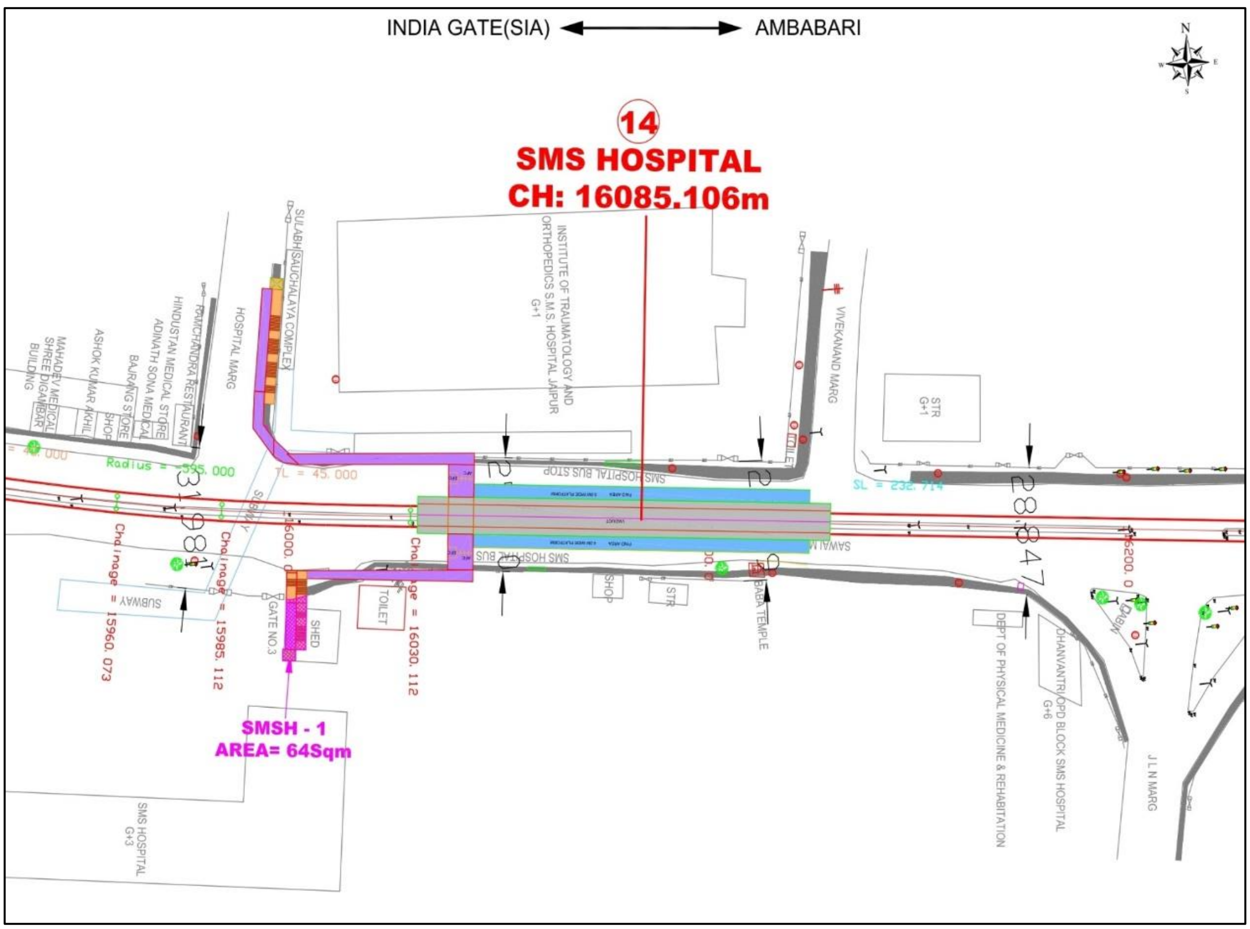


Figure 6.15: Site Conditions - SMS Hospital Station

15.	**Station**	**:**	**Ashok Marg**
	Chainage	**:**	17516.843 m
	Inter station Distance	**:**	1431.737 m from SMS Hospital station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (Box Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Station
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is situated on the Road surrounded by Patel Colony, Ashok Nagar and Bardia Colony residential areas which will be the main source of passengers to the station. Apollo Spectra Hospital is also in the proximity to this station.

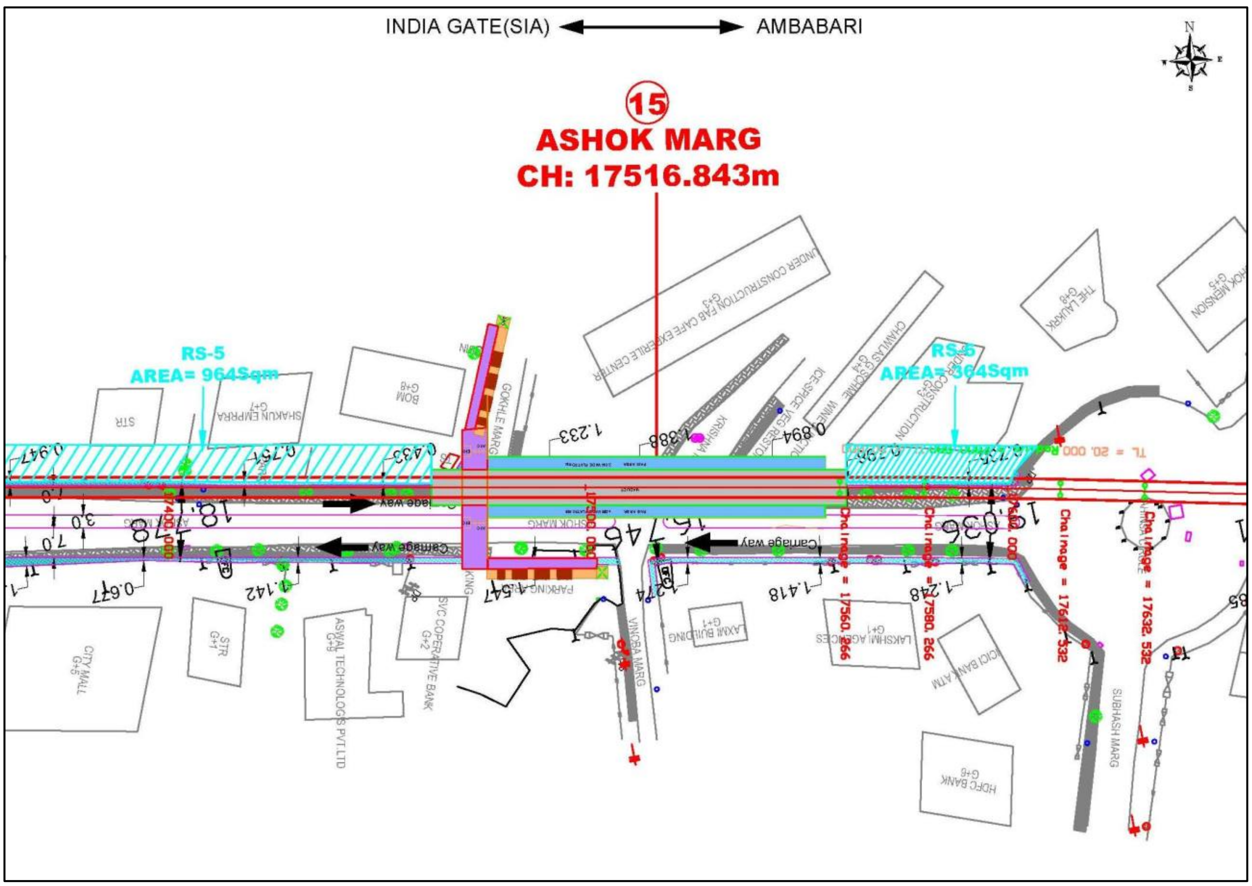


Figure 6.16: Site Conditions - Ashok Marg Station

16.	**Station**	**:**	**Government Hostel**
	Chainage	**:**	18332.952 m
	Inter station Distance	**:**	816.109 m from Ashok Marg station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (Box Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Jalupura and C scheme residential areas which will be the main source of passengers to the station

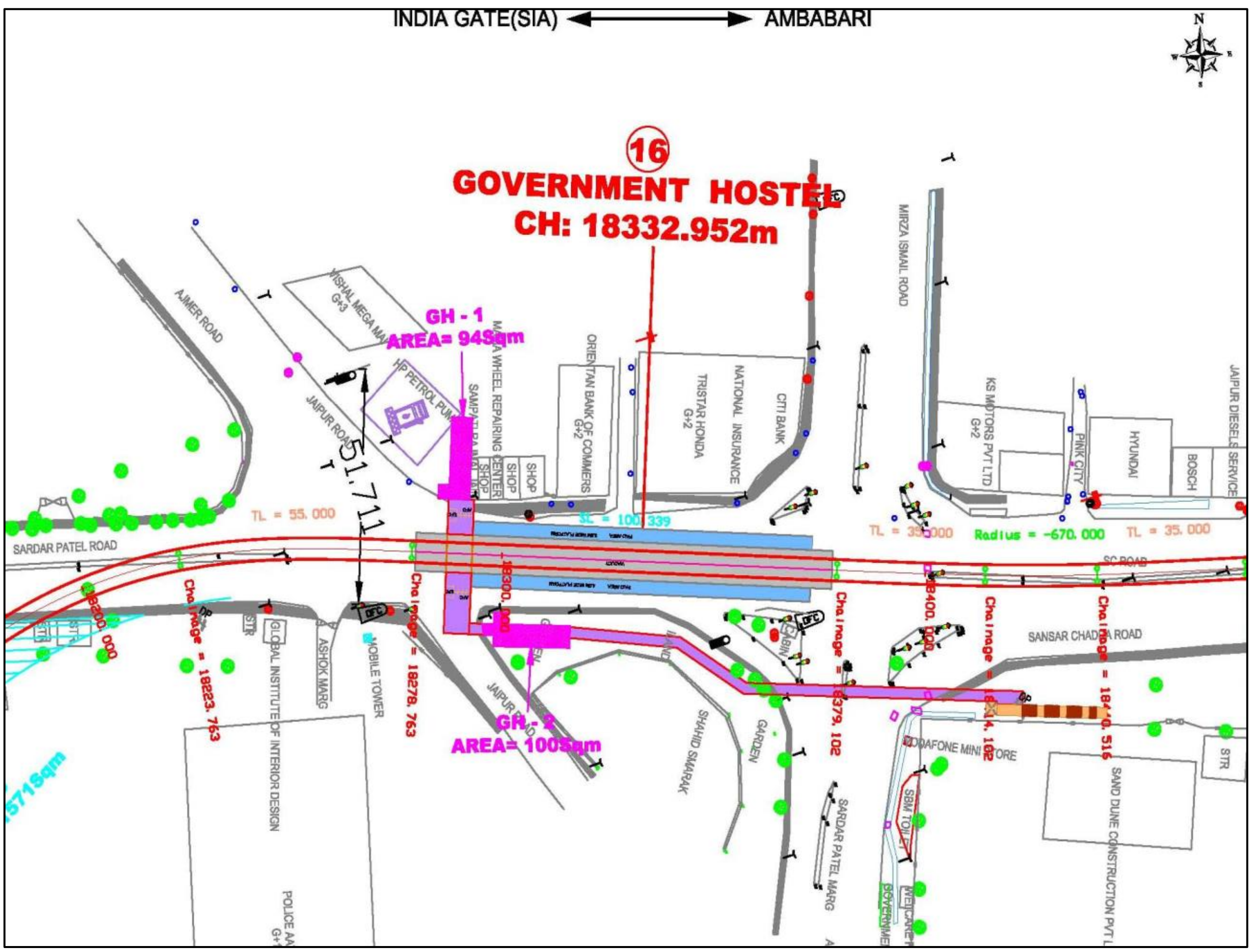


Figure 6.17: Site Conditions - Government Hostel

17.	**Station**	**:**	**Chandpole**
	Chainage	**:**	19372.919 m
	Inter station Distance	**:**	1039.967 m from Government Hostel station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (Box Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Chandpole, Mukherjee Nagar, Pink City residential areas which will be the main source of passengers to the station. This station is in the proximity with Zanana Hospital also

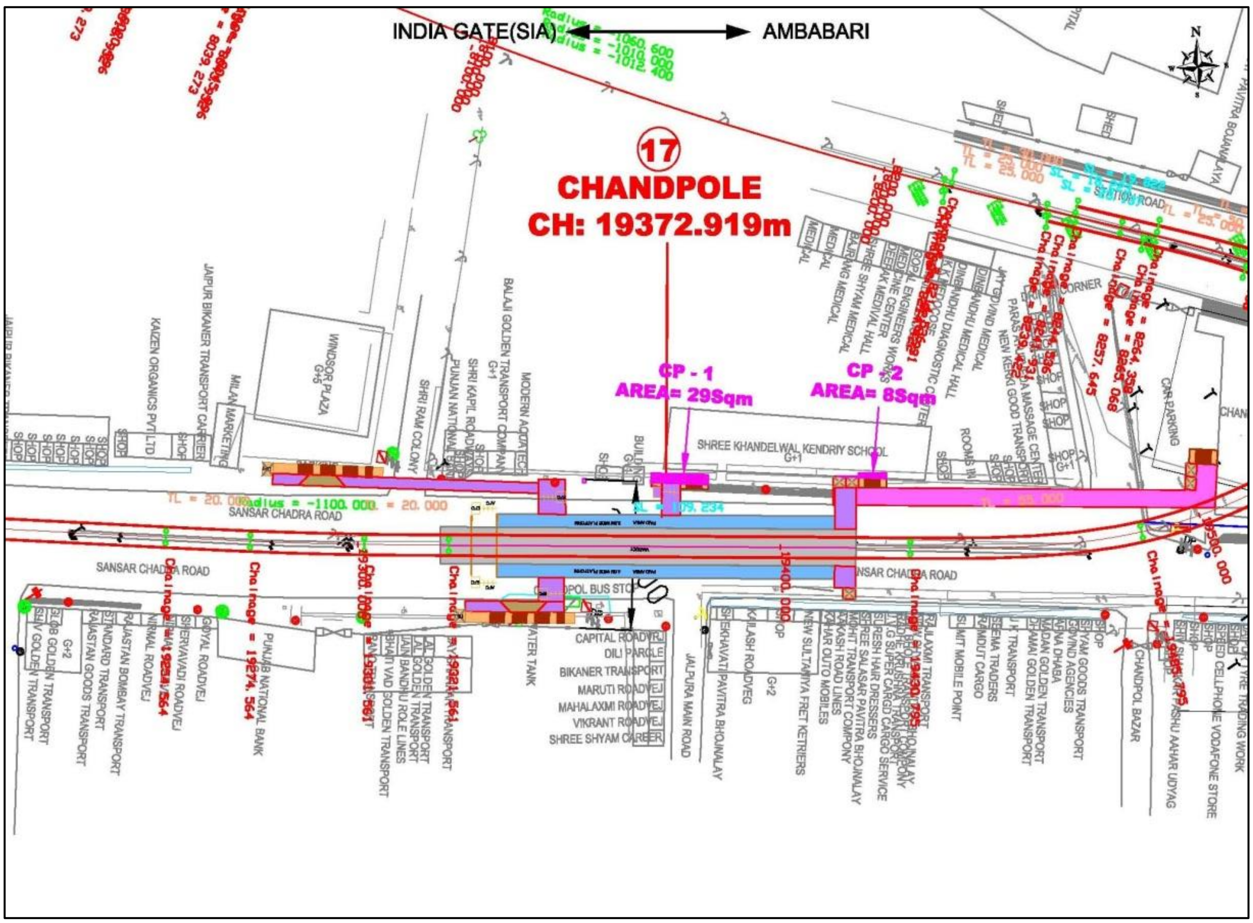


Figure 6.18: Site Conditions - Chandpole Station

18.	**Station**	**:**	**Collectorate**
	Chainage	**:**	20252.507 m
	Inter station Distance	**:**	879.588 m from Chandpole station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (Box Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Mukherjee Colony, Sindhi Colony, Bani Park residential areas. This station is in proximity with Mini Secretariat, Collectorate, District and Sessions court and Asian Super Speciality Hospital. All these elements are the main source of passengers to the station

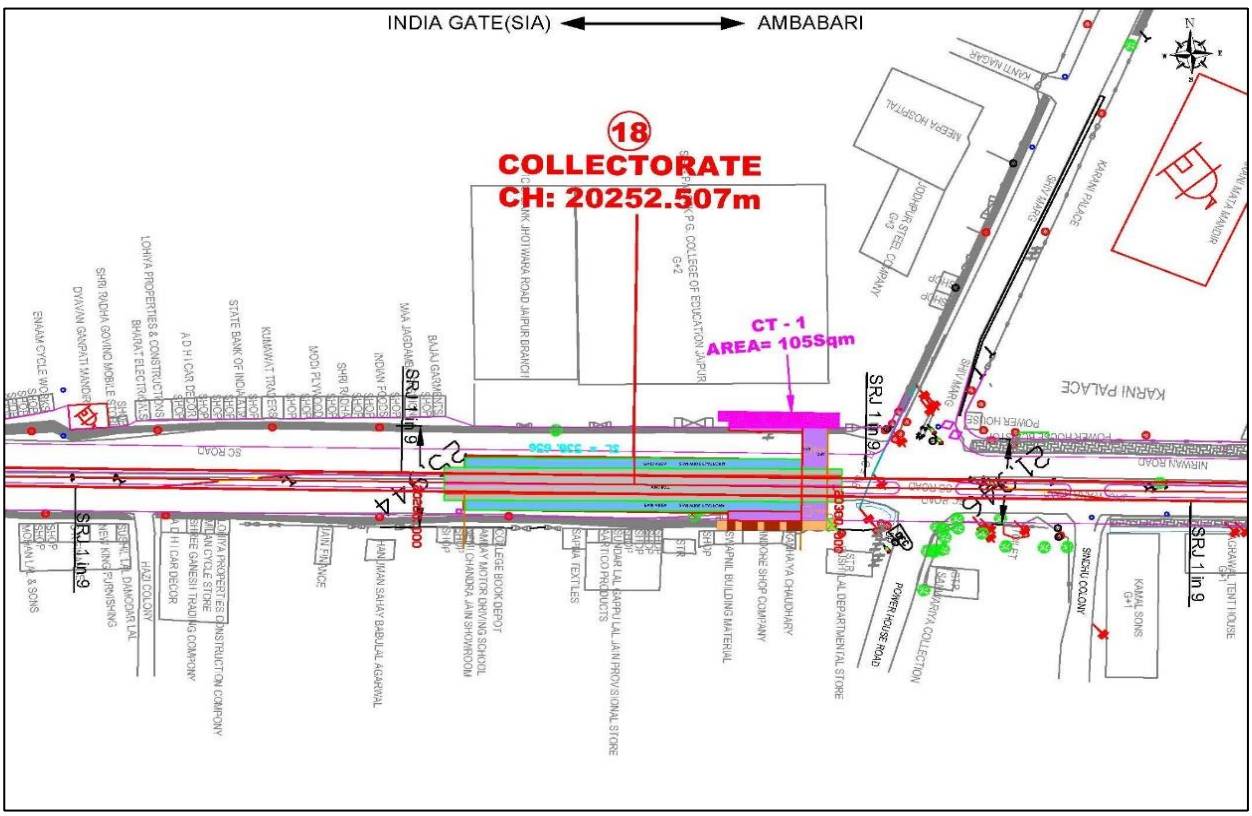


Figure 6.19: Site Conditions- Collectorate Station

19.	**Station**	**:**	**Subhash Nagar**
	Chainage	**:**	21382.664 m
	Inter station Distance	**:**	1130.157 m from Collectorate station
	Rail Level	**:**	10.2 m above Ground level
	Station type	**:**	Elevated station (Box Girder Construction)
	Entry / Exit	**:**	Proposed on both sides of the Road
	Location	**:**	The station is located on the Road.
	Catchment Area	**:**	The station is surrounded by Srirampura, Sanjay Colony residential areas. This station is in proximity with Sanjeev Hospital, Maxwell Hospital and DACH child Hospitals. All these elements are the main source of passengers to the station

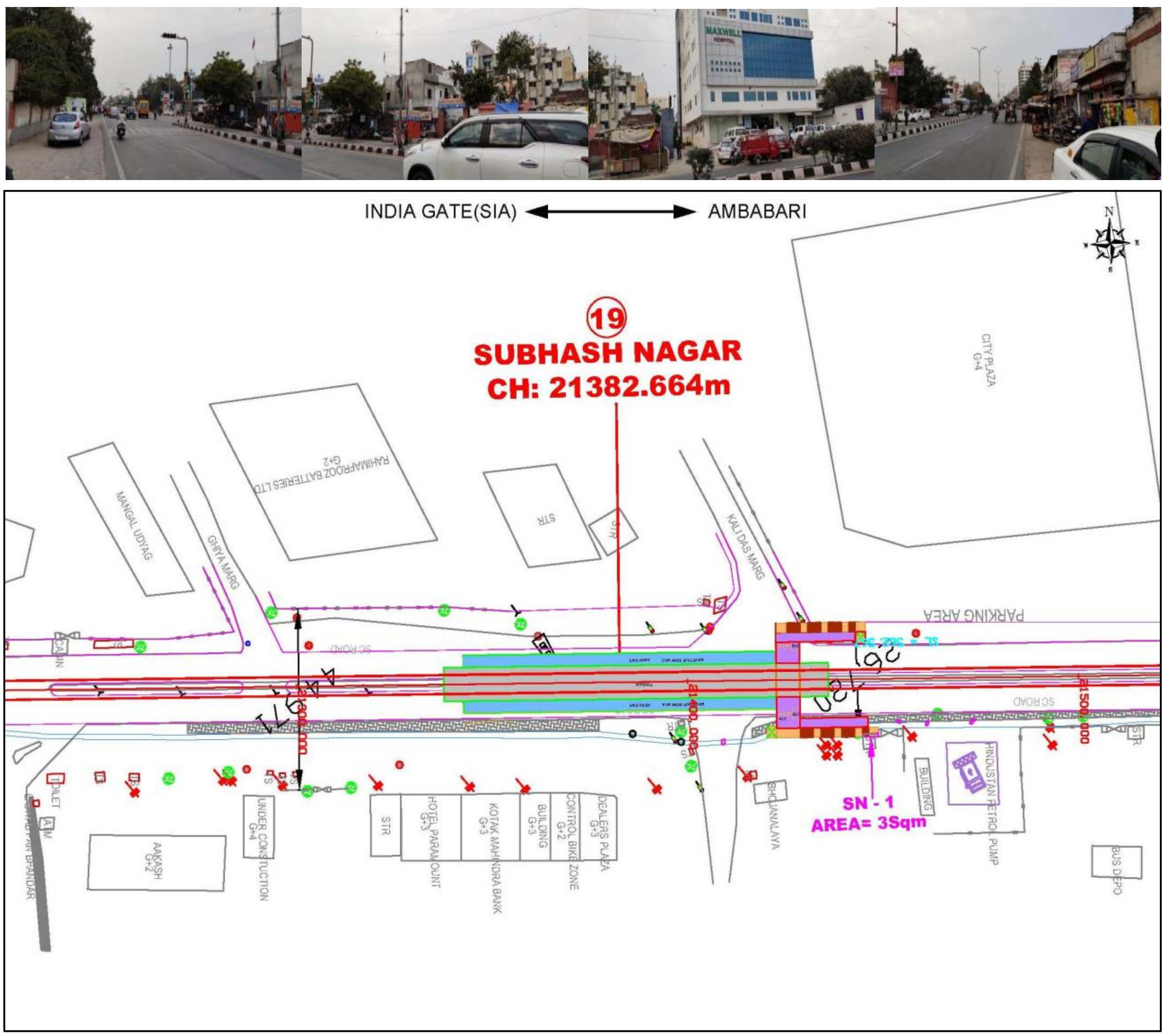


Figure 6.20: Site Conditions - Subhash Nagar Station

20.	Station	:	Panipech
	Chainage	:	22223.813 m
	Inter station Distance	:	841.149 m from Subhash Nagar station
	Rail Level	:	10.2 m above Ground level
	Station type	:	Elevated station
	Entry / Exit	:	Proposed on both sides of the Road
	Location	:	The station is located on the Road.
	Catchment Area	:	The station is surrounded by Srirampura, Sanjay Colony residential areas. This station is in proximity with Military Cantonment, Regional Science Centre and Science park. All these elements are the main source of passengers to the station

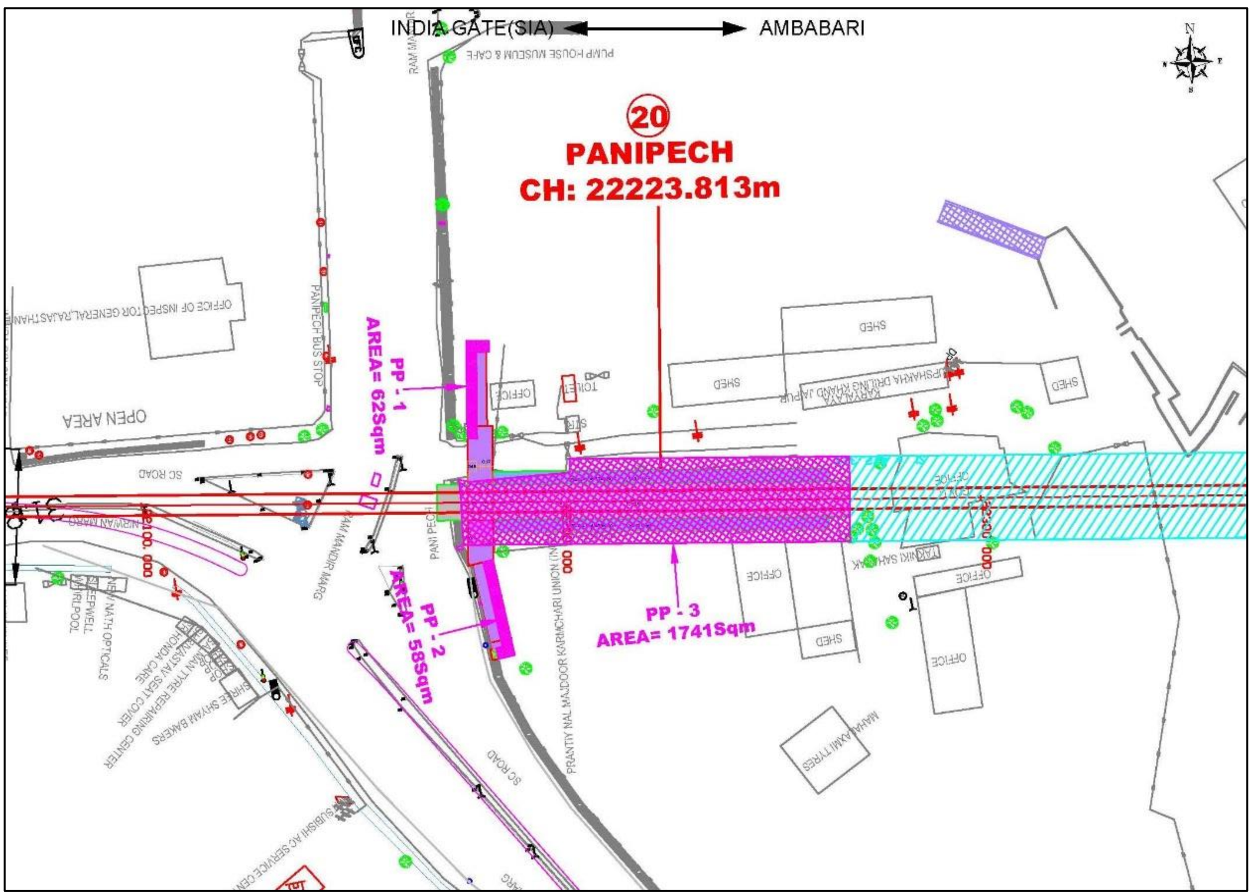


Figure 6.21: Site Conditions - Panipech Station

21.	**Station**	**:**	**Ambabari**
	Chainage	**:**	23060.000 m
	Inter station Distance	**:**	836.187 m from Panipech station
	Rail Level	**:**	8.5 m above Ground level
	Station type	**:**	Elevated station
	Entry / Exit	**:**	Proposed beside the Road
	Location	**:**	The station is located besides the Road.
	Catchment Area	**:**	The station is surrounded by Ambabari, Sanjay Colony and Srirampura residential areas. This station is in proximity with Military Cantonment. All these elements are the main sources of passengers to the station

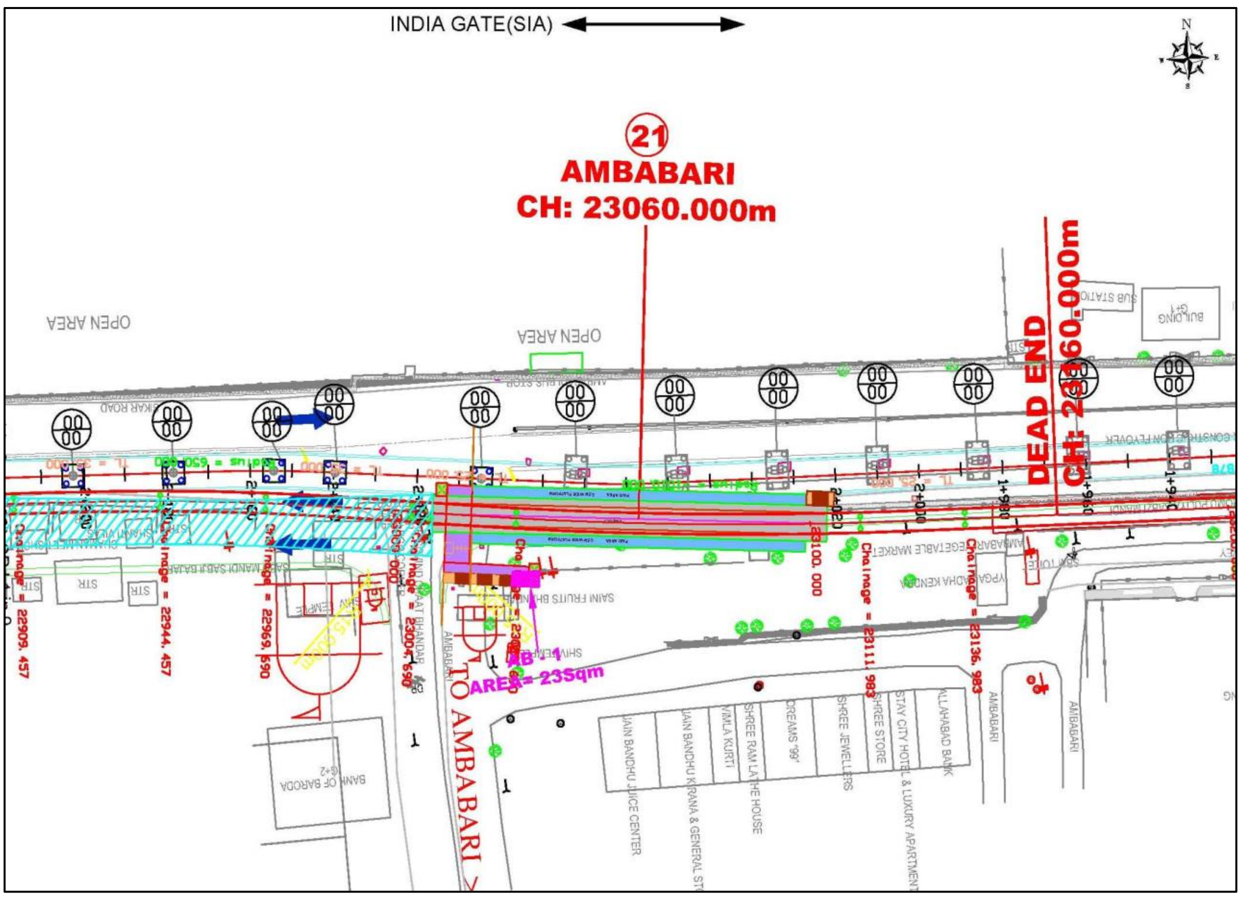


Figure 6.22: Site Conditions - Ambabari Station

Table 6.2: Pasenger Aminity Requirements in the Station (Morning Peak)

PASSENGER AMENITY REQUIREMENTS IN STATION Ambabari-India Gate (SIA) Corridor (Horizon Year 2051)									
Daily Ridership									
S.No.	Station	Daily Boarding	Daily Alighting	Sectional Load	Peak Minute Boarding	Peak Minute Alighting	TOM Required	Head way	Platform Width Required
1	Ambabari	5,383	0	0	89	0	5	2.5	3
2	Panipech	1,867	20	5,383	31	0	2	2.5	3
3	Subhash Nagar	1,372	32	7,230	23	1	2	2.5	3
4	Collectorate	2,023	74	8,570	34	1	3	2.5	3
5	Chandpole	10,029	3,148	10,519	166	52	9	2.5	4
6	Government Hostel	1,876	491	17,400	31	8	2	2.5	3
7	Ashok Marg	1,191	949	18,785	20	16	2	2.5	3
8	SMS Hospital	882	500	19,027	15	8	2	2.5	2
9	Narayan Singh Circle	1,276	1,300	19,409	21	22	2	2.5	3
10	Ram Bagh Circle	1,076	1,651	19,385	18	27	2	2.5	2
11	Tonk Phatak	1,220	2,765	18,810	20	46	2	2.5	3
12	Gandhi Nagar	165	560	17,265	3	9	2	2.5	2
13	Dev Nagar	256	1,491	16,870	4	25	2	2.5	2
14	Mahaveer Nagar	130	1,490	15,635	2	25	2	2.5	2
15	Durgapura	170	2,045	14,275	3	34	2	2.5	2
16	B2 Bypass	103	2,461	12,400	2	41	2	2.5	2
17	Sanganer Sethu	40	1,626	10,042	1	27	2	2.5	2
18	Pinjara Pole Gaushala	25	3,745	8,456	0	62	2	2.5	2
19	Haldi Ghati Gate	5	2,063	4,736	0	34	2	2.5	2
20	Kumbha Marg	1	1,703	2,678	0	28	2	2.5	2
21	India Gate (SIA)	0	976	976	0	16	2	2.5	2

Table 6.3: Pasenger Aminity Requirements in the Station (Evening Peak)

PASSENGER AMENITY REQUIREMENTS IN STATION Ambabari-India Gate (SIA) Corridor (Horizon Year 2051)									
Daily Ridership									
S.No.	Station	Daily Boarding	Daily Alighting	Sectional Load	Peak Minute Boarding	Peak Minute Alighting	TOM Required	Head way	Platform Width Required
1	India Gate (SIA)	955	1	955	30	0	2	2.5	2
2	Kumbha Marg	1,792	5	2,746	36	0	2	2.5	3
3	Haldi Ghati Gate	2,157	23	4,898	70	0	3	2.5	3
4	Pinjara Pole Gaushala	4,198	37	9,073	30	0	4	2.5	3
5	Sanganer Sethu	1,831	101	10,867	45	1	2	2.5	3
6	B2 Bypass	2,702	169	13,468	35	2	3	2.5	3
7	Durgapura	2,083	133	15,382	26	3	3	2.5	3
8	Mahaveer Nagar	1,589	254	16,838	27	2	2	2.5	3
9	Dev Nagar	1,623	170	18,207	10	4	2	2.5	3
10	Gandhi Nagar	606	1,290	18,643	47	3	2	2.5	2
11	Tonk Phatak	2,833	1,135	20,186	27	21	3	2.5	3
12	Ram Bagh Circle	1,653	1,355	20,704	21	19	2	2.5	3
13	Narayan Singh Circle	1,282	910	20,631	8	23	2	2.5	3
14	SMS Hospital	510	1,274	20,231	14	15	2	2.5	2
15	Ashok Marg	855	2,158	19,812	8	21	2	2.5	2
16	Government Hostel	475	10,474	18,129	53	36	2	2.5	2
17	Chandpole	3,188	2,089	10,843	1	174	3	2.5	3
18	Collectorate	75	1,443	8,829	1	35	2	2.5	2
19	Subhash Nagar	31	1,957	7,417	0	24	2	2.5	2
20	Panipech	19	5,481	5,479	0	33	2	2.5	2
21	Ambabari	0	0	0	16	91	2	2.5	3

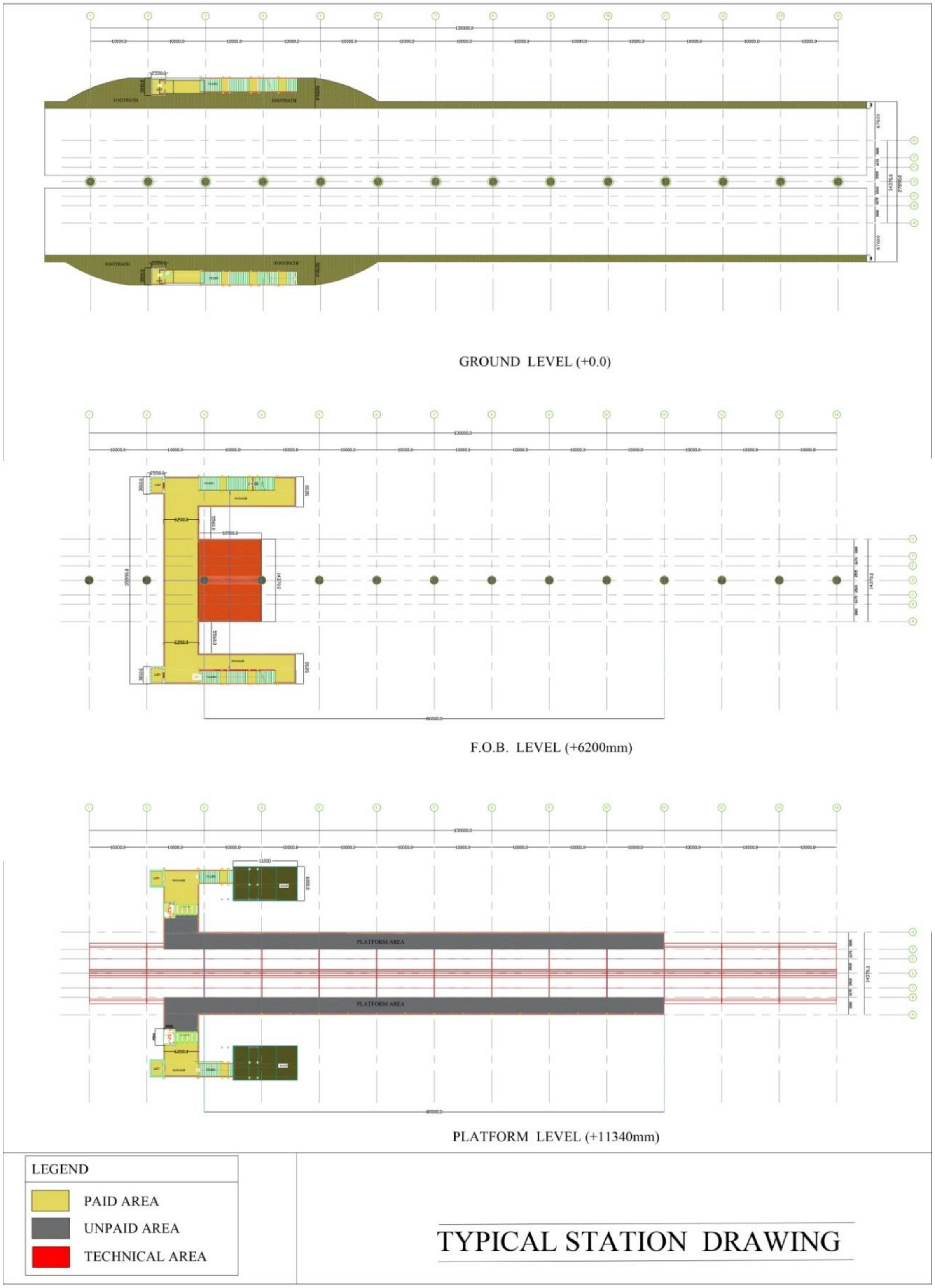
Table 6.4: AFC Gates Requirements in the Stations

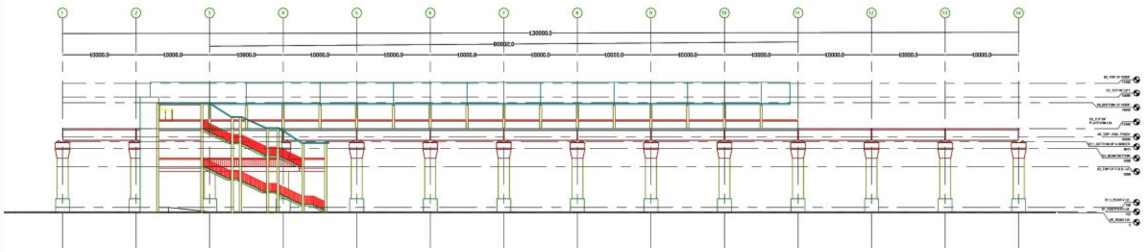
S.No.	Station	AFC Gates required		
		Gates In	Gates Out	Rev
1	India Gate (SIA)	1	1	1
2	Kumbha Marg	1	1	1
3	Haldi Ghati Gate	1	1	1
4	Pinjara Pole Gaushala	2	2	1
5	Sanganer Sethu	1	1	1
6	B2 Bypass	2	2	1
7	Durgapura	1	1	1
8	Mahaveer Nagar	1	1	1
9	Dev Nagar	1	1	1
10	Gandhi Nagar	1	1	1
11	Tonk Phatak	2	2	1
12	Ram Bagh Circle	1	1	1
13	Narayan Singh Circle	1	1	1
14	SMS Hospital	1	1	1
15	Ashok Marg	1	1	1
16	Government Hostel	1	1	1
17	Chandpole	7	6	1
18	Collectorate	1	1	1
19	Subhash Nagar	1	1	1
20	Panipech	1	1	1
21	Ambabari	1	3	1

Table 6.5: Multimodal Integration at Stations

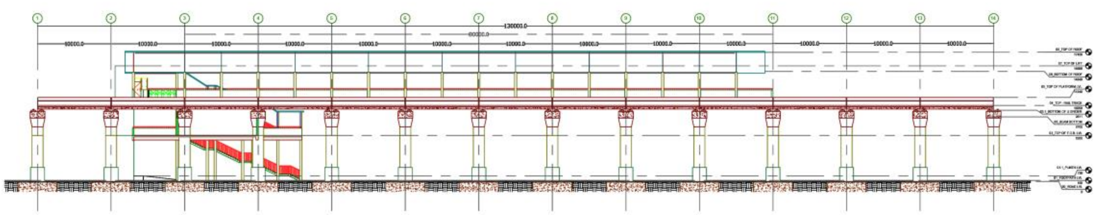
S.No.	Station	E-Rickshaw	Auto-Rickshaw	Gramin Seva	Car Dropoff	Bus Stop
1	India Gate (SIA)	Provided	Provided	Provided	Provided	Provided
2	B2 Bypass	Provided	Provided	Provided	Provided	Provided
3	Durgapura	Provided	Provided	Provided	Provided	Provided
4	Gandhi Nagar	Provided	Provided	Provided	Provided	Provided
5	Tonk Phatak	Provided	Provided	Provided	Provided	Provided
6	Ram Bagh Circle	Provided	Provided	Provided	Provided	Provided
7	Narayan Singh Circle	Provided	Provided	Provided	Provided	Provided
8	Government Hostel	Provided	Provided	Provided	Provided	Provided
9	Chandpole	Provided	Provided	Provided	Provided	Provided
10	Collectorate	Provided	Provided	Provided	Provided	Provided
11	Subhash Nagar	Provided	Provided	Provided	Provided	Provided
12	Pani Petch	Provided	Provided	Provided	Provided	Provided
13	Ambabari	Provided	Provided	Provided	Provided	Provided

TYPICAL ELEVATED STATION
(U GIRDER CONSTRUCTION TYPE)

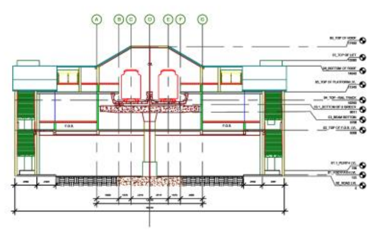




SOUTH SIDE ELEVATION



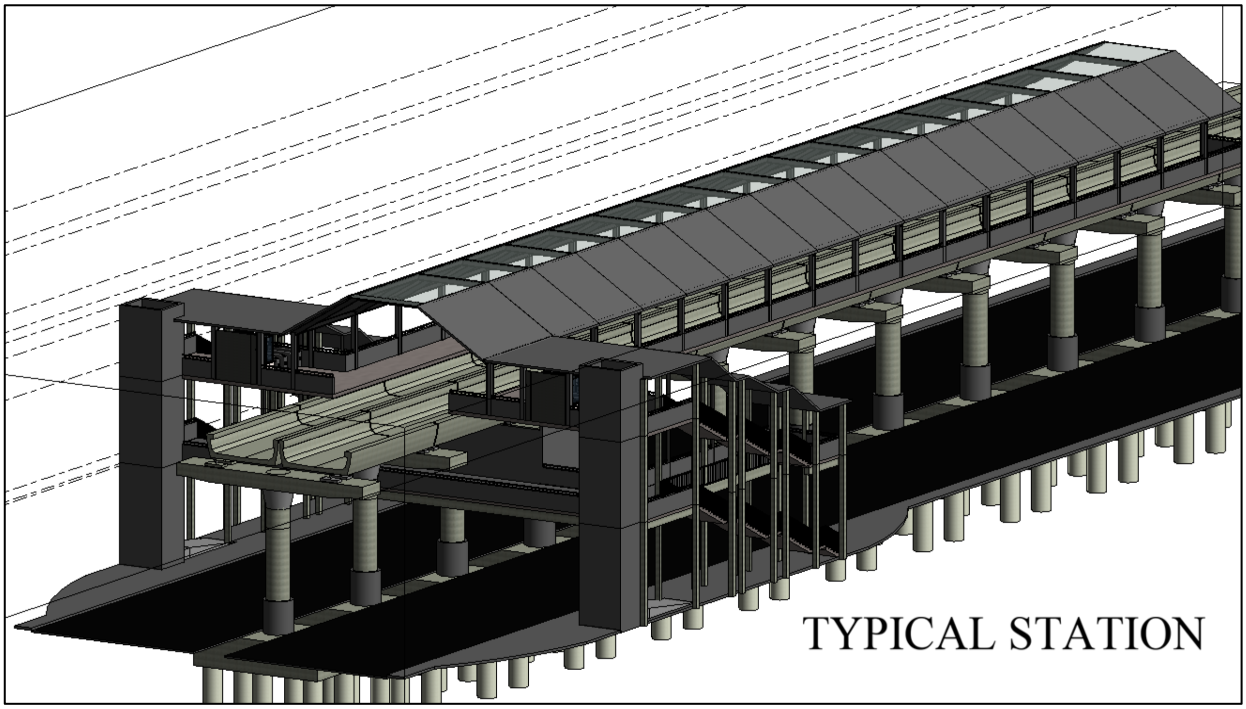
LONG SECTIONAL ELEVATION



CROSS SECTIONAL ELEVATION

LEGEND
PAID AREA
UNPAID AREA
TECHNICAL AREA

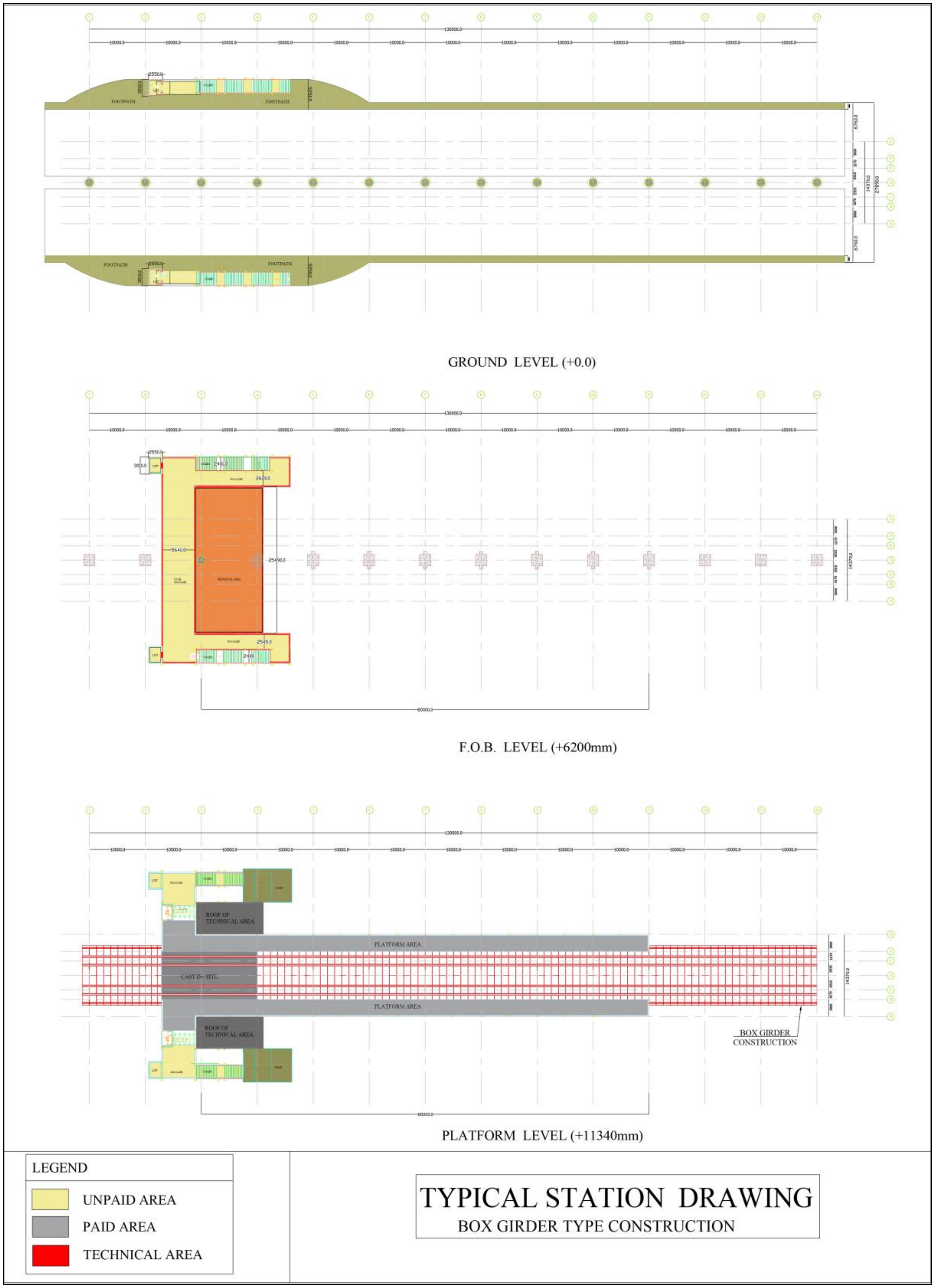
TYPICAL STATION DRAWING

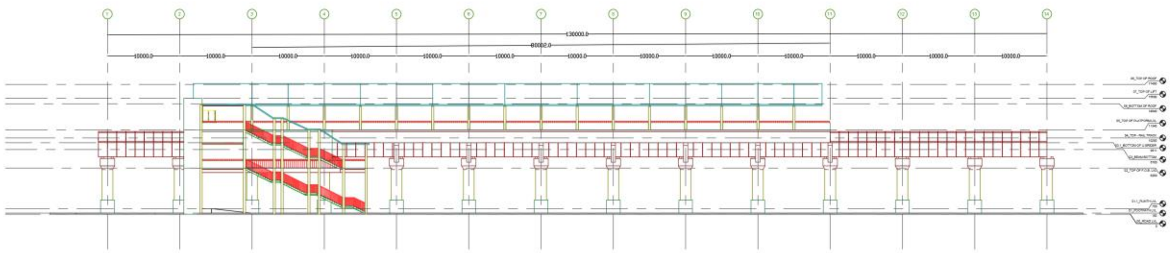


(U GIRDER CONSTRUCTION TYPE)

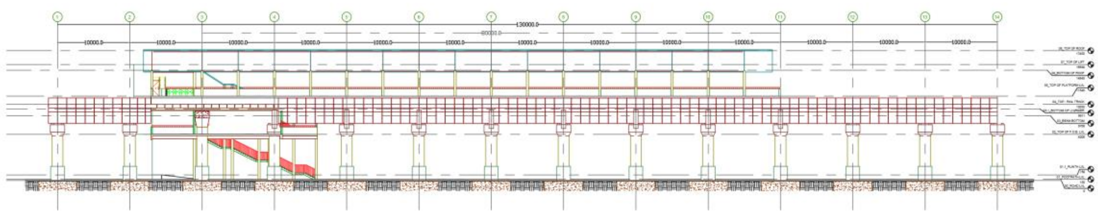
TYPICAL ELEVATED STATION

(BOX GIRDER CONSTRUCTION TYPE)

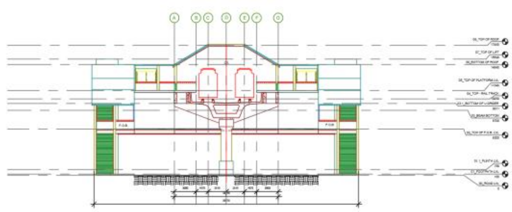




SOUTH SIDE ELEVATION



LONG SECTIONAL ELEVATION



CROSS SECTIONAL ELEVATION

LEGEND

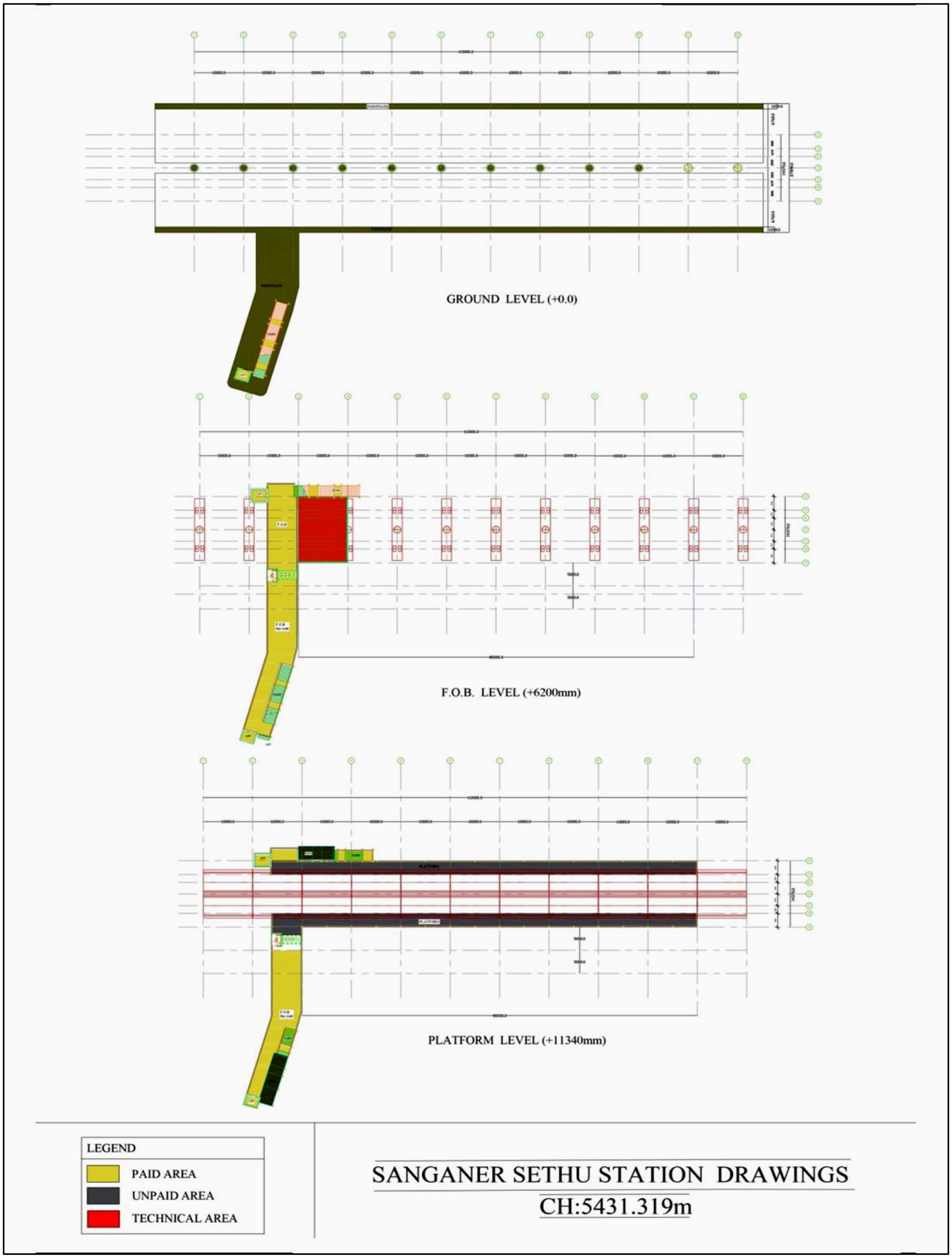
- UNPAID AREA
- PAID AREA
- TECHNICAL AREA

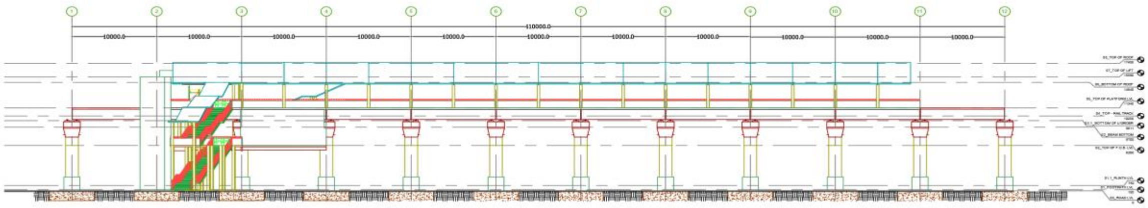
TYPICAL STATION DRAWING

BOX GIRDER TYPE CONSTRUCTION

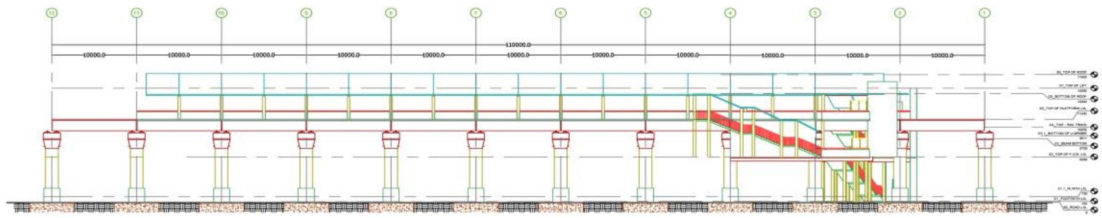
SANGANER SETHU STATION

(U GIRDER CONSTRUCTION TYPE)





LONG SECTIONAL ELEVATION



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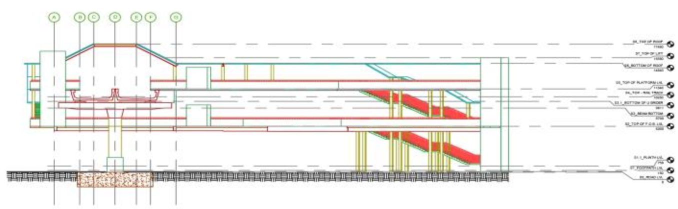

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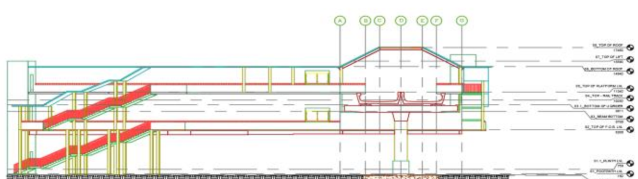

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SANGANER SETHU STATION DRAWINGS

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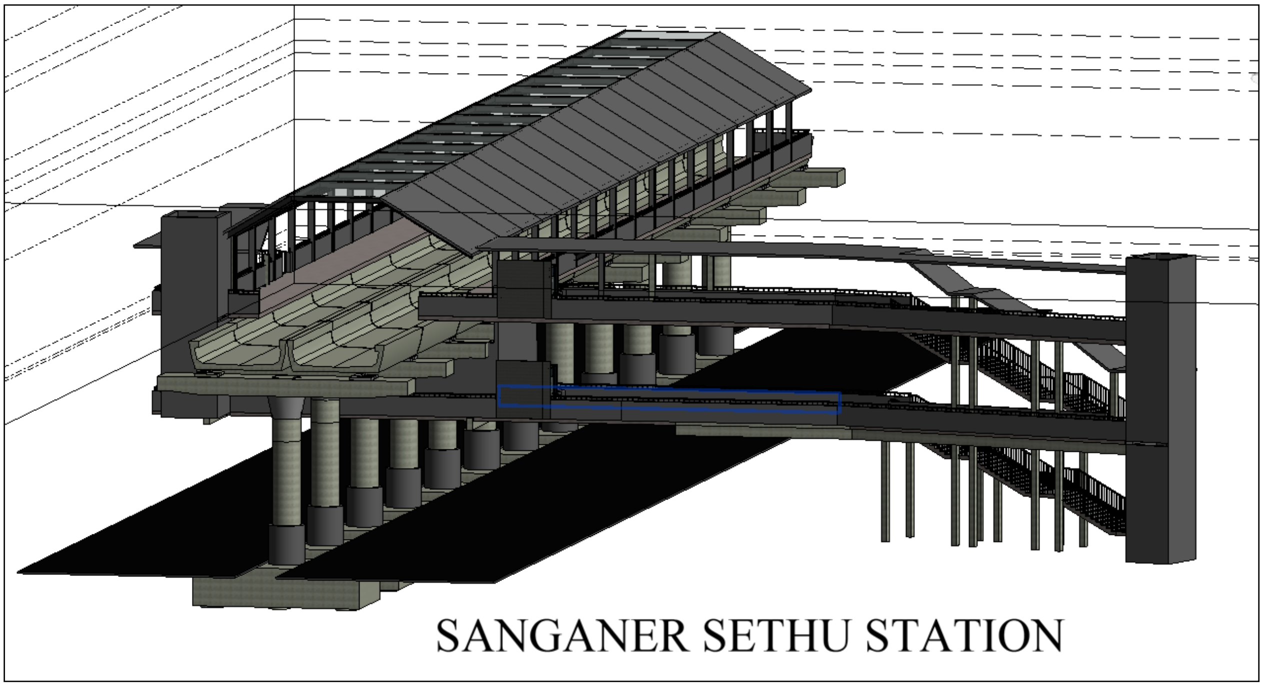
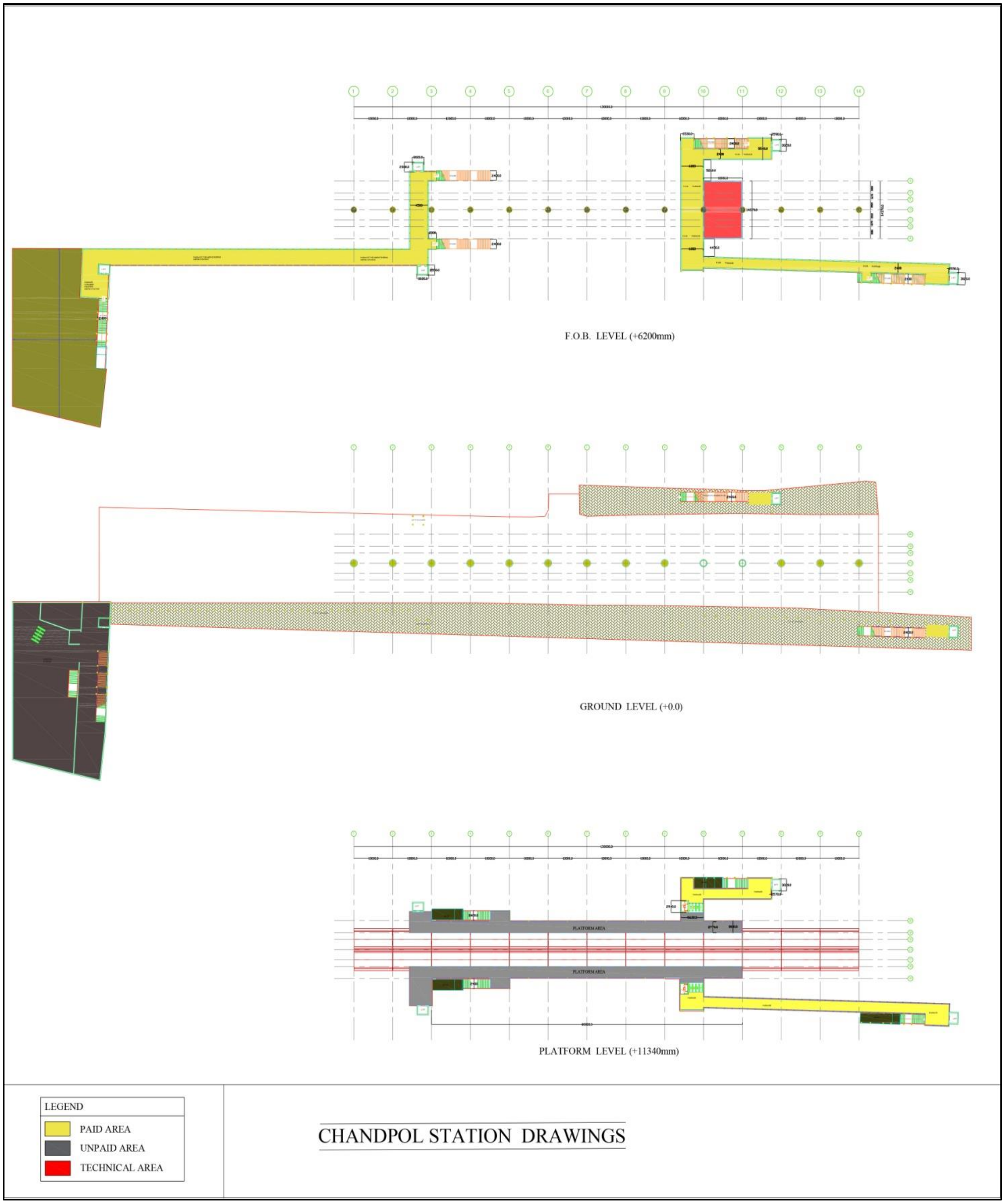
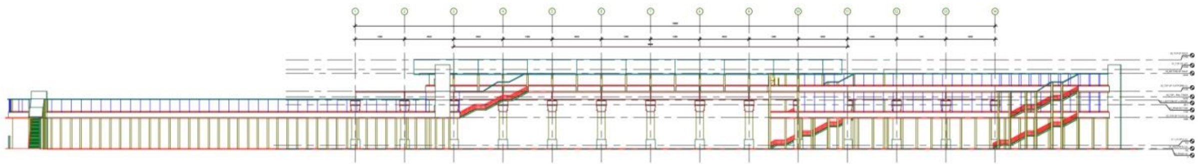


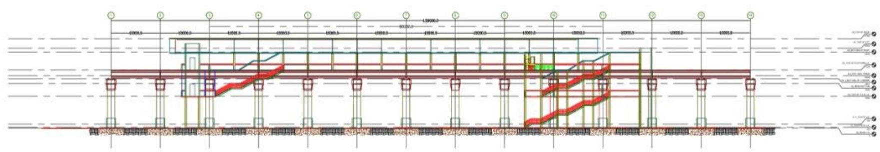
(U GIRDER CONSTRUCTION TYPE)

CHANDPOL METRO STATION
(BOX GIRDER CONSTRUCTION TYPE)





SOUTH SIDE ELEVATION



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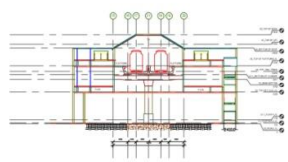

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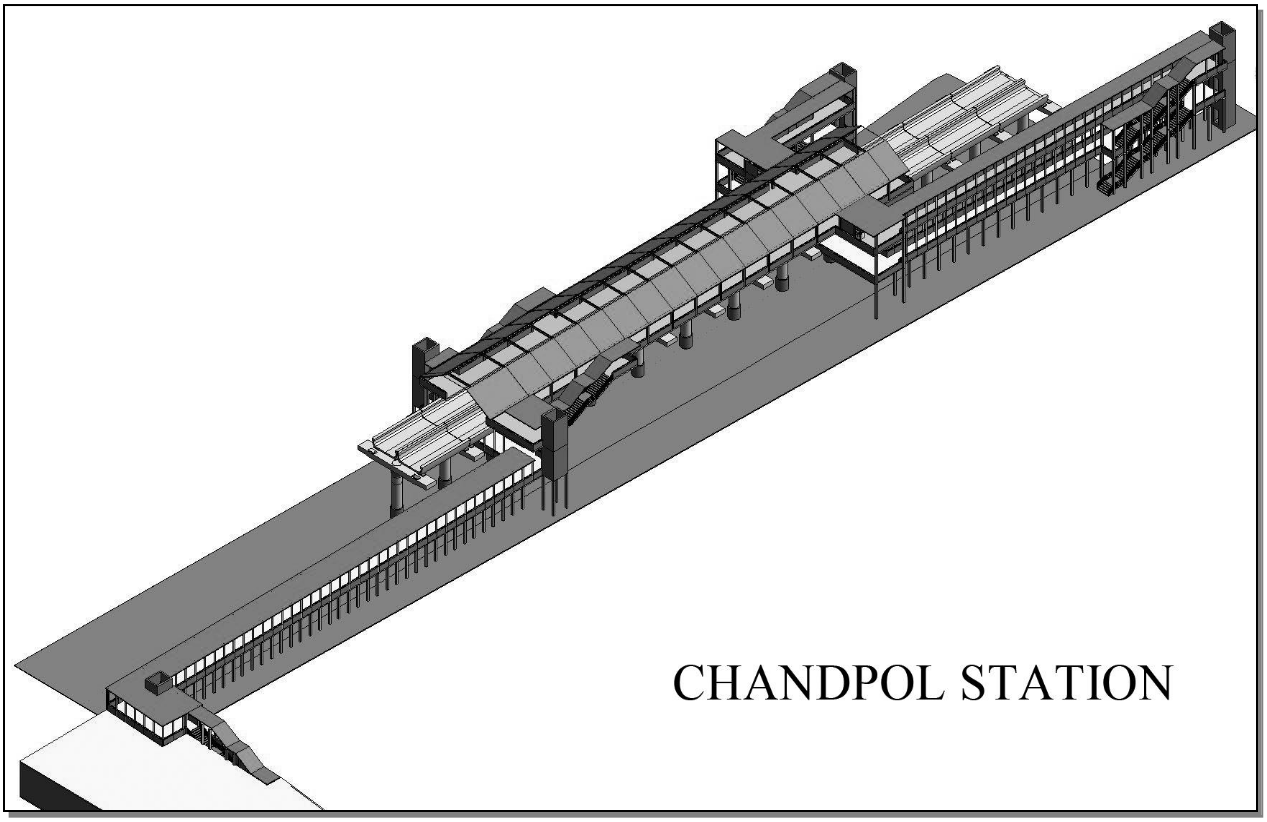

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NARAYAN SINGH CIRCLE STATION
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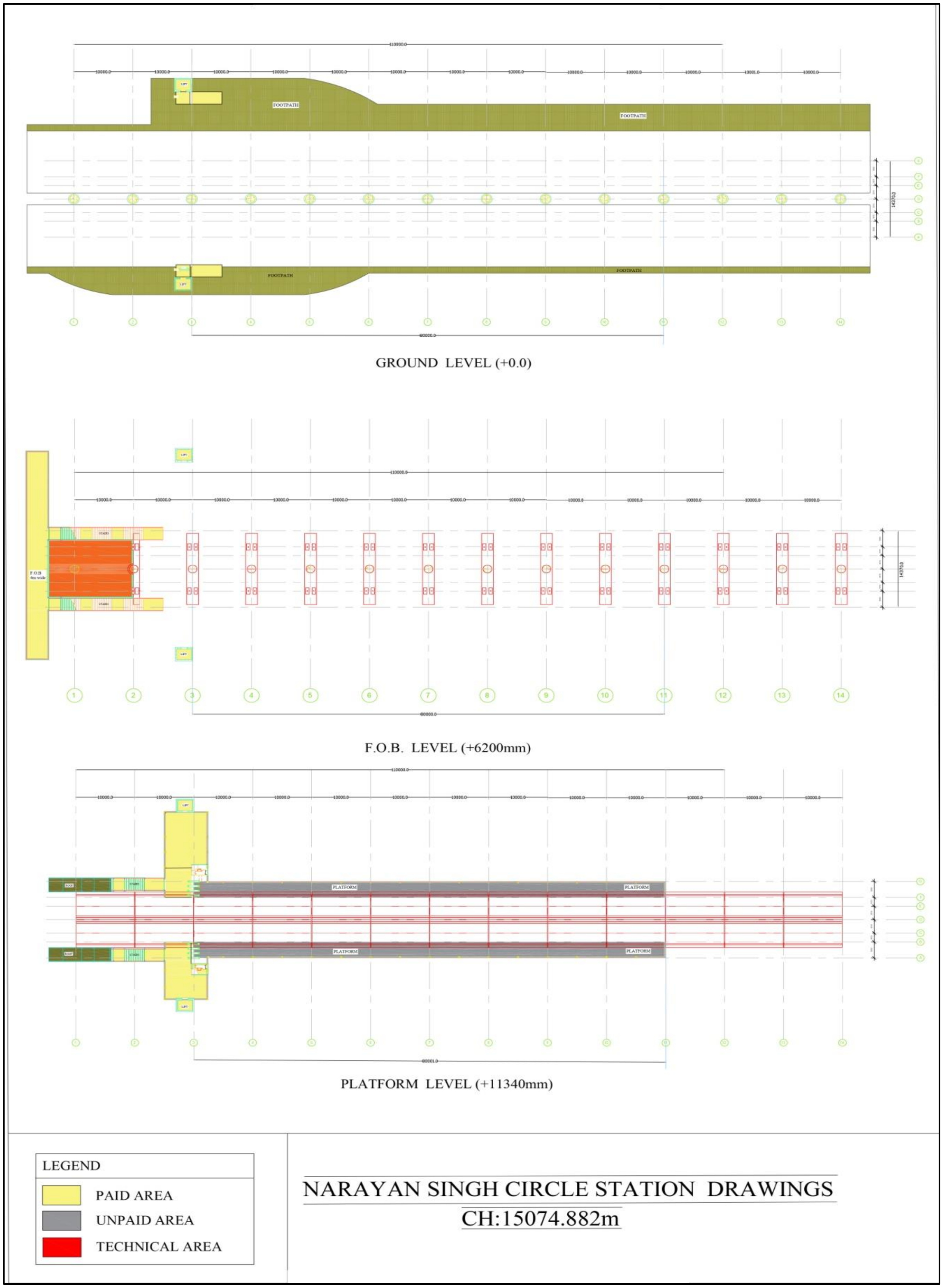

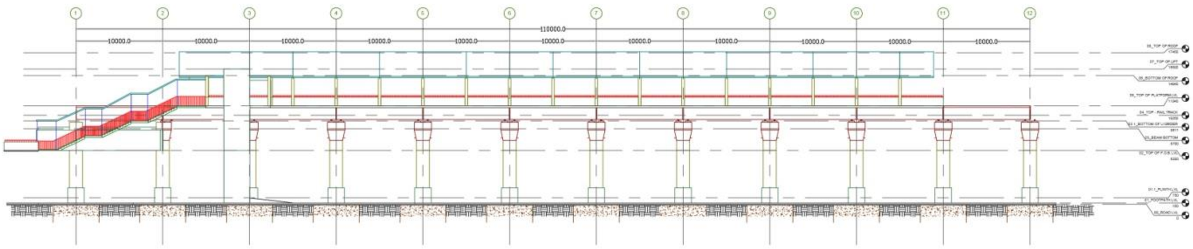

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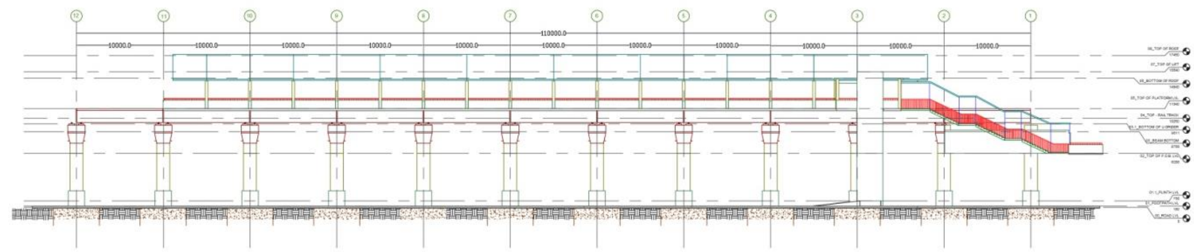

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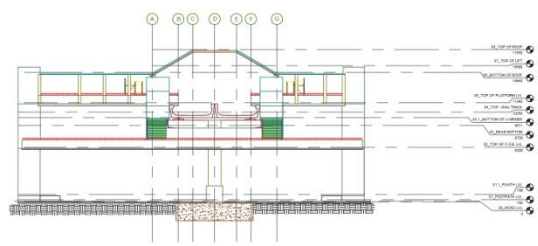

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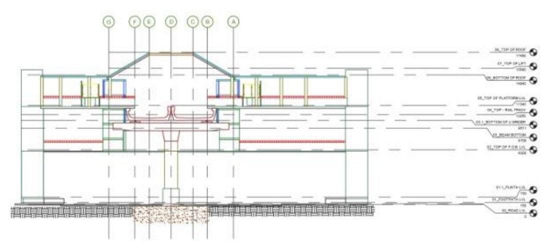

CROSS SECTIONAL ELEVATION

NARAYAN SINGH CIRCLE STATION DRAWINGS

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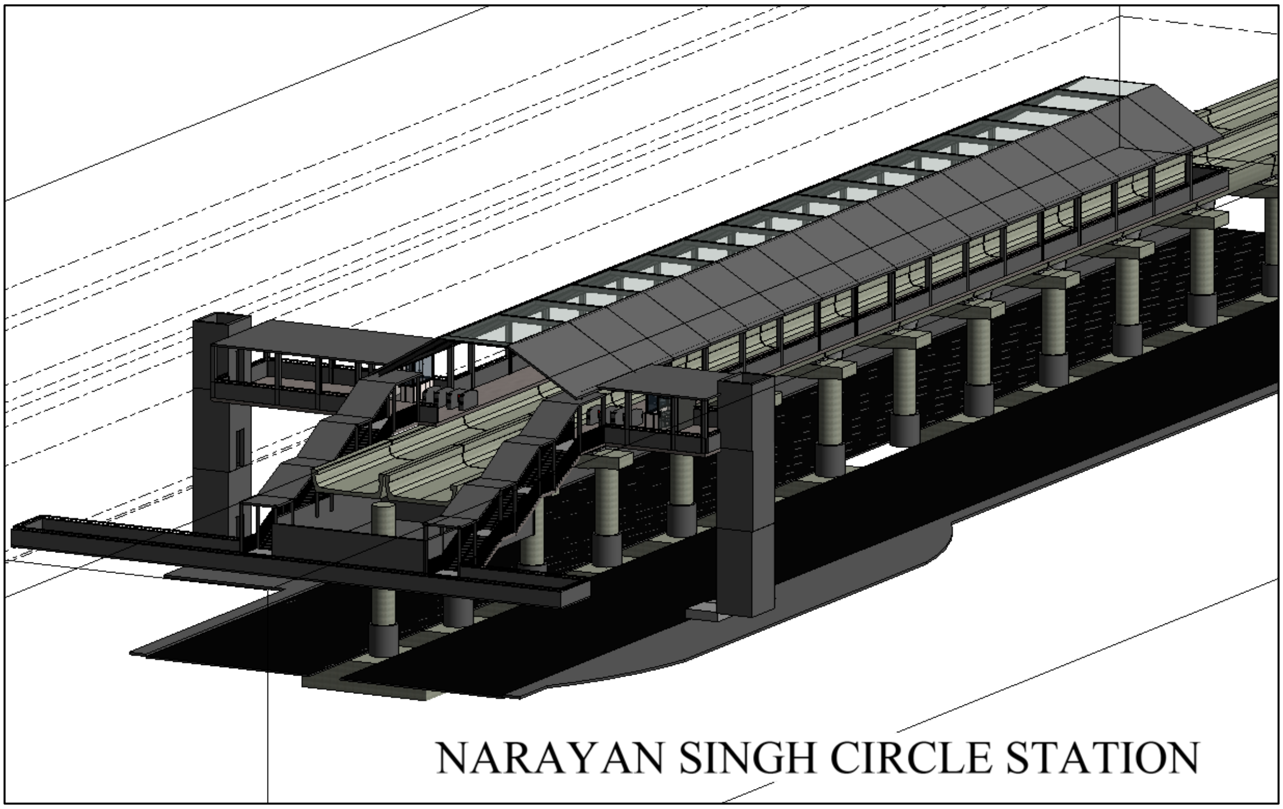

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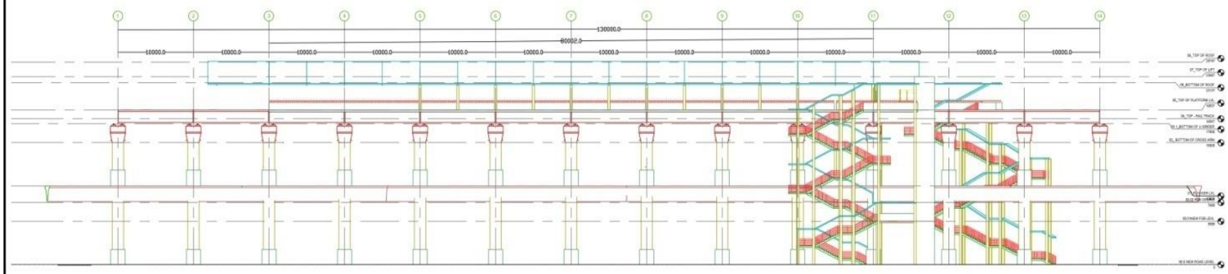
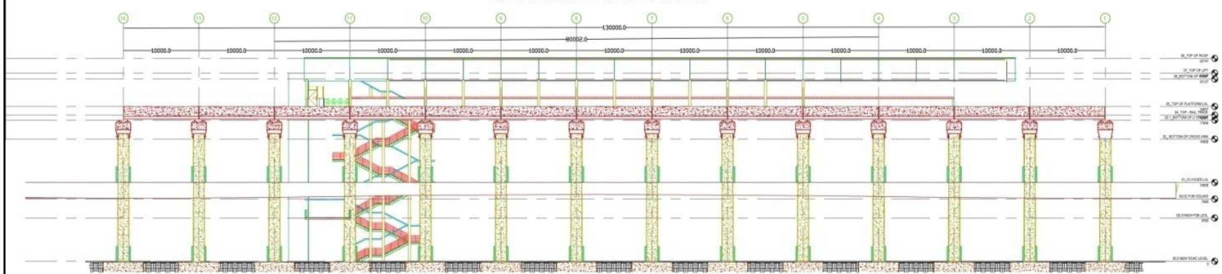


SOUTH SIDE ELEVATION



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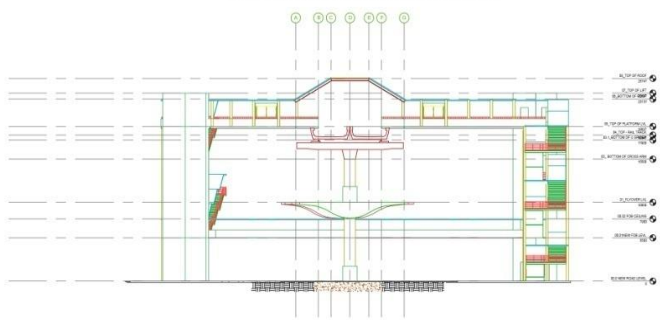

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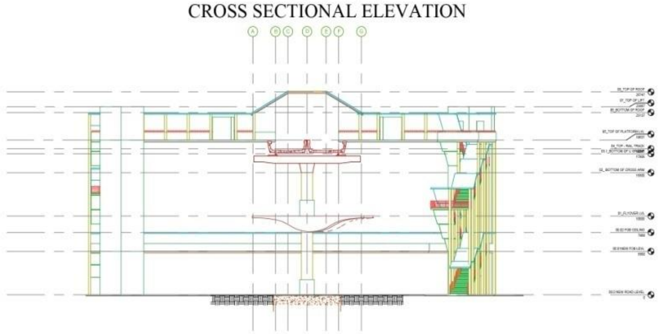
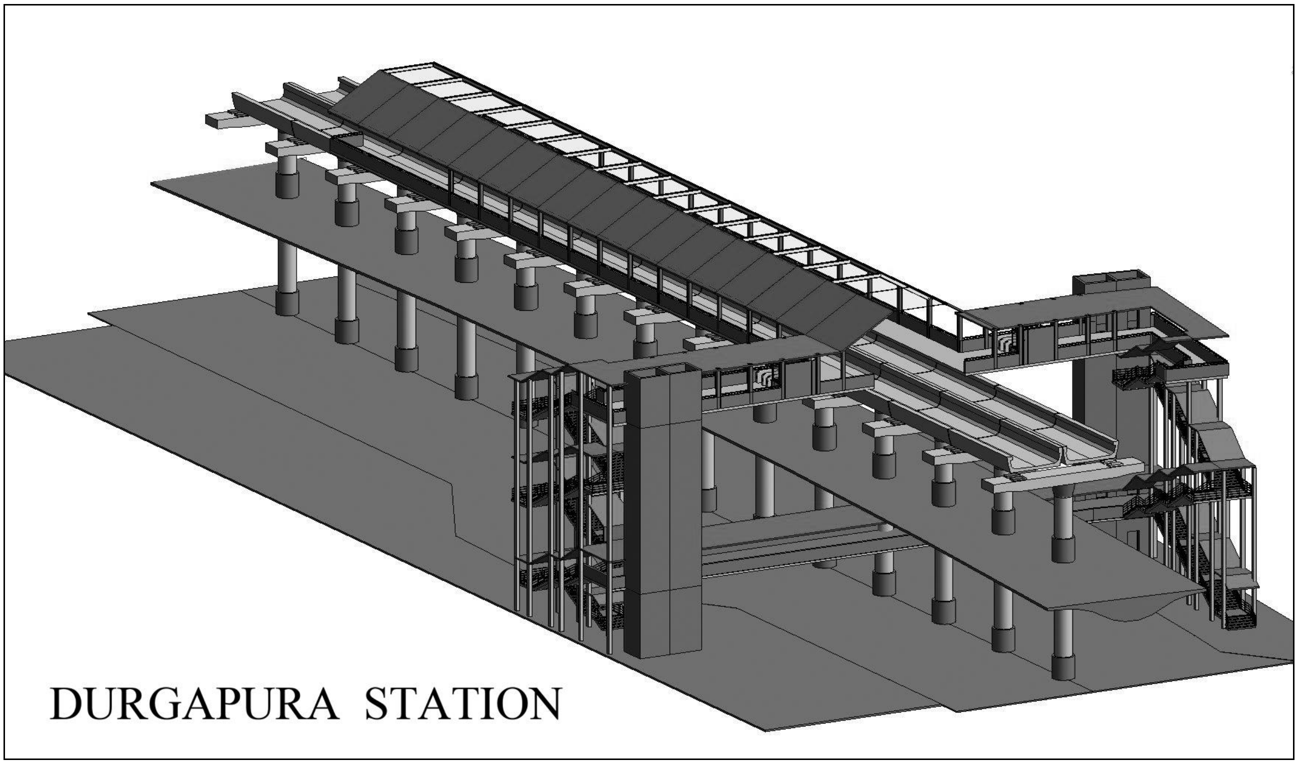


CROSS SECTIONAL ELEVATION

DURGAPURA STATION DRAWINGS



(U GIRDER CONSTRUCTION TYPE)

CHAPTER 7–TRAIN OPERATION PLAN

CHAPTER - 7

TRAIN OPERATION PLAN

7.1 OPERATION PHILOSOPHY

The underlying operation philosophy is to make the MRT System more attractive and economical, the main features being:

- Selecting the most optimum frequency of Train services to meet sectional capacity requirement during peak hours on most of the sections.
- Economical & optimum train service frequency not only during peak period, but also during off-peak period.
- Optimization of train's reliability for achieving best possible availability on line.
- A train consists of 3 coaches with high frequency service.
- Multi-tasking of train operation and maintenance staff.

7.2 STATIONS

List of stations for Jaipur Metro Corridor (India Gate (SIA) to Ambabari) is given below:

Table 7.1: Stations

S. No.	Station Name	Chainage(m)	Inter Distance	Station Type
1	India Gate (SIA)	0.000		Elevated
2	Kumbha Marg	1599.564	1599.564	Elevated
3	Haldi Ghati Gate	2439.871	840.307	Elevated
4	Pinjra Pole Gaushala	3357.734	917.863	Elevated
5	Sanganer Sethu	5431.316	2073.582	Elevated
6	B2 Bypass Circle	7914.327	2483.011	Elevated
7	Durgapura	9219.655	1305.328	Elevated
8	Mahaveer Nagar	9984.491	764.836	Elevated
9	Dev Nagar	11028.593	1044.102	Elevated
10	Gandhi Nagar	11705.394	676.801	Elevated
11	Tonk Phatak	12819.654	1114.260	Elevated
12	Ram Bagh Circle	14363.115	1543.461	Elevated
13	Narayan Singh Circle	15069.586	706.471	Elevated
14	SMS Hospital	16085.106	1015.520	Elevated
15	Ashok Marg	17516.843	1431.737	Elevated
16	Government Hostel	18332.952	816.109	Elevated
17	Chandpole	19372.919	1039.967	Elevated
18	Collectorate	20252.507	879.588	Elevated
19	Subhash Nagar	21382.664	1130.157	Elevated
20	Panipech	22223.813	841.149	Elevated
21	Ambabari	23060.000	836.187	Elevated

7.3 TRAIN OPERATION PLAN: SALIENT FEATURES

- Running of services for 19 hours of the day (5 AM to Midnight) with a station dwell time of 30 seconds.
- Make up time of 5-10% with 8-12% coasting.
- Scheduled speed for this corridor has been considered as 33 kmph.

7.4 TRAFFIC DEMAND

Peak hour peak direction traffic demands (PHPDT) for the Jaipur Metro Corridor: India Gate to Ambabari in the year 2023, 2031, 2041 and 2051 for the purpose of planning are indicated in Attachment I/A, I/B. I/C and I/D respectively.

7.5 TRAIN FORMATION

To meet the above projected traffic demand, the possibility of running trains with composition of 3 cars in year 2023, 2031, 2041 and 2051 with different headway has been examined.

The basic unit of 3-car train comprising of DMC-TC-DMC configuration has been selected for this corridor for the year 2023, 2031, 2041 & 2051.

Composition
DMC : Driving Motor Car
TC : Trailer Car
DMC : Driving Motor Car
Train Composition: DMC+TC+DMC

Capacity (@ 6 passengers per square meter of standee area)

Driving Motor Car (DMC)	- 247 (43 seated + 204 standing)
Trailer Car (TC)	- 270 (50 seated + 220 standing
3 Car Train	- 764 (136 seated + 628 standing)

7.6 TRAIN OPERATION PLAN

This new corridor from India Gate (SIA) to Ambabari has no operational link with the existing corridor of Jaipur Metro. Based on the projected PHPDT demand, Train operation plan with train carrying capacity @ 6 persons per square meter of standee area for the Jaipur Metro Line: India Gate (SIA) to Ambabari for the year 2023,2031,2041 and 2051 is given below:

I. **Year 2023 (Refer Attachment I/A1):** Train operation with 3 car train combination with headway of 10.00 minutes will run from India Gate (SIA) to Ambabari. The maximum PHPDT demand of 3,930 is in the Section between Narayan Singh Circle to SMS Hospital. The planned capacity **(4,584 @6 persons per square meter of standee area and 5,832@8 persons per square meter of standee area)** is more than the PHPDT Demand.

II. **Year 2031 (Refer Attachment I/B1):** Train operation with 3 car train combination with headway of 7.00 minutes will run from India Gate (SIA) to Ambabari. The maximum PHPDT demand of 6,994 is in the Section between Narayan Singh Circle to SMS Hospital. The planned capacity **(6,549 @6 persons per square meter and 8,331 @ 8 persons per square meter)** is sufficient to sufficient to manage PHPDT Demand.

III. **Year 2041 (Refer Attachment I/C1):** Train operation with 3 car train combination with headway of 4.00 minutes will run from India Gate (SIA) to Ambabari. The maximum PHPDT demand of 12,771 is in the Section between SMS Hospital to Ashok Marg. The planned capacity **(11,460 @6 persons per square meter and 14,580 @ 8 persons per square meter)** is sufficient to sufficient to manage PHPDT Demand.

IV. **Year 2051 (Refer Attachment I/D1):** Train operation with 3 car train combination with headway of 2.50 minutes will run from India Gate (SIA) to Ambabari. The maximum PHPDT demand of 20,704 is in the Section between Ram Bagh Circle to Narayan Singh Circle. The planned capacity **(18,336 @6 persons per square meter and 23,328 @ 8 persons per square meter** is sufficient to sufficient to manage PHPDT Demand.

The PHPDT capacity provided on the route in different years of operation is tabulated below:

Table 7.2: Capacity Provided for Jaipur Metro Corridor (India Gate (SIA) to Ambabari)

Particular	2023	2031	2041	2051
Car/Trains	3	3	3	3
Headway(min)	10.00	7.00	4.0	2.50
Max. PHPDT Demand	3,930	6,994	12,771	20,704
PHPDT Capacity available	4,584 (5,584)*	6,549 (8,331)*	11,460 (14,580)*	18,336 (23,328)*

***** @ 8 persons per square meter of standee area

7.7 TRAIN FREQUENCY

Table 7.3: Train Frequency

Section	2023		2031		2041		2051	
	Peak Hour Head-way	Lean Hour Head-way	Peak Hour Head-way	Lean Hour Head-way	Peak Hour Head-way	Lean Hour Head-way	Peak Hour Head-way	Lean Hour Head-way
India Gate to Ambabari	10.00 Min	16 to 40 min	7.00 min	10 to 30 min	4.00 min	6 to 20 min	2.50 min	4 to 10 min

No services are proposed between 00:00 hrs to 5.00 hrs, which are reserved for maintenance of infrastructure and rolling stock.

7.8 HOURLY TRAIN OPERATION PLAN

The hourly distribution of daily transport capacity for 'India Gate (SIA) to Ambabari' Section for the years 2023, 2031, 2041 and 2051 enclosed as **Attachment II.**

Number of train trips per direction per day for 'India Gate (SIA) to Ambabari' for the year 2023, 2031, 2041 and 2051 are 67, 102, 167 and 280 respectively.

The directional split for 'India Gate (SIA) to Ambabari' Section is enclosed as **Attachment III**.

7.9 VEHICLE KILOMETER

Based on above planning, after considering maintenance period and assuming 340 days in service in a year, Vehicle Kilometers for Jaipur Metro Rail Network, 'India Gate (SIA) to Ambabari' Section is enclosed as **Attachment IV**.

7.10 YEAR WISE RAKE REQUIREMENT

Based on Train formation and headway as decided above to meet Peak Hour Peak Direction Traffic Demand, rake requirement has been calculated and enclosed as **Attachment V.**

Requirements of coaches is calculated based on following assumptions-

Assumptions –

(i) Train Composition planned as under
3 Car Train Compositions: DMC-TC-DMC

Train Carrying Capacity of 3 Car Train
Train @6 person per square meter: 764 passengers
Train @8 person per square meter: 972 passengers
Coach requirement has been calculated based on headway during peak hours.

(ii) Traffic reserve is taken as one train to cater to failure of train on line and to make up for operational time list.
(iii) Repair and maintenance reserve has been estimated as 8 % of total requirement (Bare).
(iv) The calculated number of rakes in fraction is rounded off to next higher number.
(v) Schedule speed is taken as: 33kmph
(vi) Total Turn round time is taken as 6 min at terminal stations.

7.11 COST ESTIMATE

The estimated cost per coach at Jan'20 Price level excluding taxes and duties may be assumed as INR 8.4 Crores per Coach. For the year 2023 total rakes requirement is 12 and hence 36 cars are required for Jaipur Metro 'India Gate (SIA) to Ambabari'. Hence budget provision of Rs. 302.4 Crores (approx.) is to be kept in the Estimate for Rolling stock.

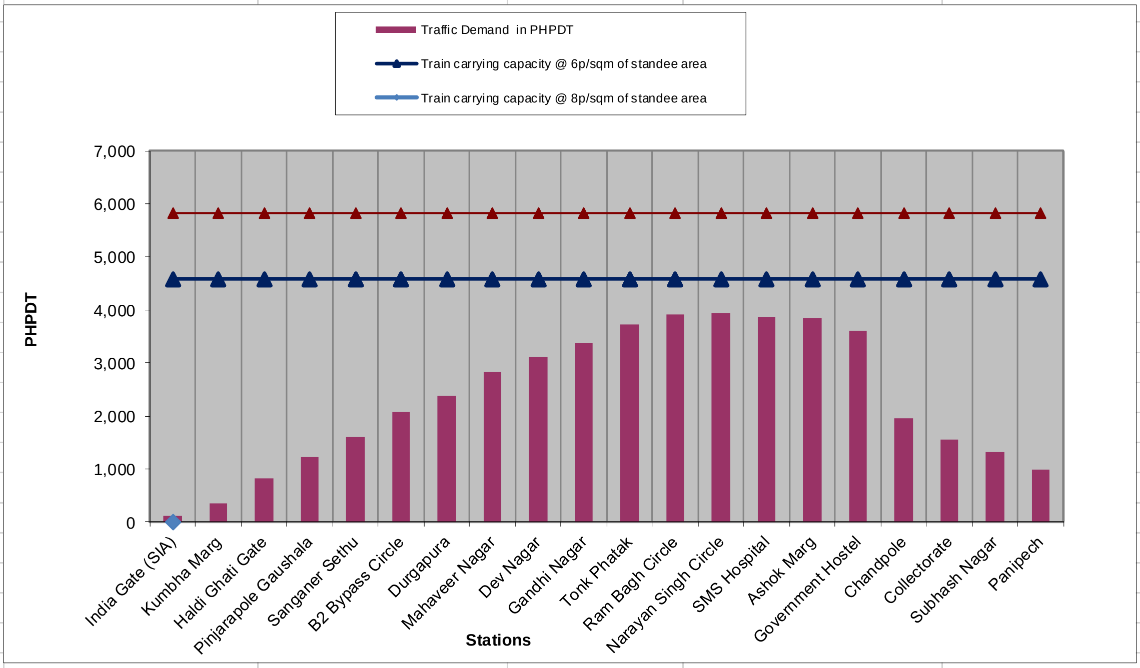
Attachment - I/A

PHPDT Demand and Capacity Chart

Line-2 (India Gate (SIA) to Ambabari)

Year:	2023
No. of cars per train	3
Passenger Capacity @ 6persons/sqm of a 3-Car- Train:	764
Passenger Capacity @ 8persons/sqm of a 3-Car- Train:	972
Headway (min)	10.00

S.N	FROM	TO	Traffic Demand in PHPDT	Train carrying capacity @ 6p/sqm of standee area	Train carrying capacity @ 8p/sqm of standee area
1	India Gate (SIA)	Kumbha Marg	111	4,584	5,832
2	Kumbha Marg	Haldi Ghati Gate	349	4,584	5,832
3	Haldi Ghati Gate	Pinjarapole Gaushala	815	4,584	5,832
4	Pinjarapole Gaushala	Sanganer Sethu	1,216	4,584	5,832
5	Sanganer Sethu	B2 Bypass Circle	1,605	4,584	5,832
6	B2 Bypass Circle	Durgapura	2,069	4,584	5,832
7	Durgapura	Mahaveer Nagar	2,382	4,584	5,832
8	Mahaveer Nagar	Dev Nagar	2,830	4,584	5,832
9	Dev Nagar	Gandhi Nagar	3,100	4,584	5,832
10	Gandhi Nagar	Tonk Phatak	3,380	4,584	5,832
11	Tonk Phatak	Ram Bagh Circle	3,713	4,584	5,832
12	Ram Bagh Circle	Narayan Singh Circle	3,904	4,584	5,832
13	Narayan Singh Circle	SMS Hospital	3,930	4,584	5,832
14	SMS Hospital	Ashok Marg	3,870	4,584	5,832
15	Ashok Marg	Government Hostel	3,843	4,584	5,832
16	Government Hostel	Chandpole	3,595	4,584	5,832
17	Chandpole	Collectorate	1,962	4,584	5,832
18	Collectorate	Subhash Nagar	1,552	4,584	5,832
19	Subhash Nagar	Panipech	1,310	4,584	5,832
20	Panipech	Ambabari	994	4,584	5,832



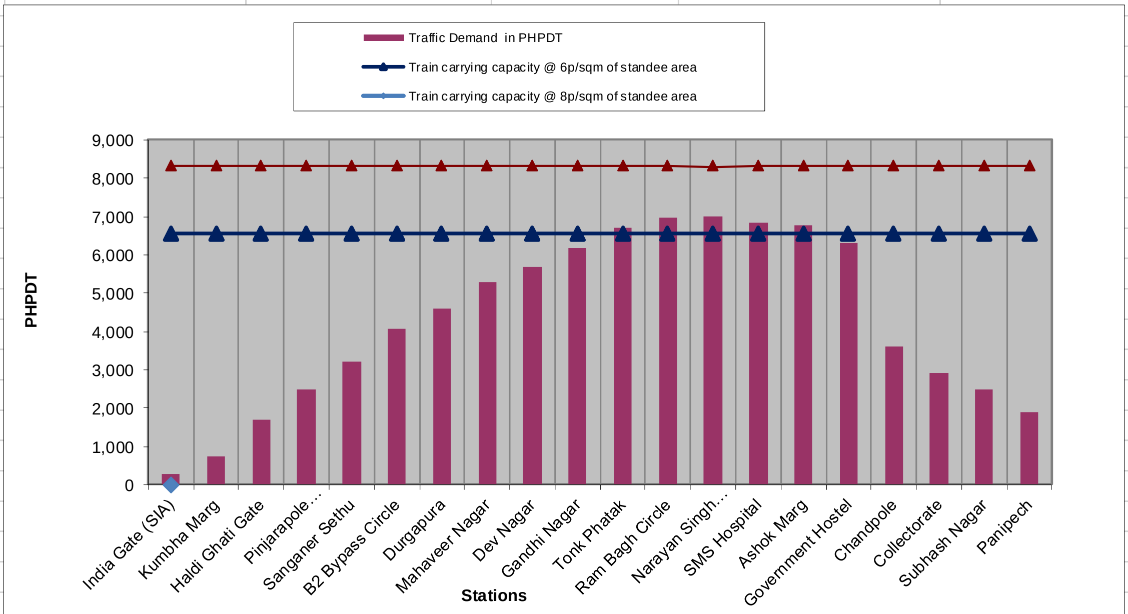
Attachment - I/B

PHPDT Demand and Capacity Chart

Line-2 (India Gate (SIA) to Ambabari)

Year:	**2031**
No. of cars per train	**3**
Passenger Capacity @ 6persons/sqm of a 3-Car- Train:	**764**
Passenger Capacity @ 8persons/sqm of a 3-Car- Train:	**972**
Headway (min)	**7.00**

S.N.	FROM	TO	Traffic Demand in PHPDT	Train carrying capacity @ 6p/sqm of standee area	Train carrying capacity @ 8p/sqm of standee area
1	India Gate (SIA)	Kumbha Marg	285	6,549	8,331
2	Kumbha Marg	Haldi Ghati Gate	755	6,549	8,331
3	Haldi Ghati Gate	Pinjarapole Gaushala	1,712	6,549	8,331
4	Pinjarapole Gaushala	Sanganer Sethu	2,493	6,549	8,331
5	Sanganer Sethu	B2 Bypass Circle	3,218	6,549	8,331
6	B2 Bypass Circle	Durgapura	4,064	6,549	8,331
7	Durgapura	Mahaveer Nagar	4,606	6,549	8,331
8	Mahaveer Nagar	Dev Nagar	5,298	6,549	8,331
9	Dev Nagar	Gandhi Nagar	5,697	6,549	8,331
10	Gandhi Nagar	Tonk Phatak	6,166	6,549	8,331
11	Tonk Phatak	Ram Bagh Circle	6,705	6,549	8,331
12	Ram Bagh Circle	Narayan Singh Circle	6,985	6,549	8,331
13	Narayan Singh Circle	SMS Hospital	6,994	6,549	8,331
14	SMS Hospital	Ashok Marg	6,850	6,549	8,331
15	Ashok Marg	Government Hostel	6,774	6,549	8,331
16	Government Hostel	Chandpole	6,296	6,549	8,331
17	Chandpole	Collectorate	3,611	6,549	8,331
18	Collectorate	Subhash Nagar	2,913	6,549	8,331
19	Subhash Nagar	Panipech	2,479	6,549	8,331
20	Panipech	Ambabari	1,907	6,549	8,331



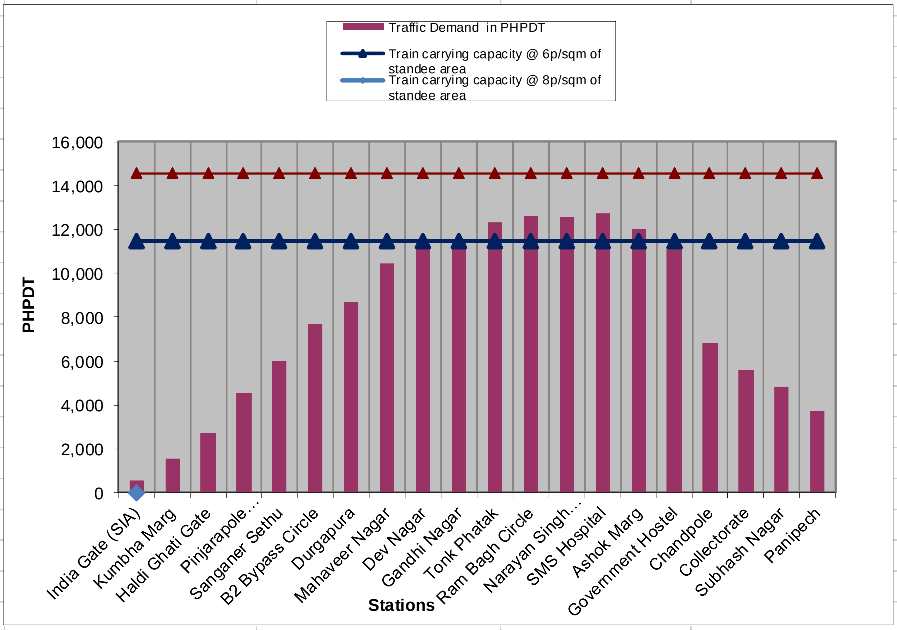
Attachment - I/C

PHPDT Demand and Capacity Chart

Line-2 (India Gate (SIA) to Ambabari)

Year:	2041
No. of cars per train	3
Passenger Capacity @ 6persons/sqm of a 3-Car- Train:	764
Passenger Capacity @ 8persons/sqm of a 3-Car- Train:	972
Headway (min)	4.00

S.N.	FROM	TO	Traffic Demand in PHPDT	Train carrying capacity @ 6p/sqm of standee area	Train carrying capacity @ 8p/sqm of standee area
1	India Gate (SIA)	Kumbha Marg	573	11,460	14,580
2	Kumbha Marg	Haldi Ghati Gate	1,545	11,460	14,580
3	Haldi Ghati Gate	Pinjarapole Gaushala	2,711	11,460	14,580
4	Pinjarapole Gaushala	Sanganer Sethu	4,537	11,460	14,580
5	Sanganer Sethu	B2 Bypass Circle	6,014	11,460	14,580
6	B2 Bypass Circle	Durgapura	7,687	11,460	14,580
7	Durgapura	Mahaveer Nagar	8,693	11,460	14,580
8	Mahaveer Nagar	Dev Nagar	10,436	11,460	14,580
9	Dev Nagar	Gandhi Nagar	11,232	11,460	14,580
10	Gandhi Nagar	Tonk Phatak	11,478	11,460	14,580
11	Tonk Phatak	Ram Bagh Circle	12,362	11,460	14,580
12	Ram Bagh Circle	Narayan Singh Circle	12,627	11,460	14,580
13	Narayan Singh Circle	SMS Hospital	12,559	11,460	14,580
14	SMS Hospital	Ashok Marg	12,771	11,460	14,580
15	Ashok Marg	Government Hostel	12,057	11,460	14,580
16	Government Hostel	Chandpole	11,105	11,460	14,580
17	Chandpole	Collectorate	6,799	11,460	14,580
18	Collectorate	Subhash Nagar	5,610	11,460	14,580
19	Subhash Nagar	Panipech	4,813	11,460	14,580
20	Panipech	Ambabari	3,738	11,460	14,580



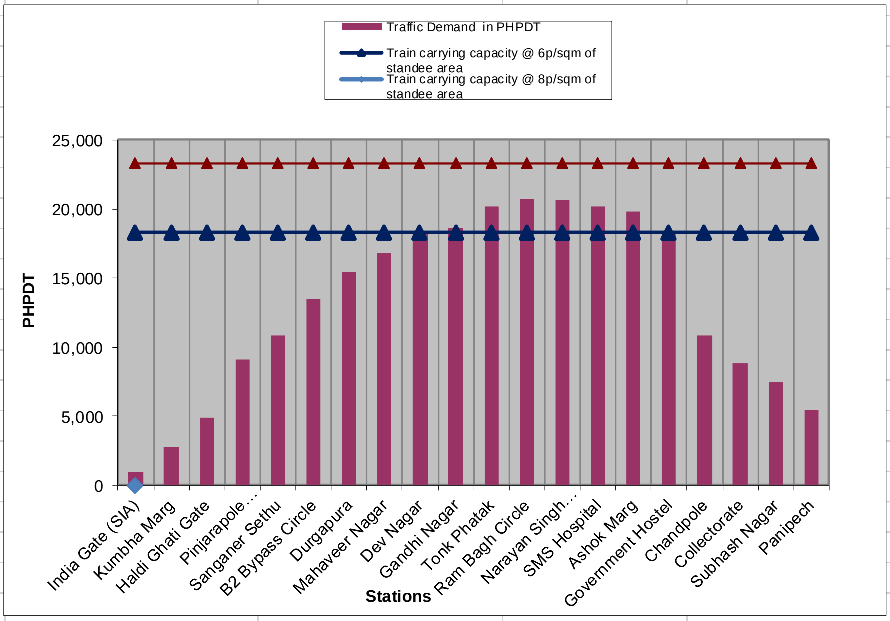
Attachment - I/D

PHPDT Demand and Capacity Chart

Line-2 (India Gate (SIA) to Ambabari)

Year:	**2051**
No. of cars per train	**3**
Passenger Capacity @ 6persons/sqm of a 3-Car- Train:	**764**
Passenger Capacity @ 8persons/sqm of a 3-Car- Train:	**972**
Headway (min)	**2.50**

S.N.	FROM	TO	Traffic Demand in PHPDT	Train carrying capacity @ 6p/sqm of standee area	Train carrying capacity @ 8p/sqm of standee area
1	India Gate (SIA)	Kumbha Marg	955	18,336	23,328
2	Kumbha Marg	Haldi Ghati Gate	2,746	18,336	23,328
3	Haldi Ghati Gate	Pinjarapole Gaushala	4,898	18,336	23,328
4	Pinjarapole Gaushala	Sanganer Sethu	9,073	18,336	23,328
5	Sanganer Sethu	B2 Bypass Circle	10,867	18,336	23,328
6	B2 Bypass Circle	Durgapura	13,468	18,336	23,328
7	Durgapura	Mahaveer Nagar	15,382	18,336	23,328
8	Mahaveer Nagar	Dev Nagar	16,838	18,336	23,328
9	Dev Nagar	Gandhi Nagar	18,207	18,336	23,328
10	Gandhi Nagar	Tonk Phatak	18,643	18,336	23,328
11	Tonk Phatak	Ram Bagh Circle	20,186	18,336	23,328
12	Ram Bagh Circle	Narayan Singh Circle	20,704	18,336	23,328
13	Narayan Singh Circle	SMS Hospital	20,631	18,336	23,328
14	SMS Hospital	Ashok Marg	20,231	18,336	23,328
15	Ashok Marg	Government Hostel	19,812	18,336	23,328
16	Government Hostel	Chandpole	18,129	18,336	23,328
17	Chandpole	Collectorate	10,843	18,336	23,328
18	Collectorate	Subhash Nagar	8,829	18,336	23,328
19	Subhash Nagar	Panipech	7,417	18,336	23,328
20	Panipech	Ambabari	5,479	18,336	23,328



Attachment- II

TABLE 1.1

Hourly Train Operation Plan
Line-2 (India Gate (SIA) to Ambabari)
Year 2023

10.00

Time of Day	Headway in Minutes	No. of Train trips per day	
		UP	DN
5 to 6	32	1	1
6 to 7	24	2	2
7 to 8	16	4	4
8 to 9	**10**	**6**	**6**
9 to 10	**10**	**6**	**6**
10 to 11	**10**	**6**	**6**
11 to12	16	3	3
12 to 13	24	3	3
13 to 14	32	2	2
14 to 15	32	2	2
15 to 16	24	3	3
16 to 17	16	3	3
17 to 18	**10**	**6**	**6**
18 to 19	**10**	**6**	**6**
19 to 20	**10**	**6**	**6**
20 to 21	16	4	4
21 to 22	24	2	2
22 to 23	32	1	1
23 to 24	40	1	1
Total No. of train trips per direction per day		**67**	**67**

TABLE 1.2

Hourly Train Operation Plan
Line-2 (India Gate (SIA) to Ambabari)
Year 2031

7.00

Time of Day	Headway in Minutes	No. of Train trips per day	
		UP	DN
5 to 6	24	2	2
6 to 7	20	3	3
7 to 8	10	6	6
8 to 9	**7**	9	9
9 to 10	**7**	9	9
10 to 11	**7**	9	9
11 to12	10	6	6
12 to 13	20	3	3
13 to 14	24	3	3
14 to 15	24	3	3
15 to 16	20	3	3
16 to 17	10	6	6
17 to 18	**7**	9	9
18 to 19	**7**	9	9
19 to 20	**7**	9	9
20 to 21	10	6	6
21 to 22	20	3	3
22 to 23	24	2	2
23 to 24	30	2	2
Total No. of train trips per direction per day		**102**	**102**

TABLE 1.3			
Hourly Train Operation Plan Line-2 (India Gate (SIA) to Ambabari) Year 2041			
4.00			
Time of Day	**Headway in Minutes**	**No. of Train trips per day**	
		UP	**DN**
5 to 6	16	3	3
6 to 7	12	5	5
7 to 8	6	10	10
8 to 9	**4**	15	15
9 to 10	**4**	15	15
10 to 11	**4**	15	15
11 to12	6	10	10
12 to 13	12	5	5
13 to 14	16	4	4
14 to 15	16	4	4
15 to 16	12	5	5
16 to 17	6	10	10
17 to 18	**4**	15	15
18 to 19	**4**	15	15
19 to 20	**4**	15	15
20 to 21	6	10	10
21 to 22	12	5	5
22 to 23	16	3	3
23 to 24	20	3	3
Total No. of train trips per direction per day		**167**	**167**

TABLE 1.4			
Hourly Train Operation Plan Line-2 (India Gate (SIA) to Ambabari) Year 2051			
2.50			
Time of Day	**Headway in Minutes**	**No. of Train trips per day**	
		UP	**DN**
5 to 6	8	7	7
6 to 7	6	10	10
7 to 8	4	15	15
8 to 9	**2.5**	24	24
9 to 10	**2.5**	24	24
10 to 11	**2.5**	24	24
11 to12	4	15	15
12 to 13	6	10	10
13 to 14	8	8	8
14 to 15	8	8	8
15 to 16	6	10	10
16 to 17	4	15	15
17 to 18	**2.5**	24	24
18 to 19	**2.5**	24	24
19 to 20	**2.5**	24	24
20 to 21	4	15	15
21 to 22	6	10	10
22 to 23	8	7	7
23 to 24	10	6	6
Total No. of train trips per direction per day		**280**	**280**

Attachment III

TABLE 2.1
Line-2 (India Gate (SIA) to Ambabari)
PHPDT for the year 2021

S.No	From Station	To Station	Peak hour Load	Directional Split to Ambabari	Directional Split to India Gate (SIA)
1	India Gate (SIA)	Kumbha Marg	111	50%	50%
2	Kumbha Marg	Haldi Ghati Gate	349	50%	50%
3	Haldi Ghati Gate	Pinjarapole Gaushala	815	50%	50%
4	Pinjarapole Gaushala	Sanganer Sethu	1,216	50%	50%
5	Sanganer Sethu	B2 Bypass Circle	1,605	50%	50%
6	B2 Bypass Circle	Durgapura	2,069	50%	50%
7	Durgapura	Mahaveer Nagar	2,382	50%	50%
8	Mahaveer Nagar	Dev Nagar	2,830	50%	50%
9	Dev Nagar	Gandhi Nagar	3,100	50%	50%
10	Gandhi Nagar	Tonk Phatak	3,380	50%	50%
11	Tonk Phatak	Ram Bagh Circle	3,713	50%	50%
12	Ram Bagh Circle	Narayan Singh Circle	3,904	50%	50%
13	Narayan Singh Circle	SMS Hospital	3,930	50%	50%
14	SMS Hospital	Ashok Marg	3,870	50%	50%
15	Ashok Marg	Government Hostel	3,843	50%	50%
16	Government Hostel	Chandpole	3,595	50%	50%
17	Chandpole	Collectorate	1,962	50%	50%
18	Collectorate	Subhash Nagar	1,552	50%	50%
19	Subhash Nagar	Panipech	1,310	50%	50%
20	Panipech	Ambabari	994	50%	50%

Attachment IV

TABLE 3.1
Vehicle Kilometer
Line-2 (India Gate (SIA) to Ambabari)

Year	2023	2031	2041	2051
Section Length	23.28	23.28	23.28	23.28
No. of cars per train	3	3	3	3
No. of working Days in a year	340	340	340	340
Number of Trains per day each Way	67	102	167	280
Daily Train -KM	3119	4748	7774	13035
Annual Train - KM (10^5)	10.60	16.14	26.43	44.32
Annual Vehicle - KM (10^5)	31.81	48.43	79.29	132.96

Attachment V

RAKE REQUIREMENT

Line-2 (India Gate (SIA) to Ambabari)

2023

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Rake Requirement				Total cars
	From	To										Bare	Traffic Reserve	R&M	Total (a)	
1	India Gate (SIA)	Ambabari	23.276	33	2023	10.00	42.32	6	0	6	90.64	10	1	1	12	36

2031

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Rake Requirement				Total cars
	From	To										Bare	Traffic Reserve	R&M	Total (a)	
1	India Gate (SIA)	Ambabari	23.276	33	2031	7.00	42.32	6	0	6	90.64	13	1	1	15	45

2041

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Rake Requirement				Total cars
	From	To										Bare	Traffic Reserve	R&M	Total (a)	
1	India Gate (SIA)	Ambabari	23.276	33	2041	4.00	42.32	6	0	6	90.64	23	1	2	26	78

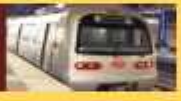
2051

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Rake Requirement				Total cars
	From	To										Bare	Traffic Reserve	R&M	Total (a)	
1	India Gate (SIA)	Ambabari	23.276	33	2051	2.50	42.32	6	0	6	90.64	37	1	3	41	123

Note

1. Passenger capacity @ 6p/sqm for a train of 3 - car	764
2. Passenger capacity @ 8p/sqm for a train of 3 - car	972

3. R&M has been considered as 10% of (Bare+ Traffic reserve)



CHAPTER 8 – MAINTENANCE DEPOT

CHAPTER –8

MAINTENANCE DEPOT

8.1 INDIA GATE (SIA) TO AMBABARI CORRIDOR COMPRISES AS BELOW:

Table 8.1: Corridor

Corridor	Route Length (km)
India Gate (SIA) to Ambabari	23.51

8.2 DEPOT- CUM- WORKSHOP AT SITAPURA DEPOT

8.2.1 It is proposed to establish one depot- cum- workshop with following functions:

(i) Major overhauls of all the trains.
(ii) All minor schedules and repairs.
(iii) Lifting for replacement of heavy equipment and testing thereafter.
(iv) Repair of heavy equipment.

8.2.2 The Depot planning is based on following assumptions:

(i) Enough space should be available for establishment of a Depot- Cum-workshop.
(ii) All inspection lines, workshop lines, stabling lines are designed to accommodate one train of 3- Car.
(iii) All Stabling lines are designed to accommodate two trains of 3- Car each.
(iv) All stabling lines are planned in the proposed depot-cum-workshop assuming adequate space availability. In case of space constraints, if any, stabling facilities may need to be created at terminal stations or elsewhere (preferably as close to depot as possible) to cater to the required stability facilities.
(v) In case of space constraint for depot two storeyed Stabling lines can also be planned

In broad terms, based on the planned Rolling Stock requirements, this chapter covers conceptual requirements on following aspects and will work as a guide for detailed design later:

- Layout of Stabling-shed, Inspection-shed, minor repairs and heavy repair overhauling workshop and cleaning of Rolling Stock.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage.

8.3 MAINTENANCE PHILOSOPHY

- Monitoring of the performance of equipment by condition monitoring of key parameters. The concept is to evolve the need based maintenance regime, which can be suitably configured in the form of schedules like daily check, “A” checks, “B” type checks, “IOH” and “POH”.
- Labour intensive procedures are kept to the minimum. Automation with state of the art machinery to ensure quality with reliability.
- Multi skilling of the Maintenance staff to ensure quality and productivity in their performance.
- Periodic review of maintenance practices to update replacement cycle of critical components based on experience.
- Energy conservation is given due attention.

8.4 ROLLING STOCK MAINTENANCE NEEDS

8.4.1 Maintenance Schedule

The following maintenance schedule has been envisaged for conceptual design of depots assuming approx. 259 kms running per train per day, taking in consideration the passenger load of 2023, 2031, 2041& 2051 respectively.

Table 8.2: Maintenance Schedule

Type of Schedule	Interval	Work Content	Locations
Daily	Daily	Check on the train condition and function at every daily service completion. Interval cleaning/mopping of floor and walls with vacuum cleaner.	Stabling Lines
“A” Service Check	5,000 km (approx. 15 days)	Detailed inspection and testing of sub - systems, under frame, replacement/ topping up of oils & lubricants.	Inspection Bays
“B” Service Check	15,000 km (approx. 45 days)	Detailed Inspection of ‘A’ type tasks plus items at multiples of 15,000 km (‘B’ type tasks)	Inspection Bays
Intermediate Overhaul (IOH)	420,000 Km, (3 and half Years approx.) whichever is earlier	Check and testing of all sub-assemblies (Electrical + Mechanical). Overhaul of pneumatic valves, Compressor. Condition based maintenance of sub-systems to bring them to original condition. Replacement of parts and rectification, trial run.	Workshop
Periodical Overhaul (POH)	840,000 km, (7 Years approx.) whichever is earlier	Dismantling of all sub-assemblies, bogies suspension system, traction motor, gear, control equipment, air-conditioning units etc. Overhauling to bring them to original condition.	Workshop

Type of Schedule	Interval	Work Content	Locations
		Checking repair and replacement as necessary. Inspection and trial.	
Heavy Repairs	-	Changing of heavy item such as bogies, traction motor, axles, gear cases & axle boxes etc.	Workshop

The above Schedule may need slight revision based on the actual earned kilometers per train and the specific maintenance requirements of Rolling Stock finally procured.

8.4.2 Washing Needs of Rolling Stock

Cleanliness of the trains is essential. Following schedules are recommended for Indian environment:

Table 8.3: Washing Schedule

S.No.	Kind Inspection	Maint. Cycle	Time	Maintenance Place
1.	Outside cleaning (wet washing on automatic washing plant)	3 Days	10 mins.	Single Pass through Automatic washing plant of Depot
2.	Outside heavy Cleaning (wet washing on automatic washing plant and Front Face, Vestibule/Buffer area. Floor, walls inside/outside of cars and roof. Manually)	30 days	2 – 3 hrs.	Automatic washing plant and cleaning & washing shed

8.5 YEAR-WISE PLANNING OF MAINTENANCE FACILITY SETUP AT DEPOT CUM WORKSHOP BASED ON PLANNED ROLLING STOCK REQUIREMENT IN TOP IS TABULATED BELOW

(i) Planned rakes as per TOP:

Table 8.4: Planned Rakes

Year	No. of Rakes	No. of coaches
2023	12	36
2031	15	45
2041	26	78
2051	41	123

(ii) Requirement of Stabling Lines (SBL), Inspection Lines (IBL) and Workshop Lines (WSL) in the Depot -cum-Workshop.

Table 8.5: Requirement of SBLs, IBLs and WSLs in Depot

<table>
<tr><th>Year</th><th>No. of Rakes</th><th>SBLs*</th><th>IBLs</th><th>WSLs</th></tr>
<tr><td>2023</td><td>12</td><td>5 lines x two train of 3-car</td><td rowspan="4">One bay of 3 lines each with one train of 3- cars length required for 2023 and will cater need up to 2041.
One bay to 3 lines each with one train of 3-car length required for 2051.</td><td rowspan="4">Two bay of 2 lines each with one train of 3- cars length which are required for the year 2021 which will cater the need up to 2041.
Tow bay of 2 Lines each with one train of 3- cars length are required for the year 2051.</td></tr>
<tr><td>2031</td><td>15</td><td>7 lines x two trains of 3-car</td></tr>
<tr><td>2041</td><td>26</td><td>12 lines x two trains of 3-car</td></tr>
<tr><td>2051</td><td>41</td><td>18 lines x two trains of 3-car</td></tr>
</table>

8.6 REQUIREMENT OF MAINTENANCE/INSPECTION LINES(IBL**) FOR DEPOT-CUM-WORKSHOP:

Table 8.6: Requirement of Maintenance/Inspection Lines in Depot

Schedule	Maintenance Requirement (No. of Cars)	Lines Needed
i) Year 2023 - Maximum no. of rake holding is 12 TS x3 (= 36 Cars)		
'A' Checks (5000 km) approx. 15 days	(12X3) Cars = 36 Cars	1 Line x 1 train of 3 - Car (with Sunken Floor)
'B' Checks (15000 km) approx. 45 days.	(12X3) Cars = 36 Cars	1 Line x 1 train of 3- Car (with Sunken Floor)
Unscheduled line & adjustment lines	For minor repairs, testing and after IOH/POH adjustments	1 Line x 1 train of 3- Car (with Sunken Floor)
Requirement		One bay of 3 lines each with one train of 3-cars
ii) Year 2031 - Maximum no. of rake holding is 15 TS x3 (= 45Cars)		
'A' Checks (5000 km) approx. 15 days	(15X3) Cars = 45 Cars	1 Line x 1 train of 3 - Car (with Sunken Floor)
'B' Checks (15000 km) approx. 45 days.	(15X3) Cars = 45 Cars	1 Line x 1 train of 3- Car (with Sunken Floor)
Unscheduled line & adjustment lines	For minor repairs, testing and after IOH/POH adjustments	1 Line x 1 train of 3- Car (with Sunken Floor)
Requirement		One bay of 3 lines each with one train of 3-cars

Schedule	Maintenance Requirement (No. of Cars)	Lines Needed
iii) Year 2041 - Maximum no. of rake holding is 26TS x3 (= 78Cars)		
‘A’ Checks (5000 km) approx. 15 days	(26X3) Cars = 78 Cars	1 Line x 1 train of 3 - Car (with Sunken Floor)
‘B’ Checks (15000 km) approx. 45 days.	(26X3) Cars = 78 Cars	1 Line x 1 train of 3- Car (with Sunken Floor)
Unscheduled line & adjustment lines	For minor repairs, testing and after IOH/POH adjustments	1 Line x 1 train of 3- Car (with Sunken Floor)
Requirement		One bay of 3 lines each with one train of 3-cars
iv) Year 2051 - Maximum no. of rake holding is 41TS x3 (= 123Cars)		
‘A’ Checks (5000 km) approx. 15 days	(41X3) Cars = 123 Cars	‘A’ Checks (5000 km) approx. 15 days
‘B’ Checks (15000 km) approx. 45 days.	(41X3) Cars = 123 Cars	‘B’ Checks (15000 km) approx. 45 days.
Unscheduled line & adjustment lines	For minor repairs, testing and after IOH/POH adjustments	Unscheduled line & adjustment lines
Requirement		2 bay of 3 Line x 1 train of 3-Car (with Sunken Floor)

8.7 INSPECTION REQUIREMENTS AT DEPOT

Facilities for carrying out inspection activities shall be provided in the inspection bay for following Systems / Equipments of a train:

- Electronics; PA/PIS
- Mechanical components, couplers etc
- Batteries
- Air conditioner
- Brake modules
- Bogie
- Traction Motor
- Vehicle doors, windows and internal fittings
- Power system including converter, circuit breaker etc.

These activities shall be grouped into “A” checks and “B” checks. The minor scheduled inspections (“A” checks) shall be carried out during the day off peak and night. Since

"B" checks take longer time, these cannot be completed in the off peak times. Certain inspection lines will be nominated for "A" checks. For "B" checks, separate line will be nominated where the rakes may be kept for long time.

8.7.1 Stabling Lines at Depot:

(i) Length of one 3- car rake= 69m
(ii) Gap between two trains 3-car rakes =10m
(iii) Free length at outer ends of two trains of 3- cars (for cross pathway, Signal and Friction buffers) = 10m each side
(iv) Total length of Stabling lines = (iii)+(i) +(ii) +(i) +(iii) = 10+ 69+10+69+10= 168 m

Looking to the car width of 2900 mm on SG, 5 m "Track Centre" is proposed for all the stabling lines. Thus, space between stabling shall be sufficient to include 1 m wide pathway to be constructed between tracks to provide access for internal train cleaning and undercarriage inspection with provision of following facilities:

a) Each Stabling line to have water connection facility so that local cleaning, if required, is facilitated.
b) Platforms at suitable points at each end of stabling lines to enable train operators to board or de- board conveniently.

8.7.2 Inspection Bay at depot-cum-workshop:

The length of Inspection shed is computed as below:

(i) Length of a 3-car rake= 69m.
(ii) Embedded track in the entry side =10 m
(iii) Pit length of IBL = 73 m
(iv) Embedded track length at outer ends of IBL = 12 m
(v) Free length at outer ends of two trains of 3- Car rakes (for cross pathway, Signal and Friction buffers) = 10m
(vi) Total length of Inspection lines = (ii) + (iii) + (iv) = 10+73+12= 95 m (approx.)

The width of the Inspection bay is computed as below:

(i) Centre – to- centre spacing between the two lines= 6.25 m
(ii) Centre line of outer lines to column of Shed=4.25m
(iii) Width of a 3 line Inspection Bay= (ii)+(i)+ (i)+(ii)= 4.25+ 6.25+ 6.25+4.25= 21m

a) There shall be one inspection bay of 3 lines of 95 m X 21 m size each with provision of accommodating three inspection lines each having sunken floor and overhead roof inspection platforms at each of the line. The floor will be sunken by 1100mm. The track spacing between the adjacent IBLs shall be 6.25 m.

b) Roof Inspection platforms of 1.2m width and walkways for roof inspection supported on the columns shall be provided. There would be lighting below the rail level to facilitate the under frame inspection. Ramps of 1:10 slopes, 3 meter wide should be provided with sunken floor system for movement of material for the cars. Further, 10m cross pathways are left at each end for movement of material by fork lifter/Leister/Hand trolley. 415V 3 phase 50 Hz, 230V 1 phase 50 Hz AC supply and Pneumatic supply shall also be made available on each inspection shed columns. Air-circulators shall be provided on each column. The inspection bay shall be provided with EOT crane of 1.5T to facilitate lifting of equipment.

Roof and walls shall be of such design that optimum natural air ventilation occurs all the time and sufficient natural light is also available. Each Inspection bay will also have arrangement close by for cleaning of HVAC filter under high pressure water jet.

8.7.3 Workshop Shed at Depot:

Requirement of workshop lines is planned as under:

The length of Workshop shed is computed as below:

(i) Length of one 3- Car rake=69m
(ii) Embedded track in the entry side =10 m
(iii) Embedded track length at outer ends of WSL = 16 m
(iv) Total length of workshop lines = 10+69+16= 95m

The width of the workshop bay is computed as below:

(i) Centre – to- Centre spacing between the lines= 8m
(ii) Centre line of outer line to inner face of column of Shed= 6.5 m
(iii) Width of a 2-line Workshop Bay= 6.5+ 8 + 6.5= 21 meter

8.7.4 Workshop Shed at Depot:

Requirement of workshop lines is planned as under:

Table 8.7: Requirement of Workshop Lines in Depot

<table>
<tr><th>Year</th><th>IOH & POH</th><th>Major Overhauling</th><th>Unscheduled repairs /lifting</th><th>Total</th><th>Remarks</th></tr>
<tr><td>2023</td><td colspan="2">1 line x 1 train of 3-Car train</td><td>1 line x1 train of -3 Car length.</td><td rowspan="4">One bay of 2 lines each with one train of 3-Cars is to be required for the year 2023 which will cater the need upto 2041. One bay of 2 lines each with 3 car length train is additionally required for year 2051.</td><td rowspan="4">The size of workshop shall be 95 m X 21 m for 2 bays of 2 lines each capable of accommodating one train 3-Car rake with Bogie turn table facility</td></tr>
<tr><td>2031</td><td colspan="2">do-</td><td>do-</td></tr>
<tr><td>2041</td><td colspan="2">do-</td><td>do-</td></tr>
<tr><td>2051</td><td>1</td><td>2 line x 1 train of 3-Car train</td><td>1 line x1 train of -3 Car length.</td></tr>
</table>

(a) There shall be two bays comprising of two lines each (as detailed in 'Remarks' above). Size of the workshop bay is proposed to be 95 m x 21 m. The unscheduled lifting and heavy repair line shall be fitted with jack system capable to lift the 3-Car unit simultaneously for quick change of bogie, thereby saving down time of Rolling Stock. The arrangement of jack system shall be such that lifting of any coach in train formation for replacement of bogie/equipments is also individually possible. One line shall be available for stocking of Bogies and wheels. These lines are to be provided with pits at regular intervals for inspection of undercarriage with turn tables. Each workshop bay shall be equipped with two 15T and 3T overhead cranes, each spanning the entire length of the workshop bay.

(b) There shall be provided space for repairs of HVAC, Door, and Traction motor etc. repairs. Distinct spaces shall be earmarked for dismantling/repairs/ assembling and testing of each of these equipments. Related machinery for Overhauling / Repairs & testing activities of every equipment are also to be housed in the space earmarked.

(c) There shall be washing and cleaning equipments on the workshop floor. Bogie test stand shall be provided in the workshop. Other heavy machinery shall also be suitably installed on the workshop floor. Air-circulators, lights, Powers supply points and compressed air supply line shall be provided on each workshop column.

(d) Workshop lines shall be inter-linked through turn tables, each suitable for movement of a train in AW0 (unloaded) condition and shall also be capable to rotate with a fully loaded bogie on it. Repair of heavy equipments such as air conditioners shall be so located so that it does not affect the movement inside workshop.

(e) There shall be walkways on columns for roof inspections, along the workshop lines. These walkways shall not infringe with cars being lifted/ lowered by means of mobile jacks. Suitable space between the nearest exterior of a car and farthest edge of the walkway has to be ensured to avoid conflict in lifting and lowering of cars.

(f) The small component, bogie painting and battery maintenance cells will be located in the workshop with arrangement that fumes are extracted by suitable exhaust systems.

(g) Workshop will have service building with array of rooms along its length. Total size is proposed to be 95 x 8m. These can be made by column and beam structure and architecture made of brick works. These shall cater for overhauling sections, offices, costly store item, locker rooms, toilets etc. Two trains opposite sides width wise be open to facilitate natural air circulation and cross ventilation besides the egress & ingress for coaches. The sidewalls shall also have sufficient width of louvers for providing adequate ventilation.

(h) There shall be space for bogie/ axle repair shop with necessary infrastructure for disassembly, overhead, assembly and testing of mechanical components of bogies/ axle. The repair shop shall be easily approachable from with the workshop for transportation of components.

Following equipment repair/overhaul facilities are planned in the workshop and wheel repairs shop at the workshops depots:

1. Body furnishing
2. Bogie
3. Wheels
4. Traction Motors
5. Axle Box and Axle Bearing

6. Pantographs
7. Transformer, converter/inverter, circuit breaker
8. Battery
9. Air Compressor
10. Air-conditioner
11. Brake Equipment
12. Door actuators
13. Control and measuring equipments
14. Pneumatic equipment
15. Dampers and Springs
16. Couplers/Gangways
17. Coach Painting (Applicable only for Aluminum coaches, if any)

8.8 CAR DELIVERY AREA

There shall be rail connectivity between the Depot-cum- Workshop and mainline and all trains due for scheduled/ unscheduled works shall reach the depot-cum- Workshop by rail.

However, in case of newly procured coaches, which are transported by road, these shall reach the Depot-cum Workshop by the road on trailers. To unload the coaches and bring them to the track, provision of space, along the side of shunting neck, has to be made for unloading of cars and other heavy materials. This area shall have an insulated track embedded in the floor facilitating the movement of road trawler, which brings in the cars. The length of the track embedded area shall be about 50m long. The unloading bay should be of 50 m X 30 m and the bearing capacity of the floor should be 15-20 MT/m^2. There should be enough space available for movement of heavy cranes for lifting of coaches. The unloading area should be easily accessible for heavy duty hydraulic trailers and minimum turning radius for the trailer movement should be 20-23 m. in case of space limitation a point lifting jack system can be installed.

8.9 OPERATIONAL FEATURES

The rake induction and withdrawal to main line will be primarily from the stabling shed. Further, provisions are there for direct rake induction and withdrawal to main line from Inspection Shed/workshop area. Movement from depot to the main line is so planned that the headway of main line is not affected. Simultaneous receipt and dispatch of trains from depot to main line is feasible in the present site scenario. Both of these activities will be done effectively without effecting the train operation on the main line. The stabling lines would be interlocked with the main line thereby induction of train from the stabling would be safe and without loss of time. The proposition for a transfer track on the incoming line as well as on the outgoing line to facilitate the movement of rake in the depot by Operation Control Centre(OCC), even though the further path inside the depot is not clear shall be explored in the detailed design stage depending on the actual availability of land. An emergency line is also provided from which an emergency rescue vehicle may be dispatched to main line in the event of emergency if necessary.

8.10 INFRASTRUCTURE FACILITIES IN DEPOT

(I) Inspection and Workshop facilities:
As indicated in 8.7.2 & 8.7.3 above.

(II) Stabling Lines in Depot:

a) The requirement of lines shall be in accordance with the details indicated in para8.7.1 above. A part of the stabling siding in the depot shall be covered with a roof in order to facilitate testing of air conditioning of trains and their pre-cooling under controlled condition of temperature.

b) Separate toilets adjustment to stabling lines shall be provided with small room for keeping cleaning aids and for utilization by the working staff.

(III) Automatic Coach Washing Plant (AWP)
Provision to be made for Rolling Stock exterior surfaces to be washed using a fully automated Train Washing System, with a throughput capacity of approximately ten trains per hour. The AWP shall be situated at such a convenient point on the incoming route so that incoming trains can be washed before entry to the depot and undesirable movement/shunting over ingress and egress routes within the depot is avoided. Additional space for plant room for AWP system shall be earmarked alongside the washing apron as indicated Para 8.11.

(IV) Train Operators Booking Office
Suitable office facility adjacent to the stabling lines at each depot should be provided so that train operators reporting 'On' duty or going 'Off' duty can obtain updates regarding 'Special Notices', 'Safety Circulars' and other technical updates/information in vogue. These offices should have an attached a cycle/scooter/car stand facility for convenience of the train operating staff.

(V) Test Track
A test track of 1000 mts. in length covered & fenced should be provided beside workshop in the depot. It shall be equipped with signaling equipments (ATP/ATO/UTO). It shall be used for the commissioning of the new trains, their trials and testing of the trains after the IOH and POH. Entry into the test track shall be planned for a 3-car train. In compliance to safety norms, the boundary of the track shall be completely fenced to prevent unauthorized trespassing across or along the track.

(VI) Heavy Cleaning Shed
Monthly heavy cleaning of interior walls, floors, seats, windows glasses etc, outside heavy cleaning, Front/rear Face, Vestibule/ Buffer area, outside walls and roof shall be done manually in the interior cleaning plant designed for cleaning of one at a time. A line adjacent to inspection shed should be so provided that placement of rakes is possible from workshop or inspection lines & vice – versa conveniently.

(VII) Power Supply
Auxiliary substations are planned for catering to the power supply requirement of the whole depot and workshop. Details of connected load feeder shall be worked out.

Taking diversity factor of 0.5 the maximum demands shall be computed. Two Auxiliary substations are proposed, as the demand by machines in Workshop area would be very large. The standby power supply is proposed through DG set with AMF panel. The capacity of DG set will be adequate to supply all essential loads without overloading.

(VIII) Compressed Air Supply

Silent type compressor units shall be suitably installed inside the depots at convenient location for the supply of compressed air to workshop and Inspection sheds. Thus, the pneumatic pipeline shall run within the workshop and inspection bays as to have compressed air supply line at all convenient points.

(IX) Water Supply, Sewerage and Drainage Works

In house facilities shall be developed for the water supply of each depot. Sewerage, storm water drainage shall be given due care while designing the depots for efficient system functioning. Past records of Municipal Corporation shall be used to design the drainage system. Rainwater harvesting would be given due emphases to charge the underground reserves.

(X) Ancillary Workshop

This workshop will have a line at floor level with provision of pits. Arrangement for repairs of Shunters, Rail Road Vehicles and other ancillary vehicles will be provided. These vehicles will also be housed here itself. Heavy lifting works can be carried out in main workshop.

(XI) Ancillary workshop will be used for storing OHE/rigid OHE parts and their maintenance/ Watch Towers

There shall be provision of adequate number of watchtowers for the vigilance of depot boundary.

(XII) Administrative Building

An administrative building close to the main entrance is planned. It can be suitably sized and architecturally designed at the detailed design stage. A time and security office is also provided close to main entrance. It shall be equipped with suitable Access control system for all the staff working in the complex repair for restoration of 25 kV feed system.

(XIII) Parking Facilities

a) Ample parking space shall be provided for the two trains wheelers and four wheelers at the following points.

i) Close to the depot entry.
ii) Close to the stabling lines.
iii) Close to the Workshop/IBL.

b) Space for parking of road and re-railing equipments

Enough space for parking of road vehicle/ trailers/ trucks etc. Enough space will also have to be earmarked adjacent to workshops. Similarly, provision of space for parking of re-railing equipments will have to be made close to the main exit gate of the Depot.

(XIV) Shed and Buildings

The shed and buildings normally provided in the depot with their sizes and brief functions are indicated in Para 8.11. At the detailed design stage depending upon the land availability, the decision to locate these buildings can be taken. These can then be architecturally and functionally grouped.

(XV) Plant and Machinery

(a) Separate building is planned for housing pit wheel lathe (PWL), approachable from workshop, inspection bay and stabling lines through rail and road for placement of cars for re- profiling of wheels within the depot along with space for depot of scrap.

(b) Requirement of buildings and major plants and machinery, is given in Para 8.11.

8.10.1 Following Safety features should be incorporated in the design of the Maintenance Depot-cum-Workshop

(a) 1.5 EOT cranes in the inspection bay should be interlocked with 25 kV ac OHE in such a way that, the cranes become operational only when the OHE is isolated and grounded.

(b) Red flashers lights should be installed along the inspection lines at conspicuous location to indicate the OHE is Live‟.

(c) Multi-level wheel and TM stacking arrangement should be inbuilt feature at the end of Heavy repair bay.

(d) Pillars in the inspection bay & workshop should have provision for power sockets.

(e) Placement of rakes from inspection/workshop lines on to washing lines for interior cleaning on their own power should be possible. Linking of supply system and its isolation at the cleaning area should be provided. Necessary requirements of safety should be kept in view.

(f) The roof inspection platform should have at least two openable doors to facilitate staff to go up the roof for cleaning of roof. Suitable safety interlock should be provided to ensure maintenance staff are enabled to climb on the roof inspection platform only after the traction supply is isolated.

(g) Control Centre, PPIO & store depot must be close to Workshop.

(h) Width of the doors of the sections wherein repairs of equipments are done should be at least 2 meters wide to allow free passage of equipment through them.

(i) Provision of water hydrants should be done in workshops stabling yards also.

(j) Compressed air points along with water taps should be available in interior of buildings for cleaning.

(k) Ventilation arrangement inside the inspection shed and workshop. Arrangement for natural cross ventilation from one side to another of inspection & workshop bays to be incorporated along with optimum availability of natural light at floor level.

8.11 LIST OF BUILDINGS & LIST OF PLANTS & EQUIPMENTS AT DEPOT-CUM-WORKSHOP:

Table 8.8: List of Buildings, Plants and Equipments in Depot

S.No.	Name of Building	Size	Remarks
1.	Inspection Shed	95 m x 21m for each bay.	Servicing of Cars for 15 days & 45 days inspection.
	Workshop Shed	95 x 21m for each bay.	Major repair & overhaul of rolling stocks, diesel shunters, electric tractors, tower wagons. All heavy lifting jobs.
	Associated Sections	95 m x 8m	Rooms for carrying out the inspection & workshop activity.
	Stabling line shed	168 m x30m (for initial provision of 5 SBL lines)	Provisional for total area as per requirement of stabling of 41 rakes during year 2051 is to be made (with initial provision for 12 rakes only).
2.	Stores Depot & Offices including Goods Platform with Ramp	45m x 45m	i. Stocking of spares for regular & emergency requirement including consumable items. ii. This store caters for the requirement of depot for rolling stock & other disciplines. iii. To be provided with computerized inventory control. iv. Loading/Unloading of material received by road.
3.	Elect. Substation & DG set room	20m x 15m	To cater for normal and emergency power supply for depot, workshop, service and all other ancillary buildings, essential power supply for essential loads and security light.
4.	Traction repair depot and E&M repair shop	80m x 30m (partly double storey)	Stabling and routine maintenance of shunting engine etc. & Traction maintenance depot. For maintenance of lifts/escalators and other General service works.
5.	Cycle / Scooter / Car Parking	100m x 6m 60m x 6m	i. Close to the depot entry. ii. Close to the stabling lines.
6.	Auto coach washing plant	60m x 10m	For automatic washing of coaches. Provision of Washing apron for collection of dripping water and its proper drainage to be ensured.
	Auto coach washing platform	20m X 10m	
7.	Washing apron for Interior Cleaning	184m x 6.5m	Heavy wet washing of rakes from inside, under frame, roof at 30 days interval.

S.No.	Name of Building	Size	Remarks
8.	Blowdown plant	30m X 5m (additional to intensive cleaning)	Heavy cleaning of underframe and roof through compressed air at 30 days interval.
9.	P-way office, store & Workshop including Welding plant	80m x 20m	i. For track maintenance of section and depot. ii. To weld rails for construction period only. iii. To stable track Tamping machine.
10.	ETU Building	30m X 15m	For parking of CMV and OHE machinery.
11.	Security office & Time Office Garages (4 Nos.)	15m x 8m	For security personnel. For time punching For parking vehicle jeep, truck etc.
12.	Check Post (2 Nos.)	5m x 3m	For security check of incoming/outgoing staff material and coaches.
13.	Depot control centre & Crew booking centre	25m x 20m (double storey)	To control movement of trains in and out of the depot and for crew booking.
14.	O.H raw water Tank	1,00,000 Ltrs. Capacity	For Storage of water.
15.	Pump house Bore well	7.3mx5.4m (200 mm bore)	Submersible type pump planned with 200 mm diameter bore well.
16.	Dangerous goods Store	15m x 10m	For Storage of paints, inflammables & Lubricants
17.	a)Traction 25/33kV/66kV sub station b) Feeding Post	a)120m x 80m b) 15m x30m	Traction Power Supply
18.	Waste Collection Bin	10m x 10m	Garbage dumping
19.	Repair shops for S & T	40m x 20m	For the AFC gates, Signaling and telecom equipment.
20.	Work shop Manager Office	30m x 20m	Office of Depot in charge
21.	ATP & ATO Room	10m x 8m	To keep equipments of ATP/ATO
22.	Waste Water Treatment Plant	12m x 6m	For treating the discharge waters of the depot and remove the oil, acids etc. before discharging into the river, with U/G tank.
23.	Canteen	200 sqm.	To cater staff of depot and workshop. Should be in a separate building with modern kitchen ware and facilities. Obligatory as per statutory requirements.
24.	Toilets -Gents -Ladies	10m x 7m 10m x 7m	These toilets shall be approachable both from workshop as well as from inspection bay and ladies toilets shall be completely insulated from gent's toilet.

8.12 LIST OF PLANTS & EQUIPMENTS AT DEPOT-CUM-WORKSHOP

Table 8.9: Cost

S. No.	Description	Approx. Unit Price (INR Lakh)	Qty (set)	Approx. cost Provision (INR Lakh)
1	Under floor Pit Wheel lathe	621.00	1	621.00
2	Syn. Pit Jacks-for **3 cars** unit	728.52	1	728.52
3	Automatic Train Washing Plant	268.00	1	268.00
4	Battery Shunting Loco	349.89	1	349.89
5	Electric Tractors (RRM)	224.58	1	224.58
6	Electric Tractors (RRM) for UFWL	224.58	1	224.58
7	Syn. Mobile Jacks for **3 cars** unit	177.36	1	177.36
8	Bogie Turn Table	27.86	2	55.72
9	Re-railling & Rescue equipments (set)	81.99	1	81.99
10	Rail cum Road Vehicle	42.26	1	42.26
11	Blow Down Plant	196.00	1	196.00
12	Mobile jib Cranes(1T Manual)	1.53	1	1.53
13	Under track Mobile Lifting Table (1T for IBL)	2.75	2	5.50
14	CI/SIV Mobile Lifting Table (3T for WS)	3.62	1	3.62
15	Arial Work Lift Platform	19.61	1	19.61
16	High Pressure Wash Pumps	5.37	2	10.74
17	AC Filter cleaning machine	23.50	1	23.50
18	Mobile compressor-10bar	4.20	1	4.20
19	HP compressor-17bar	3.36	1	3.36
20	Compressor for UFWL	4.20	1	4.20
21	EMU Battery Charger	5.56	1	5.56
22	Box Container for rerailing equipment	5.12	1	5.12
23	wooden blocks	0.77	1	0.77
24	Auxiliary truck	1.82	1	1.82
25	Road Truck	10.56	1	10.56
26	Bat. Op. Platform Truck	6.33	1	6.33
27	Welding & Cutting Equipments	2.24	1	2.24
28	Work Benches	0.54	10	5.40
29	Vertical Carousal storage system	35.00	1	35.00
30	Weighing scales	2.65	1	2.65
31	Storage Bins	7.59	1	7.59
32	Pallet Trucks	0.39	5	1.93
33	Fork Lift Truck-3T(Elect)	10.35	1	10.35
34	Stackers(1T for DCOS)	9.50	1	9.50

S. No.	Description	Approx. Unit Price (INR Lakh)	Qty (set)	Approx. cost Provision (INR Lakh)
35	Mobile Safety Steps & Al-Ladders	5.12	LS	5.12
36	Set of Pallets	15.00	LS	15.00
37	Storage racks for DCOS stores	62.50	LS	62.50
38	Storage racks for workshop, tool room	31.50	LS	31.50
39	Electric and Pneumatic Tools	33.50	LS	33.50
40	Measuring & calibration Instruments	62.51	LS	62.51
41	Special Jigs and Fixtures	60.29	LS	60.29
42	Industrial Furniture	90.00	LS	90.00
43	Miscellaneous/other machinery	93.71	LS	93.71
44	Display board	7.50	1	7.50
45	Industrial vacuum Cleaners	4.83	1	4.83
46	Small Part Cleaner	1.00	1	1.00
47	Polyster Web Sling	1.00	1	1.00
48	25KV Live Indicators	7.50	1	7.50
49	Wheel Gauges/Templetes	3.80	1	3.80
50	Ultrasonic Flaw Detector	2.18	1	2.18
51	Memory Hicorder/Chart recorder etc.	10.00	1	10.00
52	Inductrion heater	8.40	1	8.40
53	Hyd. Axle Bearing puller	9.60	1	9.60
54	Training equipment/ diagnostic software/Camera, Projector, computer equipment/laptop etc.	16.79	LS	16.79
55	Industrial Video scope	10.13	2	20.26
56	Lifting jacks for Aircon	4.37	1	4.37
57	Auto wheel profile meter	20.36	1	20.36
58	Digital wheel data mgt., distance gauge	8.16	1	8.16
59	Coupler backlog Gauge	8.15	1	8.15
60	20 Ton Hydraulic C frame Press*	10.00	1	10.00
61	Hydraulic work bench for Gear Box	16.00	1	16.00
62	Special tools for coupler	17.50	1	17.50
63	Other tools/ equipments as per RS Contractor	50.00	LS	50.00
64	Bogie Test Stand*	388.00	1	388.00
65	Wheel press*	467.50	1	467.50
66	Vertical turret lathe*	131.00	1	131.00
67	Damper testing machine*	52.98	1	52.98
68	Spring testing machine*	166.10	1	166.10

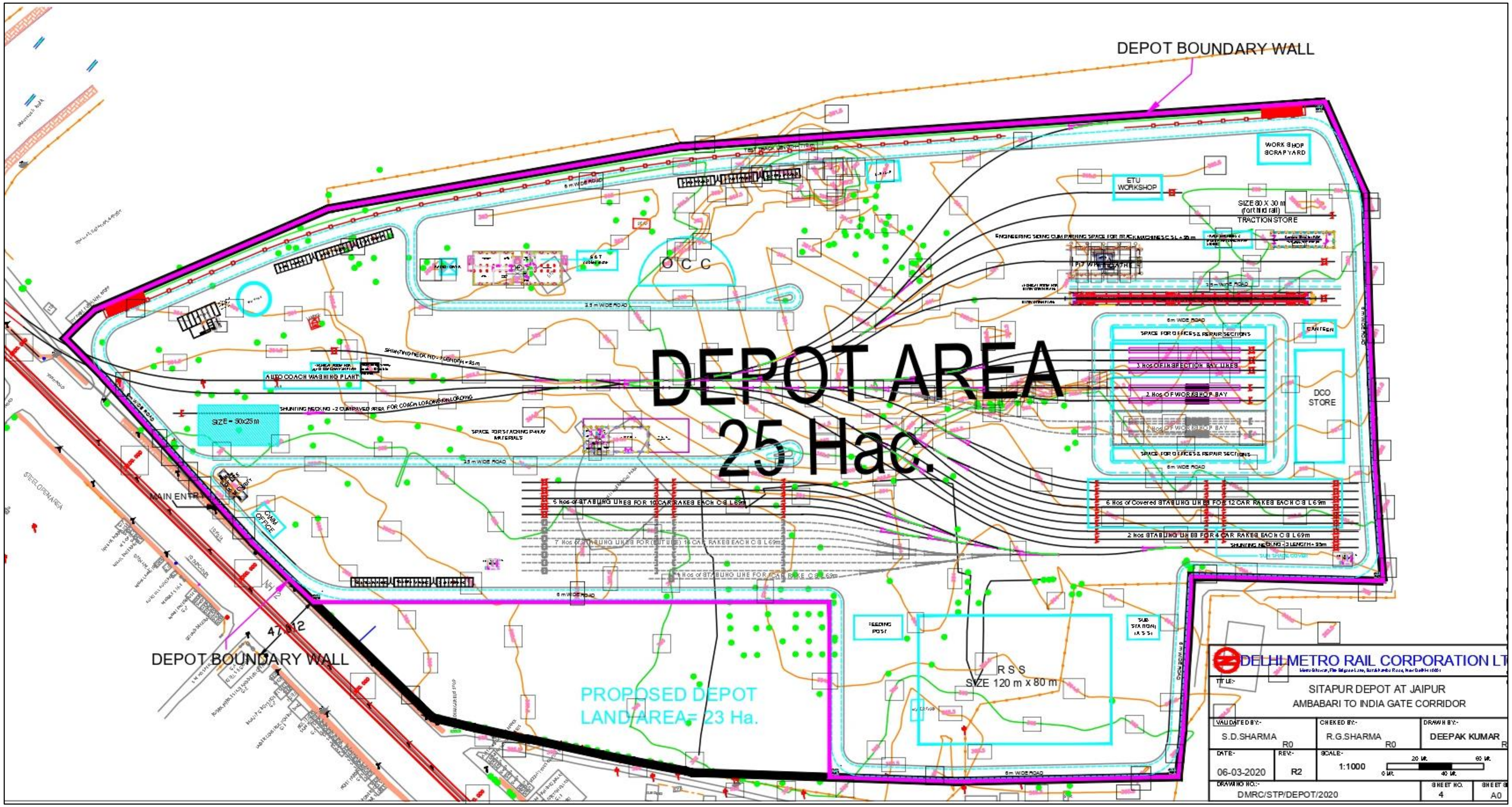
S. No.	Description	Approx. Unit Price (INR Lakh)	Qty (set)	Approx. cost Provision (INR Lakh)
69	Rail Fed Bogie Wash Plant*	188.10	1	188.10
70	Heating Oven for TM*	5.88	1	5.88
71	High Voltage Test set*	2.00	1	2.00
72	SS Cage for HV test set*	6.30	1	6.30
73	Impulse tester for TMs*	11.80	1	11.80
74	Analyzer with Sound Level Meter*	14.50	1	14.50
	G. Total in Lakh			**5266.67**

8.13 COST ESTIMATE

The total estimated cost at Jan'19 price level may be assumed as approximately Rs.52.67 Crores. This would be required for Rolling Stock M&P equipment for one depot at Sitapura.

8.14 UN-ATTENDED TRAIN OPERATION (UTO):

(i) Proper segregation for UTO and non-UTO zone shall be earmarked while finalizing of depot layout.
(ii) Train Operator (TO) platform of 10m X 12m (L X B) shall be provided in each overlap zone of UTO and non-UTO.
(iii) Bulb fencing of depot tracks shall be done up to 1.5 m height from T.O.R. (Top of the Rail) level.
(iv) Gates should be provided in some interval with locking facility.
(v) All crossing roads which crosses the track should have gates with locking facilities.
(vi) All stabling lines should have SPK (Staff Protection Key) to avoid unauthorized entry.


DEPOT BOUNDARY WALL
WORK SHOP SCRAP YARD
ETU WORKSHOP
TRACTION STORE
O C C
AUTO COACH WASHING PLANT
SIZE= 50x25 m
DEPOT AREA
25 Hac.
CANTEEN
DCO STORE
MAIN ENTRY
47.612
DEPOT BOUNDARY WALL
PROPOSED DEPOT
LAND AREA= 23 Ha.
FEEDING POST
RSS
SIZE 120 m x 80 m
DELHI METRO RAIL CORPORATION LT
TITLE:-
SITAPUR DEPOT AT JAIPUR
AMBABARI TO INDIA GATE CORRIDOR
VALIDATED BY:-
S.D.SHARMA
CHEKED BY:-
R.G.SHARMA
DRAWN BY:-
DEEPAK KUMAR
DATE:-
06-03-2020
REV:-
R2
SCALE:-
1:1000
DRAWING NO.:-
DMRC/STP/DEPOT/2020
SHEET NO.
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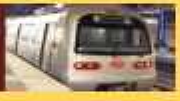


CHAPTER 9 – ROLLING STOCK

CHAPTER – 9

ROLLING STOCK

9.1 INTRODUCTION

The required transport demand forecast is the governing factor for the choice of the Rolling Stock. The forecasted Peak Hour Peak Direction Traffic for a Medium Rail Transit System (MRTS).

9.2 OPTIMIZATION OF COACH SIZE

The following optimum size of the coach, as opted for this corridor, has been chosen for this corridor as mentioned in Table 9.1.

Table 9.1: Size of the coach

	Length*	Width	Height
Driving Motor Car (DMC)	21.64 m	2.9 m	3.9 m
Trailer car (TC)/Motor Car (MC)	21.34 m	2.9 m	3.9 m

**Maximum length of coach over couplers/buffers = 23 m*

9.3 PASSENGER CARRYING CAPACITY

In order to maximize the passenger carrying capacity, longitudinal seating arrangement shall be adopted. The whole train shall be vestibuled to distribute the passenger evenly in all the coaches. Criteria for the calculation of standing passengers are 3 persons per square meter of standing floor area in normal state and 6 persons in crush state of peak hour.

Therefore, for the Rail Vehicles with 2.9 m maximum width and longitudinal seat arrangement, conceptually the crush capacity of 43 seated, 204 standing thus a total of 247 passengers for a Driving Motor Car, and 50 seated, 220 standing thus a total of 270 for a trailer car is envisaged.

Following train composition is recommended:
3-car Train: DMC + TC + DMC

Table 9.2 and 9.3 shows the carrying capacity of Medium Rail Vehicles with standing passenger @ 6 passengers per sqm of standee area and @ 8 passengers per sqm of standee area respectively.

Table 9.2: Carrying Capacity of Rail Vehicles (Crush@6 Person/sqm of standee area)

	Driving Motor car		Trailer car / Motor car		3 Car Train	
	Normal	Crush	Normal	Crush	Normal	Crush
Seated	43	43	50	50	136	136
Standing	102	204	110	220	314	628
Total	145	247	160	270	450	764

NORMAL - 3 Person/sqm of standee area

CRUSH - 6 Person/sqm of standee area

Table 9.3: Carrying Capacity of Rail Vehicles (Dense Crush@8 Person/sqm of standee area)

	Driving Motor car		Trailer car		3 Car Train	
	Normal	Dense Crush	Normal	Dense Crush	Normal	Dense Crush
Seated	43	43	50	50	136	136
Standing	102	272	110	292	314	836
Total	145	315	160	342	450	972

NORMAL - 6 Person/sqm of standee area

DENSE CRUSH - 8 Person/sqm of standee area

9.4 WEIGHT

The weights of driving motor car and trailer car have been estimated as in Table 9.4, referring to the experiences in Delhi Metro, the average passenger weight has been taken as 65 kg.

Table 9.4: Weight of Rail Vehicles (TONNES)

	DMC	TC	3 Car train
TARE (maximum)	42	40	124
Passenger			
(Normal)	9.425	10.40	29.25
(Crush @6p/sqm)	16.05	17.55	49.66
(Crush @8p/sqm)	20.47	22.23	63.18
Gross			
(Normal)	51.42	50.4	153.25
(Crush @6p/sqm)	58.05	57.55	173.66
(Crush @8p/sqm)	62.47	62.23	187.18
Axle Load@6 person/sqm	14.51	14.38	43.40
Axle Load@8 person/sqm	15.61	15.55	46.77

The axle load @ 6persons/sqm of standing area works out in the range of 14.51T to 14.38T. Heavy rush of passenger, having 8 standees per sq. meter can be experienced occasionally. It will be advisable to design the coach with sufficient strength so that even with this overload, the design will not result in over stresses in the coach. Coach and bogie should, therefore, be designed for **16T axle** load.

9.5 PERFORMANCE PARAMETERS

Motorisation of 67% for all categories of Metro Rolling Stock.

The recommended performance parameters are:

Item	Values
Minimum Design Average Acceleration rate for fully loaded (seating plus standees @8 persons per sqm) train on level tangent track shall be as under: 0 to 40 kmph 0 to 60 kmph 0 to 80 kmph	 1.0m/s^2 0.6m/s^2 0.3m/s^2
Minimum Operational Average Acceleration rate for (seating plus standees @6 persons/sq.m) loaded on level tangent track shall be as under: 0 to 35 kmph 0 to 60 kmph 0 to 80 kmph	 1.20 m/s^2 0.65 m/s^2 0.35 m/s^2
Service braking rate from 80 kmph to standstill for fully loaded (seating plus standees @8 persons per sqm) train on level tangent track:	1.0 m/s^2
Service braking rate from 80 kmph to standstill for fully loaded (seating plus standees @6 persons per sqm) train on level tangent track:	1.1 m/s^2
Emergency braking rate from 80 kmph to 0 kmph for fully loaded train on level tangent track:	1.3 m/s^2
Jerk rate (maximum)	0.75 m/s^2

9.6 COACH DESIGN AND BASIC PARAMETERS

The important criteria for selection of rolling stock are as under:

(i) Proven equipment with high reliability
(ii) Passenger safety feature
(iii) Energy efficiency
(iv) Light weight equipment and coach body
(v) Optimized scheduled speed
(vi) Aesthetically pleasing Interior and Exterior
(vii) Low Life cycle cost
(viii) Flexibility to meet increase in traffic demand
(ix) Anti-telescopic

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

9.7 SELECTION OF TECHNOLOGY

Low life cycle cost

Low life cycle cost is achieved by the way of reduced scheduled and unscheduled maintenance and high reliability of the sub-systems. It is possible to achieve these objectives by adopting suitable proven technologies. Selection of following technologies has been recommended to ensure low life cycle cost-.

9.7.1 Car body

In the past carbon high tensile steel was invariably used for car bodies. In-fact almost all the coaches built by Indian Railways are of this type. These steel bodied coaches need frequent painting and corrosion repairs, which may have to be carried out up to 4-5 times during the service life of these coaches. It is now a standard practice to adopt stainless steel or aluminum for carbody.

The car bodies with aluminum require long and complex extruded sections which are still not manufactured in India. Therefore aluminum car body has not been considered for use. Stainless steel sections are available in India and therefore stainless steel car bodies have been specified. No corrosion repair is necessary on stainless steel cars during their service life.

Stainless steel car body leads to energy saving due to its lightweight. It also results in cost saving due to easy maintenance and reduction of repair cost from excellent anti corrosive properties as well as on improvement of riding comfort and safety in case of a crash or fire.

9.7.2 Bogies

Bolster less lightweight fabricated bogies with rubber springs are now universally adopted in metro cars. These bogies require less maintenance and overhaul interval is also of the order of 4,20,000 km. Use of air spring at secondary stage is considered with a view to keep the floor levels of the cars constant irrespective of passenger loading unlike those with coil spring. Perturbation from the track are also dampened inside the car body on account of the secondary air spring along with suitable Vertical Hydraulic Damper. The primary suspension system improve the curve running performance by reducing lateral forces through application of conical rubber spring. A smooth curving performance with better ride index is being ensured by provision of above type of bogies.

9.7.3 Braking System

The brake system shall consist of

(i) An electro-pneumatic (EP) service friction brake

(ii) A fail safe, pneumatic friction emergency brake
(iii) A spring applied air-release parking brake
(iv) An electric regenerative service brake
(v) Provision of smooth and continuous blending of EP and regenerative braking

The regenerative braking will be the main brake power of the train and will regain the maximum possible energy and pump it back to the system and thus fully utilize the advantage of 3 phase technology. The regenerative braking should have air supplement control to bear the load of trailer car. In addition, speed sensors mounted on each axle, control the braking force of the axles with anti-skid valves, prompting re-adhesion in case of a skid. The brake actuator shall operate either a tread brake or a wheel disc brake, preferably a wheel disc brake.

9.7.4 Propulsion System Technology

In the field of Electric Rolling Stock, DC series traction motors have been widely used due to its ideal characteristics and good controllability for traction applications. But these required intensive maintenance because of commutators and electro-mechanical contractors, resistors etc.

The brush less 3 phase induction motors has now replaced the D.C. Series motors in traction applications. The induction motor, for the same power output, is smaller and lighter in weight and ideally suited for rail based Medium Rail Transit applications. The motor tractive effort and speed is regulated by 'Variable Voltage and Variable frequency' control and can be programmed to suit the track profile and operating requirements. Another advantage of 3 phase a.c. drive and VVVF control is that regenerative braking can be introduced by lowering the frequency and the voltage to reverse the power flow and to allow braking to very low speed.

For this corridor, three phase a.c. traction drive that are self-ventilated, highly reliable, robust construction and back up by slip/slid control have been recommended for adoption. The AC catenary voltage is stepped down through a transformer and converted to DC voltage through converter and supply voltage to DC link, which feeds Inverter operated with Pulse Width Modulation (PWM) control technology and using Insulated Gate Bipolar Transistors (IGBT). Thus three-phase variable voltage variable frequency output drives the traction motors for propulsion.

Recently advanced IGBT has been developed for inverter units. The advanced IGBT contains an Insulated Gate Bipolar Transistor (IGBT) and gate drive circuit and protection. The advanced IGBT incorporates its own over current protection, short circuit protection, over temperature protection and low power supply detection. The IGBT has internal protection from over current, short circuit, over temperature and low control voltage.

The inverter unit uses optical fiber cable to connect the control unit to the gate interface. This optical fiber cable transmits the gate signals to drive the advanced IGBT via the gate interface. This optical fiber cable provides electrical isolation between the advanced IGBT and the control unit and is impervious to electrical interference. These are recommended for adoption in Trains of MRTS.

9.7.5 Interior and Gangways

Passenger capacity of a car is maximized in a Metro System by providing longitudinal seats for seating and utilizing the remaining space for standing passenger. Therefore, all the equipments are mounted on the under frame for maximum space utilization.

The gangways are designed to give a wider comfortable standing space during peak hours along with easy and faster passenger movement especially in case of emergency. Some equipments may be mounted in the under seat cubicles to have more standing capacity in the gangway.

Interior View

9.7.6 Passenger Doors

For swift evacuation of the passenger in short dwell period, four doors of adequate width, on each side of the coach have been considered. These doors shall be of such dimensions and location that all the passenger inside the train are able to evacuate within least possible time without conflicting movement. As the alignment passes through elevated section above ground, automatic door closing mechanism is envisaged from consideration of passenger safety. Passenger doors are controlled electrically by a switch in Driver cab. Electrically controlled door operating mechanism has been preferred over pneumatically operated door to avoid cases of air leakage and sluggish operation of doors.

The door shall be of Bi-parting Sliding Type as in the existing coaches of DMRC.

Passenger Door

9.7.7 Air–conditioning

With heavy passenger loading of 6 persons/sqm for standee area and doors being closed from consideration of safety and with windows being sealed type to avoid transmission of noise, air conditioning of coaches has been considered essential. Each coach shall be provided with two air conditioning units capable of cooling, heating and dehumidifying and thus automatically controlling interior temperature throughout the passenger area at 25°C with 65% RH all the times under varying ambient conditions up to full load. For emergency situations such as power failure or both AC failures etc, ventilation provision supplied from battery will be made. Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the coach, during an emergency condition, such as fire outside the train causing excessive heat and smoke to be drawn in to the coach. The coefficient of performance should be at least 2.5 as per MoHUA guidelines.

9.7.8 Cab Layout and Emergency Detrainment Door.

The modern stylish driver panel shall be FRP moulded which give maximum comfort and easy accessibility of different monitoring equipments to the driver along with clear visibility. The driver seat has been provided at the left side of the cabin.

Driving Cab

An emergency door for easy detrainment of the passenger on the track has been provided at the center of the front side of each cabin which has an easy operation with one handle type master controller

9.7.9 Communication

The driving cab of the cars are provided with continuous communication with base Operational Control Center and station control for easy monitoring of the individual train in all sections at all the time.

Public Address and Passenger Information Display System is provided in the car so that passengers are continuously advised of the next stoppage station, final destination station, interchange station, emergency situations if any, and other messages. The rolling stock is provided with Talk Back Units inside the cars, which permit conversation between passengers and the drivers in case of any emergency.

9.7.10 Noise and Vibration

The trains will pass through heavily populated urban area. The noise and vibration for a metro railway becomes an important criterion from public acceptance view point. The source of noise is (i) rail-wheel interaction (ii) noise generated from equipment like Blower, Compressor, air conditioner, door, Inverter etc. (iii) traction motor in running train. For elimination and reduction of noise following feature are incorporated: -

- Provision of anti-drumming floor and noise absorption material.
- Low speed compressor, blower and air conditioner.
- Mounting of under frame equipments on anti-vibration pad.
- Smooth and gradual control of door.
- Provision of GRP baffle on the via-duct for elimination of noise transmission.
- Provision of sound absorbing material in the supply duct and return grill of air conditioner.
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes.

The lower vibration level has been achieved by provision of bolster less type bogies having secondary air spring.

9.7.11 Passenger Safety Features

(i) ATP/ATO/UTO

The rolling stock is provided with Continuous Automatic Train Protection to ensure absolute safety in the train operation. It is an accepted fact that 60-70% of the accidents take place on account of human error. Adoption of this system reduces the possibility of human error.

(ii) Fire

The rolling stock is provided with fire retarding materials having low fire load, low heat release rate, low smoke and toxicity inside the cars. The electric cables used are also normally low smoking zero halogen type which ensures passenger safety in case of fire. Also, as per MoHUA guidelines para-9 two fire extinguishers per car in saloon area. One fire extinguisher per cab to be provided. All materials used for construction of metro shall comply with international standards EN 45545 for fire and smoke. Fresh air intake to the saloon area of the car shall have smoke detection system to prevent entry of external smoke into the saloon area.

(iii) Emergency door

The rolling stock is provided with emergency doors at both ends of the cab or side passenger doors as emergency evacuation door to ensure well directed evacuation of passengers in case of any emergency including fire in the train. Selection of Emergency evacuation methodology is to be define in the technical requirement by the authority.

(iv) Crash worthiness features

The rolling stock is provided with inter car couplers having crashworthiness feature which reduces the severity of injury to the passengers in case of accidents. In general, the parameters under EN15227 and EN 12663 should be followed.

(v) Gangways

Broad gangways are provided in between the cars to ensure free passenger movement between cars in case of any emergency.

Gangways

(vi) Obstruction deflection device(ODD):

ODD shall be mounted on front bogie of each driving motor car (DMC) which shall be able to deflect obstacles such as metal block, wooden block or plastic bottle with water etc. After detection and deflection of obstacle emergency brake shall be applied to stop the train automatically.

The salient features of the proposed Rolling Stock are enclosed as Attachment- I

Attachment-I

Salient features of the proposed Rolling Stock

S.No.	Parameter	Details
1	**Gauge** (Nominal)	1435mm Standard Gauge
2	**Traction system**	
2.1	Voltage	25 kV AC
2.2	Method of current collection	Overhead Current Collection System
3	**Train composition:**	
3.1	3 car trainset	DMC+TC+DMC
4	**Coach Body**	Stainless Steel/Aluminium
5	**Coach Dimensions**	
5.1	Height	3.9 m
5.2	Width	2.9 m
5.3	Length over body (approx.)	
	- Driving Motor Car (DMC)	21.64 m
	- Trailer Car (TC)	21.34 m
	Maximum length of coach over couplers/buffers:	*22 to 23m (depending upon Kinematic Envelop and SOD)*
5.4	Locked down Panto height (if applicable)	4048 mm
5.5	Floor height	1100mm
6	**Designed - Passenger Loading**	
6.1	Design of Propulsion equipment	8 Passenger/ m^2
6.2	Design of Mechanical systems	10 Passenger/ m^2
7	**Carrying capacity- @ 6 standees/sqm**	
7.1	Coach carrying capacity	
	DMC	247 (seating - 43; standing - 204)
	TC	270 (seating - 50; standing - 220)
7.2	Train Carrying capacity	
	3 car train	764 (seating - 136; standing - 628)
8	**Weight (Tonnes)**	
8.1	Tare weight (maximum)	
	DMC	42
	TC	40
8.2	Passenger Weight in tons @8 persons/m^2	@ 0.065 T per passenger
	DMC	20
	TC	22
8.3	Gross weight in tons	
	DMC	62
	TC	62
9	**Axle load(T) (@ 8 persons per sqm of standee area)**	**16 (System should be designed for 16T axle load)**
10	**Maximum Train Length - Approximate**	

S.No.	Parameter	Details
10.1	3 car trainset	69 m
11	**Speed**	
10.1	Maximum Design Speed	90 Kmph
10.2	Maximum Operating Speed	80 Kmph
12	**Wheel Profile**	RDSO/UIC 510-2
13	**Noise Limits (ISO 3381 and 3095 - 2005)**	
13.1	Stationary (Elevated and at grade)	
13.1.1	(a) All cars except in driving console	LpAEq 20sec 68 dB(A)
	(b) Driving console	LpAEq 20sec 68 dB(A)
13.1.2	External (at 7.5 mtr from centre line of track)	LpAEq 20sec 67 dB(A)
13.2	Running at 75 kmph (Elevated and at grade)	
13.2.1	(a) All cars except in driving console	LpAEq 20sec 75 dB(A)
	(b) Driving console	LpAEq 20sec 70 dB(A)
13.2.2	External (at 7.5 mtr from centre line of track)	LpAEq 20sec 82 dB(A)
14	**Traction Motors Ventilation**	Self
15	**Acceleration on level tangent track**	As define in para 9.5.2
16	**Deceleration on level tangent track**	As define in para 9.5.2
17	**Type of Bogie**	Fabricated
18	**Secondary Suspension springs**	Air
19	**Brakes**	- An electro-pneumatic (EP) service friction brake - An electric regenerative service brake - Provision of smooth and continuous blending of EP and regenerative braking - A fail safe, pneumatic friction emergency brake - A spring applied air-release parking brake - Tread Brakes - Brake Electronic Control Unit (BECU) - Independent for each bogie
20	**Coupler**	Auto
	Driving Cab end of cars (DMC)	Automatic coupler with mechanical & pneumatic coupling but without electrical coupling head

S.No.	Parameter	Details
	Between Cars of same unit	Semi-permanent couplers
21	**Detrainment Door**	Front/ Side Passenger Door
22	**Type of Doors**	Sliding
23	**Lighting**	LED based with dimmer control
24	**Passenger Seats**	Stainless Steel
25	**Cooling**	
25.1	Transformer	Forced
25.2	CI & SIV	Self/Forced
25.3	TM	Self-ventilated
26	**Control System**	Train based Monitor & Control System (TCMS)
27	**Traction Motors**	3 phase VVVF controlled
28	**Temperature Rise Limits**	
28.1	Traction Motor	Temperature Index **minus** 70° C
28.2	CI & SIV	10° C temperature margin for Junction temperature
28.3	Transformer	IEC specified limit **minus** 20° C
29	**HVAC**	- Cooling, Heating & Humidifier (As required) - Automatic controlling of interior temperature throughout the passenger area at 25°C with 60% RH all the times under varying ambient conditions up to full load. -Coefficient of performance should be at least 2.5.
30	**PA/PIS including PSSS (CCTV)**	Required
31	**Passenger Surveillance**	Required
32	**Battery**	Ni-Cd
33	**Headlight type**	LED
34	**Train Operation**	GoA2/GoA3/UTO(GoA4) with CBTC signaling system

CHAPTER 10 –POWER SUPPLY ARRANGEMENTS

CHAPTER - 10

POWER SUPPLY ARRANGEMENTS

10.1 POWER REQUIREMENTS

Electricity is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, signaling & telecom, etc.) and workshops in depots & other maintenance infrastructure within premises of metro system. The power requirement of following proposed corridor has been determined by peak-hour demands of power for traction and auxiliary applications.

Table 10.1: General Information

Description	Remarks
Name of Proposed Corridor	North South Corridor: India Gate (SIA) to Ambabari
Length of Corridor	23.51 km
Station Details	21 nos. of Elevated Stations
Depot	Sitapura Depot
Initial Year for Design	2023
Ultimate Year for Design	2051

Broad estimation of auxiliary and traction power demand is made based on the following parameters/requirements and assumptions: -

Table 10.2: Design Requirements/Parameters

Parameter/Requirement	Value/Assumption
Maximum Passenger Hour Peak Direction Traffic (PHPDT)	20,704 in 2051
Headway in the Ultimate Year	2.50 minutes
Specific energy consumption of rolling stock at Pantograph/ Current Collector	50 kWh/1000 GTKM for 25 kV ac system as per MOUD guidelines
Elevated/at –grade station load	100 kW
Proposed Voltage Levels for Grid Supply (high grid voltage)	132 kV

Keeping in view of the train operation plan and demand of traction and auxiliary power, power requirements projected for the initial Year and Ultimate Year are summarized in table 10.3 below:

Table 10.3: Power Demand Estimation (MVA)

Corridor	Load	Year	
		Initial	**Ultimate**
North South Corridor: India Gate (SIA) to Ambabari (21 Elevated, 23.51 km)	Traction	3.99	12.66
	Auxiliary	4.45	4.69
	Total	**8.44**	**17.36**

The detailed calculations of power demand estimation are attached at annexure 10.1

10.2 NEED FOR HIGH RELIABILITY OF POWER SUPPLY

The proposed section of metro system is being designed to handle maximum PHPDT when trains are expected to run at headway intervals as per Table 10.2.

Incidences of any power interruption, apart from affecting train running, will cause congestion at stations. Interruption of power at night is likely to cause alarm and increased risk to traveling public. Lack of illumination at stations, non-visibility of appropriate signages, disruption of operation of lifts is likely to cause confusion, anxiety and ire in commuters, whose tolerance level are low on account of stress. Effect on signal and communication may affect train operation and passenger safety as well. Therefore, uninterrupted power supply is mandatory for efficient metro operations.

To ensure reliability of power supply, it is essential that there must be two sources of supply and both the sources of Supply & their connected transmission & distribution networks are reliable and have adequate redundancies built in. Therefore, it is desirable to obtain power supply at high grid voltage from stable grid sub-stations and further transmission & distribution will be done by the Metro Authority itself.

10.3 SOURCES OF POWER SUPPLY

The high voltage power supply network of the city was studied in brief. The details of the Network are summarized as follows: -

Table 10.4: High Voltage Network Details

Power Transmission Company	Grid Supply Network Voltage Levels available
M/s Jaipur Vidyut Vitran Nigam Ltd.	132 kV

Keeping in view the reliability requirements and the length of the corridor, following Receiving Sub-Station is proposed to be set up for the line: -

GSS of DISCOM	Metro Authority RSS	Distance between GSS & RSS (km)
Sitapura Industrial Area GSS	Sitapura Depot RSS	5 kms approx. (Subject to verification)

The second source for this corridor is proposed from the existing Sindhi Camp RSS, by suitable augmentation/modification.

This is an economical solution without compromising reliability. It is proposed to receive power supply for traction from the grid sub-station and auxiliary services loads through Direction connection from DISCOMs at Station/Depot level. RSS location and Grid Sub-Station Power Supply Source may be finalized during Project execution stage after detailed Survey. Projected Power demand is calculated on each RSS and furnished below -

Table 10.5 – Power Demand projections for various sources

Corridor	**Input Source**	**Peak demand – Normal (MVA)**		**Peak demand** – Emergency (MVA)**	
		Year (2023)	Year (2051)	Year (2023)	Year (2051)
India Gate (SIA) to Ambabari	RSS at Sitapura Depot				
	Traction	2.49	6.83	3.99	12.66
	RSS Near Sindhi Camp Station (Augmentation of Existing RSS)				
	Traction	1.50	5.83	3.99	12.66

**In case of failure of other source of power

Traction Power Supply (1 Φ 25 kV): -

The Grid supply will be stepped down to 1 Φ 25 kV level at the proposed RSS location. The 1 Φ 25 kV will be fed to the OHE to cater to traction load.

Auxiliary Power Supply at Stations and Depot (3 Φ 415 V): -

Auxiliary Power Supply will be availed through Direct connection from DISCOM at all stations and Depot at 3 Φ 415 V at suitable load. For economy 33 kV Ring Main and 33 kV ASS will not be provided.

For Depot Power Supply at 33 kV or 11 kV may be availed from DISCOMs further build one ASS in Depot with 2 Transformers of 33 kV / 415 V or 11 kV / 415 V with maximum capacity of 2.5 MVA each.

In case of tripping of one RSS of this section owing to fault or input supply failure, train services can be maintained from standby source from RSS of the same line. However, in case of total grid failure, all trains may come to a halt but station lighting, fire detection & other essential services can be catered to by stand-by DG sets. However, no train services can be run with power supply received from these DG Sets. Therefore, while the proposed scheme is expected to ensure adequate reliability, it would cater to emergency situations as well, except for the train running.

Typical High Voltage Receiving Sub-station

Based on emergency demand expected at the RSSs of this section as shown in Table 10.5, following is proposed: -

Table 10.6: Proposed Rating of Major Equipment

S. No.	Item/ Description	Value/Capacity
1.	**RSS – 1 (Sitapura Depot)**	
1.1	Type of RSS	AIS
1.2	Cable from GSS to RSS	3-phase single core XLPE insulated cables with Aluminum conductors to meet the normal & emergency loading requirements and fault level of the 132 kV supply
1.3	Traction Transformers	2 nos. (one as standby) 132/25 kV 21.6/30 MVA (ONAN/ONAF)
1.4	Land Requirement	approx. 100 X 50 m (5000 sq. m)
1.5	Auxiliary Supply for RSS Building	By using 25 kV /230 V 1 Φ Auxiliary Transformer of 100 kW in RSS building
2.	**RSS – 2 (Augmentation of Existing RSS at Sindhi Camp Station)**	
2.1	Type of RSS	Same as existing RSS
2.2	Cable from GSS to RSS	Existing Cables to be used
2.3	Traction Transformers	Existing 25 kV bays may be extended for North – South corridor.
2.4	Land Requirement	No additional land required.
3.	**Traction Feeder Cable**	
3.1	Cable	Single-phase XLPE insulated cables with 240 mm^2 copper conductor
3.2	Number of Runs	Based on current requirements, 2 cables are required for each of the two circuits to feed power to OHE.

25 kV switchgear shall be rated for 1250 A and 2000 A being standard design. Adequate no. of cables is required for transfer of traction power from Metro's RSS to 25 kV OHE feeding Post are proposed for traction power.

The above capacities of transformers, switchgear, cables etc. have been worked out based on the conceptual design. Therefore, these may be reviewed for better accuracy during design stage of project implementation. Necessary provisions to maintain unity power factor at Power Connection Point (PCC) shall be provided at RSS.

The capacity of transformers may be reviewed considering the load requirement/ distribution of extension of this section at the time of detailed design.

10.4 PROPOSED TRACTION SYSTEM

In view of existing traction system in already operational corridor, 25 kV AC traction system is suggested for this corridor.

10.4.1 25 kV Ac Flexible Overhead Equipment (OHE) System

25 kV AC flexible OHE system shall comprise of following: -

Item	Size
contact wire	150 sq.mm silver copper
catenary wires	65 sq.mm Magnesium Copper
Return conductor (RC)	Aluminium Conductor Steel Reinforced (ACSR) of 93.3 sq.mm cross section
ATD	Mix of spring ATD and 5 pulley ATD. Spring ATD shall not be having counterweight and shall be provided at critical location like road crossing etc

Note: Because of the advancements in telecom technology, booster transformer has not been considered

Proven catenary fittings are proposed similar to DMRC system. Final size of Catenary may be decided at the time of Detailed Design Stage as per Simulation Study.

10.5 AUXILIARY SUPPLY ARRANGEMENTS FOR ELEVATED STATIONS

Auxiliary sub-stations (ASS) are not envisaged to be provided at each station. Following is proposed for Power Supply at elevated/ at-grade stations: -

Assessed Load at Elevated/at-grade Stations	100 kW approx.
Proposed Connection	Each station, depot to have direct connection from DISCOM at 415 V level 3 phase.

In addition, Auxiliary Transformer may be explored to be provided for backup supply, similar to Indian Railways at 25 kV / 230 V ac, 100 kW, single phase suitably rated for emergency loads.

(i) Electrical Loads are planned similar to Metrolite System. Therefore, Fire fighting system, hydraulic system, Air Conditioning (AC) and Escalators are not considered for load calculation.

(ii) Since Air Conditioning is not considered for all the rooms, any Air Conditioning needed later for any specific room will increase the Electrical load and cost accordingly.

(iii) It may be observed that the load is approximately 100kVA. However, the final loads may be estimated at the detail design stage.

(iv) It is observed that Electrical load (Maximum Demand) comes out to be around 100kVA, with following major heads: -

S&T - 30 + AFC - 5	= 35 kVA
Lighting	= 20 kVA
PAP (kiosk and Ad panels etc.)	= 20 kVA
Lifts	= 20 kVA
Signage	= 5 kVA
Total	**= 100 kVA**

(v) Power Factor (pf) for Auxiliary Loads is assumed to be 0.85, accordingly electrical load for elevated station is approx. 85 kW (i.e. 100 kVA x 0.85). Therefore, for the purpose of calculating Power – Energy, the station load is considered to be 100 kW.

The above are approximate assumed requirements, and since these are for Maximum Demand load, and actual loads are normally lower than MD loads, initially connection of 50 kVA may be planned from DISCOM "as permitted in Tariff order of DISCOM" to optimize the costs. In case load increases in later years, suitable arrangement station wise may be done later as necessary.

10.6 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

The entire system of power supply (receiving, traction & auxiliary supply) shall be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system. Modern SCADA system with intelligent remote terminal units (RTUs) shall be provided. Optical fiber provided for telecommunications will be used as communication carrier for SCADA system.

SCADA is proposed for providing data acquisition, data processing, overall protection control, interlocking, inter-tripping and monitoring of the entire power supply system consisting of AC switchgear, transformers, 25 kV ac switchgear and associated electrical equipment. SCADA will utilize microprocessor-based fast-acting numerical relays & Programmable Logic Controllers (PLCs) with suitable interface.

10.7 ELECTROMAGNETIC INTERFERENCE (EMI) AND ELECTROMAGNETIC COMPATIBILITY (EMC)

25 kV AC traction current may produce alternating magnetic fields that cause voltages to be induced in any conductor running along the track. Booster Transformer and Return Conductor (BT/RC) System are available for EMI mitigation, which will be evaluate during Design Stage for provision if required. Concrete structures of elevated viaducts are not good electrical earths and therefore, Earthing and Bonding of the traction system shall be in accordance with the latest standards EN50122-1, IEEE80 and other relevant standards. Two earth conductors–Overhead Protection Cable (OPC) and Buried Earth Conductor (BEC) are proposed to be laid along with elevated via duct and all the metallic structures, structural reinforcement, running rails etc will be connected to these conductors to form an equiv-potential surface & a least resistance path to the fault currents. The overhead protection cable will also provide protection against lightning to the 25 kV OHE and the elevated viaduct.

Detailed specification of equipment e.g. power cables, transformer, switchgear, E&M equipment etc shall be framed to reduce conducted or radiated emissions as per appropriate international standards. The Metro system as a whole (trains, signaling & telecomm, traction power supply, E&M system etc) shall comply with the EMC requirements of international standards viz. EN50121, EN50123, IEC61000 series etc. A detailed EMI/EMC plan will be required to be developed during project implementation stage.

10.8 MV/LV SYSTEM

Following major E&M Equipments/system shall be required for elevated stations: -

- MV/LV panels
- DG set
- UPS & Battery system
- Lifts
- Fire detection system
- Lights & fans
- Air conditioning system
- Lightning protection system
- Earthing system

Panels shall be front operated front access cubical type indoor duty floor mounted totally enclosed dust and vermin proof with neoprene gaskets fabricated from CRCA sheet with powder coated finish suitable for 415 V 3 Phase 4 wire 50 Hz system.

10.9 STANDBY DIESEL GENERATOR (DG) SETS AND UPS SUPPLY

In the unlikely event of simultaneous tripping of all the input power sources or grid failure, the power supply to stations as well as to trains will be interrupted. It is, therefore, proposed to provide a standby DG set of following: -

DG Capacity at Elevated/ at – grade stations	70 kVA approx. (actual capacity to vary based on calculations)
DG Capacity in Depot	500 KVA approx. (actual capacity to vary based on calculations)
UPS Capacity	20 KVA approx. (actual capacity to vary based on calculations)

Silent type DG sets with low noise levels are proposed, which do not require a separate room for installation.

UPS Supply to also be considered for following emergency services:

- Emergency Lighting
- Fire Detection & Fire Alarm system.
- Station Control Room
- Control Supply

Actual capacities will be calculated at detailed design stage based on the emergency loads.

10.10 SOLAR PHOTO VOLTAIC (PV) POWER SYSTEM

In DMRC solar PV power system are installed at various sites in RESCO (Renewable Energy Service Company) model. In DMRC Stations and Depots 32 MWp solar PV power system has been installed in RESCO model.

Solar PV Power panel

"RESCO Model" means where the developers intend to provide solar power system on rooftop/sites owned by DMRC on mutually agreed terms and conditions from DMRC and enters into the PPA (Power purchase agreement) with DMRC for supply of Solar power for 25 years from the date of Commissioning of project.

In elevated stations about 50 kWp to 150 kWp capacity of Solar PV power system can be provided depending upon type of roof availability, shadow free roof area, orientation of stations. In DMRC receiving sub-station 20 kWp to 50 kWp capacity Solar PV systems are generally provided. In DMRC Depot area, approx.1000 kWp to 1500 kWp of solar capacity has been provided. Solar PV system in station parking area can also be planned as per availability of area.

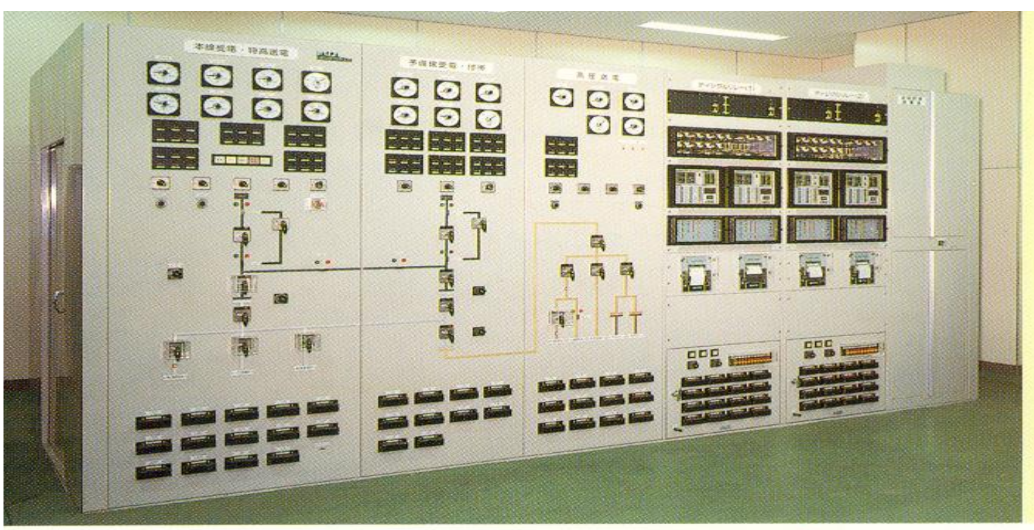
10.11 AUXILIARY SUPPLY ARRANGEMENTS FOR DEPOT

The Following major plant and machinery are to be provided in Depot: -

- Under floor Pit wheel lathe, chip crusher and conveyor for lathe on pit, Electric tractor for movement over under floor wheel lathe.
- Travelling O/H crane workshop 15T/3T,1.5T capacity(IBL), ETU shed 5T crane
- Mobile Jib crane
- Air Compressor
- Depot Control Centre, etc.

A separate ASS is required at the depot. The Depot ASSs will be provided with: -

Auxiliary transformer	33kV or 11 kV /415V, 2x2500 kVA (approx. actual capacity will be calculated at the detailed design stage)
Source of Power Supply	DISCOMs at 33 kV or 11 kV



Typical Indoor Auxiliary Sub-station

10.12 SEWAGE TREATMENT SYSTEM USING INTEGRATED CONSTRUCTED WETLANDS (ICW) IN RSS/DEPOT

Following are the objectives for providing Sewage Treatment System using Integrated Constructed Wetlands (ICW): -

1) To establish an effective option for treatment of wastewater that is generated from campus.
2) Establish an onsite treatment solution which is effective and cost effective option without producing any by products.
3) To establish a sustainable and environmental friendly solution with minimal maintenance.
4) The treated water can be reused for various non-portable applications landscaping, flushing and cleaning.

The objective of Constructed Wetlands is to utilize the decomposable organic matter present in sewage, which can be disposed of into the environment without causing health hazards or nuisance. The degree of treatment to be adopted would meet the regulatory agencies (surface water discharge standards).

Constructed wetlands (CW) are complex and modular system provides an efficient and sustainable purification treatment method that is applicable to practically all pollutant sources and in all climate and environmental conditions. CW relies on Constructed Wetlands, and is based on the activity of plants together with microorganism communities in the root zone. Together they degrade, accumulate, extract, and volatilize contaminants of all kinds in water, soil and the air, resulting in clean and purified outflow.

In DMRC Faridabad RSS 1 KLD capacity Sewage Treatment System provided through integrated constructed wetland method.

10.13 ENERGY SAVING MEASURES

Energy charges of any metro system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic. The proposed system of Metro includes the following energy saving features:

(i) Modern rolling stock with 3-phase VVVF drive and lightweight stainless steel coaches has been proposed, which has the benefit of low specific energy consumption and almost unity power factor.

(ii) Latest Rolling stock has regeneration features and it is expected that 40 – 45 % of total traction energy will be regenerated. Some of the regenerated energy rolling stock is consumed by auxiliary application itself and remaining energy is fed back to 25kV ac OHE to be consumed by nearby trains

(iii) Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).

(iv) Machine-room less type lifts with re-generative braking has been proposed with 3-phase VVVF drive. These lifts are highly energy efficient.

(v) The latest state of art and energy efficient electrical equipment (e.g. transformers, motors, light fittings etc) has been incorporated in the system design.

(vi) Efficient energy management is possible with proposed modern SCADA system by way of maximum demand (MD) and power factor control.

(vii) LED lights to be used in the station area and Depot area.

10.14 ELECTRIC POWER TARIFF

The cost of electricity is a significant part of Operation & Maintenance (O&M) charges of the Metro System, which constitutes about 30-38% of total annual working cost. Therefore, it is the key element for the financial viability of the Project.

The annual energy consumption is assessed as follows:

Year	2023 (million Units)	2051 (million Units)
Energy Consumption	21.14	55.59

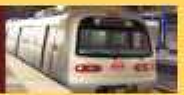
In addition to ensuring optimum energy consumption, it is also necessary that the electric power tariff be kept at a minimum in order to contain the O & M costs. Therefore, the power tariff for Metro should be at effective rate of purchase price at proposed voltage level plus nominal administrative Charges i.e. on a no profit no loss basis.
The power tariff applicable for this Metro Corridor are as follows: -

Regulatory Commission	Rajasthan State Electricity Regulatory Commission for Jaipur
For Financial Year	FY 2019 – 2020
Demand charges	Rs. 185/ - per KVA
Energy charges	Rs. 7.30 / - per Unit

It is proposed that Government takes necessary steps to fix power tariff for Metro at “No Profit No Loss” basis. Similar approach has been adopted for Delhi Metro.

North - South Corridor						Annexure-10.1
India Gate (SIA) to Ambabari						
POWER AND ENERGY (Traction & Auxiliary)						25 kV AC Traction System
S.No.	Particulars	Unit	2023	2031	2041	2051
		1	2	3	4	5
A	Traction Power Requirement					
1	No. of cars 3 (DTC+MC+DTC)	Nos.	3	3	3	3
2	Passenger Weight	T	63.2	63.2	63.2	63.2
3	Train Tare Weight	T	124.0	124.0	124.0	124.0
4	Total Train Weight	T	187.2	187.2	187.2	187.2
5	Section Length	km	23.28	23.28	23.28	23.28
6	Headway	Minute	10.00	7.00	4.00	2.50
7	Specific Energy Consumption at Pantograph (as per MoUD Guideline)	KWhr/ 1000 GTKM	50	50	50	50
8	No. of Trains/hr in both directions	Nos.	12	17	30	48
9	Peak Traction Power Requirement	MW	2.61	3.73	6.54	10.46
11	Depot Power Requirements	MW	1.0	1.0	1.0	1.0
12	No. of Depot	No	1	1	1	1
13	Total Traction Power Requirement	MW	3.61	4.73	7.54	11.46
14	**Total Traction Power Requirement (MVA) assuming 5% energy losses and 0.95 pf**	**MVA**	**3.99**	**5.23**	**8.33**	**12.66**
15	No. of Trains per direction in a day*	Nos.	67	102	167	280
16	**Yearly Traction Energy consumption with 365 days working**	**million units**	**10.65**	**16.22**	**26.56**	**44.53**
B	Aux. Power Requirement					
1	Elevated/at-grade Station Power Consumption	MW	0.10	0.10	0.10	0.10
2	No. of Elevated/at-grade Stations	Nos.	21	21	21	21
3	Total Station Aux Power Requirement	MW	2.10	2.10	2.10	2.10
4	Depot Aux Power Requirement	MW	1.50	1.65	1.65	1.70
5	Metro Bhawan & OCC Building	MW	0.00	0.00	0.00	0.00
6	No. of Depot	No.	1	1	1	1
7	No. Metro Bhawan & OCC Building	No.	0	0	0	0
8	Total Aux Power Requirement	MW	3.60	3.75	3.75	3.80
9	Total Aux. Power Requirement (MVA) assuming 5% energy losses and 0.85 pf for aux loads	**MVA**	**4.45**	**4.63**	**4.63**	**4.69**
10	Diversity Factor of Aux. loads		0.40	0.40	0.40	0.40
11	Yearly Aux. Energy Consumption 19 hrs/day and 365 days working (million units)	**million units**	**10.49**	**10.92**	**10.92**	**11.07**
C1	**(A14+B9) Grand total Traction & Aux. Power Requirement (MVA)**	**MVA**	**8.44**	**9.87**	**12.96**	**17.36**
C2	**(A16+B11) Net Annual Energy Consumption (Traction & Aux.)**	**million units**	**21.14**	**27.14**	**37.48**	**55.59**

Note: The requirement of PD load is not considered in estimation of power calculation.



CHAPTER 11- SIGNALLING AND TRAIN CONTROL SYSTEM

CHAPTER - 11

SIGNALLING AND TRAIN CONTROL SYSTEM

11.1 INTRODUCTION

The Signalling and Train Control System shall provide the highest security level for means of an efficient Train Control, ensuring safety in train movements. It assists in optimization of rail infrastructure investment and running of efficient train services on the network.

This chapter provides the main design features of the Signaling and Train Control for the operation of North- South Corridor i.e. from Ambabari to India Gate (SIA) of Jaipur Metro Rail Phase -2, taking into account the proven and advance system being used worldwide.

The Proposed North- South Corridor i.e. from Ambabari to India Gate(SIA) of Jaipur Metro Rail Corridor is planned to be operated at maximum safe speed of 90 Km/hr.

The proposed corridor is 23.51km long with 21 elevated stations. For this corridor, trains are to be maintained headway as per the Train Operation Plan. However, the Signaling System shall be designed at minimum 90 second headway in one direction.

11.2 SIGNALLING

The Signalling shall provide the highest security level to ensure that the operational activities are developed following strict safety requirements. At the same time, it shall meet the requirements for efficient train operations and high quality of service.
North- South Corridor of Jaipur Metro Phase -2 i.e. from Ambabari to India Gate(SIA) is a Separate corridor which connects with operational Phase-1 corridor at Chandpole.

The proposed Signalling System design for this corridor of Jaipur Metro Phase -2 will cater the following:

- Continuous Automatic Train Control System (CATC)
- Automatic Train Protection (ATP) System
- Automatic Train Operation (ATO)System
- Communication based Automatic Train Control (ATC) System
- On board equipment
- Cab Signalling

- Fall-Back Block Working System
- Interlocking device (Computer based Interlocking)
- Track side Radio equipment
- Track Vacancy Detection System
- Electric Point Machine
- Track Side Signals
- Centralized Traffic Control System
- OCC & BCC equipments
- Power Supply of signalling
- Cable for signalling
- Display of CCTV images from Train to OCC
- Onboard Radio Antennas, Large Video Screen, MMIs etc.

11.3 OVERVIEW OF SIGNALLING SYSTEM

It is expected to carry large number of passengers by maintaining shorter spacing between trains requiring a very high level of safety enforcement and reliability. At the same time heavy investment in infrastructure and Rolling stock necessitates optimization of its capacity to provide the best services to the people.

The requirements of the Jaipur Metro Corridors planned to be achieved by adopting following basic principles of signaling System: -

- The Train Control and Monitoring shall be ensured from Centralized Traffic control System located at Operation Control Centre (OCC). OCC equipment shall be connected to station equipment room through optical fiber network.
- Computer Based Interlocking System shall be designed on failsafe philosophy. In case of failure of any equipment, the equipment shall fail on safe side or more restrictive state. In such case the Signalling System shall authorize movement of train in normal and degraded operations.
- Track side equipment shall be connected through Electronic Interlocking (to Station Equipment Room) by secure links to ensure safe movement of trains.
- Provide high level of safety with trains running at shorter headways ensuring continuous safe train separation.
- Eliminate accidents due to driver passing Signal at Danger by continuous speed monitoring and automatic application of brake in case of disregard of signal / warning by the driver.
- Provide safety and enforce speed limit on the sections having permanent and temporary speed restrictions.
- Improve capacity with safer and smoother operations. Driver will have continuous display of Target Speed in his cab enabling him to optimize the speed potential of the track section. It provides signal / speed status in the cab even in bad weather.
- Increased productivity of rolling stock by increasing line capacity and train speeds, and enabling train to arrive at its destination sooner. Hence more trips will be possible with the same number of rolling stocks.

- Improve maintenance of Signalling and Telecommunication equipment by monitoring System status of trackside and train borne equipment and enabling preventive maintenance.
- Signalling & Train Control System on the line shall be designed to meet the required headway during peak hours.
- For monitoring inside train saloon, signaling system shall provide radio transmission media to transfer live streams to OCC controller on large video screen & MMI.

11.4 SYSTEM DESCRIPTION AND SPECIFICATIONS

The requirements of the metro are planned to be achieved by adopting 'CATC' (Continuous Automatic Train Control System) based on "CBTC" (Communication based Train Control System) which includes ATO (Automatic Train Operation), ATP (Automatic Train Protection) and ATS (Automatic Train Supervision) sub-systems using radio communication between Track side and Train.

Wireless communication system shall be used for communication between the wayside and train borne CBTC system. Radio for CBTC shall work in License free ISM band.

The Signalling and Train Control system shall be as below and Sub-system/ components will conform to international standards like CENELEC, IEC, IEEE, IS, ITU-T etc.:

11.4.1 Continuous Automatic Train Control (CATC)

Continuous Automatic Train Control based on CBTC will consist of - ATO, ATP, and ATS sub-systems. The Train- borne Automatic Train Control System will consist of Automatic Train Operation (ATO) and Automatic Train Protection (ATP).

This vital system maintains the safety of the train operations on the principle of moving block including separation of trains enforcement of speed restrictions and safe operation through interlocking.

11.4.2 Automatic Train Protection (ATP)

Automatic Train Protection is the primary function of the train control systems. This sub-system will be inherently capable of achieving the following objectives in a fail-safe manner. Line side signals will be provided at diverging routes (i.e. at points & crossings) as well as other required locations, which shall serve as backup signalling in case of failure of ATP system. ATP mode shall be the normal mode of operation in event of failure of ATO Mode. In this mode, the train control and signaling system shall

- Provide Cab Signalling.
- Determine continuously and protect the train in excess of Maximum Safety Speed (MSS) & Limit of Movement Authority (LOMA).
- Track Related Speed Profile generation based on line data and train data continuously along the track.

- Continuous monitoring of braking curve with respect to a defined target point.
- Monitoring of maximum permitted speed on the line and speed restrictions in force.
- Detection of over-speed with audio-visual warning and application of brakes, if necessary.
- Maintaining safety distance between trains.
- Monitoring of stopping point.
- Monitoring of Direction of Travel and Rollback.
- Enable opening of train doors as per stopping platform when train is docked.

The cab borne equipment will be of modular sub-assemblies for each function for easy maintenance and replacement. The ATP assemblies will be fitted in the vehicle integrated with other equipment of the rolling stock.

11.4.3 Automatic Train Operation (ATO)

This system shall operate the trains automatically from station to station while remaining within the safety envelope of ATP & open the train doors. Driver will close the train doors and press a button when ready to depart. In conjunction with ATP/ ATS, ATO can control dwell time at stations and train running in accordance with headway / timetable. In ATO mode the train control and signalling system shall carry out the following function:

- Accelerate and decelerate the train by applying traction power, coasting, and applying and removing brakes.
- Automatically control speed, acceleration, preventing unnecessary braking and stopping.
- Automatic operation of train between stations and stop the train at stations.
- Provide all indications necessary to operate the train.
- Determine continuously the Maximum Safe Speed (MSS) and Limit of Movement Authority (LOMA) with ATP function.
- Train doors open indication on the correct side when the train is docked if permitted by the ATP door release.
- Prevent the train from starting if train doors are not detected closed.

11.4.4 Automatic Train Supervision (ATS)

A train supervision system will be installed to facilitate the monitoring of train operation and also remote control of the station. The train supervision will log each train movement and display it on the workstations with each Traffic Controller at the OCC and on one workstation placed in the Station Control room (SCR) with each Station Controller.

The centralized system will be installed in the Operation Control Centre. The OCC will have a direct line projection display panel showing a panoramic view showing the status of tracks, points, signals and the vehicles operating in the relevant section / whole system. ATS will provide following main functionalities:

- Train movement control (Automatic Route setting, train dispatch, interstation stop, platform/system hold & release dwell time, skip-stop, auto crew/RS management etc.).

- Automatic Train Regulation.
- Continuous Tracking of train position.
- Display Panel & Workstation interface.
- Link to Passenger Information Display System for online information.
- Computation of train schedules & Timetable.
- Event & fault logging.
- System distinguishes between a train ready signal in ATP and a train ready signal in ATP / ATO mode.

11.4.5 Automatic Train Reversal / Turn Back (ATB)

To minimize the turn back time at terminal and intermediate station, Automatic Turn Back mode (Cycle mode/Sequence mode) is introduced to automatically operate more than one route one after the other in a sequential manner.

ATB function is a part of ATO mode function. At the terminal station or intermediate station, the train shall be operated automatically by the onboard ATC to the turn back track and back to platform level at terminal station without driver.

11.4.6 Restricted Mode (RM)/ Run of Site Mode (ROS)

This mode shall be available only when On Board ATC in operation. If the On-Board ATC does not receive ATP information, train shall be manually driven by driver using ATP (CBTC on board) with constant speed supervision. If train speed is exceeded to 25 Km/h, On Board ATC shall apply the emergency break. The On Board ATC give cab signal as soon as the train get ATP information or train reach a track position where normal running can be resumed. RM mode shall be operated in depot.

11.4.7 Cut Out Mode

This mode shall use in case of On-Board ATC failure. In this mode, the train speed is controlled entirely by the Train Operator in accordance with line side signals and verbal instruction from controller. The rolling stock provides equipment that limits speed less than 25 Kmph. If safety cut out switch is handled, On Board ATC power supply is shut down.

11.4.8 Computer Based Interlocking System (CBI)

The entire line including turn back track, transfer track, sidings will be equipped with CBI system for operation of points & crossings and setting of routes. The setting of the route and clearing of the signals will be done by workstation, which can be either locally (at station) operated or operated remotely from the OCC.

This CBI system is used for controlling vehicle movements into or out of stations automatically from a workstation. Interlocking stations having points and crossings will be provided with workstations for local control. Track occupancy, point position, etc. will be clearly indicated on the workstation. It will be possible to operate the workstation locally, if the central control hands over the operation to the local station. The interlocking system design will be based on fail-safe principle.

The equipment will withstand tough environmental conditions encountered in a Mass Transit System. Suitable IS, IRS, BS standards or equivalent international standards will be followed in case wiring, installation, earthing, cabling, power supply and for material used in axle counters, relays, point operating machines, power supply etc.

11.4.9 Track Vacancy Detection

Primary mode of track vacancy detection system on main line shall be through Radio and secondary detection can be through Axle Counter, which may be finalized at detail design stage.

The Axle counters have been used in vital train detection schemes on a large scale in Europe and outside of Europe. Also, an Axle counter is a cost-effective alternative to track circuits when applied correctly and are available from several manufacturers. In view of advantages of Axle counter, the track detection system by Axle Counter is recommended for secondary detection system.

11.4.10 Wayside Signals

Multi Aspect Color Light (LED) type Line side signals shall be installed on the Main Line at stations with point & crossing for point protection catering for bidirectional working & depot entry / exit.

11.4.11 Cab Signalling

Cab signalling is a railway safety system that communicates track status information to the cab, crew compartment or driver's compartment of a train. The train driver can see the information continuously. The DMI (Driver Machine Interface Display) is the device that displays driving information in the driver cab. Information is transmitted by the wayside radio equipment to on board Radio equipment & vice versa. The data is computed by the on-board equipment and displayed on a screen on DMI for monitoring/controlling the running of train.

Vital information concerning the safe working of the train is displayed directly in the driving cab on the DMI. The DMI displays:

- Brake details: distance to first brake application.
- Speed information: current train speed, permitted speed, target speed on circular speed gauge with speed pointer preferably with disguise color.
- Auxiliary driving information: state of brakes (service brake, emergency brake), state of the connection between the on-board and the track side equipment.

The DMI is also the interface between the driver and the on-board equipment to get driver information, train characteristics or request for shunting operation.

11.4.12 Point Machines

Non-Trailable clamp type Electrical Point Machine capable of operating with 3-phase, 50 Hz. 380V AC will be used on main line and the depot point machine will be trailable type electrical point machine capable of operating with either 3 phase, 50 Hz. 380V AC or 110V DC.

11.4.13 Train Depot: Signalling

All depot lines except the workshop area shall be interlocked. A CBI with workstation shall be provided in the Depot Control Centre for electrical operation of the points, signals and routes of the depot yard. Track vacancy detection using Radio & Axle Counter will be used in the depot as well.

The Depot shall be equipped with all mode of train operation except depot workshop line. The trains shall be controlled from DCC and OCC as well. A test track with similar Signalling and Train control system as adopted in Main Line shall be provided at Depot.

Depot for Jaipur Metro Phase-2 is proposed near Kumbha Marg Station.

11.5 SIGNALLING MODE OF OPERATION

There are five signalling modes of operation which shall be available but only one single signalling mode shall be active at any one instant of time. These five Modes are mentioned as under: -

a) Automatic Train Protection (ATP) Mode
b) Automatic Train Operation (ATO) Mode
c) Restricted Manual (RM) Mode for Depot.
d) Run on Sight Mode (ROS) Mode
e) Automatic Train Reversal / Turn Back (ATB) Mode

11.6 DISPLAY OF CCTV IMAGES FROM TRAIN TO OCC

For monitoring of train saloons, there shall be provision at OCC for displaying live video streams for the onboard CCTV cameras on each train as selected by the OCC operator on large video screen & MMIs. Onboard camera shall be provided by rolling stock, Signalling shall provide the radio infrastructure for transmission of CCTV live stream from train to OCC through use of one of the available ISM band (preferably 5.8 GHz band) frequency. Data transmission network of CCTV & CBTC shall be separate and redundancy in radio units.

Provision shall be made for displaying a minimum of four live streams from a train at OCC. Signaling shall also provide sufficient size large video screen display and MMI at OCC as per requirement. Display shall be sufficient good quality of operator to view required simultaneous live streams. However, actual bandwidth requirement, number of live streams per train, size of large video screen, etc. shall be finalized as per requirement during design stage.

11.7 CENTRALIZED TRAFFIC CONTROL (CTC)

The Metro operation shall be managed from the Central Traffic Control that located in Operation control Centre (OCC) that is in charge of managing real time traffic, safety of movement, rolling stock, on-board staffing, and work maintenance. The primary objective of the OCC system is to operate the train in ATO mode (in CBTC) and construct the routes of the trains from the origin up to the destination automatically / manually under normal / abnormal conditions, the OCC system will provide effectively alternatives to minimize the delay of the train.

Existing OCC for Jaipur Metro Phase -1 shall be augmented and utilized to handle the traffic for Jaipur Metro Phase -2 corridors.

It supplies all the information required to the centralized traffic control operator in order to check the normal operations of the trains. The CTC system interfaces to the external systems (interlocking, Radio equipment, SCADA, PIDS, PAS, etc.) to monitor and control the traffic and to ensure the safe operations of trains.

The CTC system shall meet the following requirements:

- The systems and communication lines shall be in redundant configuration and will ensure reliability and safety through continuous operations of the system.
- The CTC is interfaced with signaling devices set along the track and allow the operator to access different functionalities for traffic management with a man-machine interface (MMI).
- MMI allows the command acquisition, alarms display, and the viewing of control images.
- Each equipment units used for servers and industrial MMIs will be suitable for the metro rail environment with high MTBF. The servers for the CTC shall be self-diagnostic and fault noticing functions.
- Operation during emergency situation can be planed through the back-up CTC (BCC) when Main CTC (OCC) is not functional.
- The suitable software for each operator workstation and server is configured to achieve the convenience of the operation.

OCC shall monitor the train operations and control the operations of train so that the trains can operate safely & efficiently. The functions of the operating room will be supported by the LDP (Large Display Panel), and Workstations for the operators. The LDP in the operating room shows the entire track line of the Metro Rail in real-time so as to monitor it any time.

11.8 FALL- BACK BLOCK WORKING SYSTEM

A Fall-Back block working system shall be used by using secondary detection (axle counters) & Track Side Signals in case of failure of CBTC System or wayside communication link become unavailable.

The Fall-Back Block working system shall follow fixed block working, it can temporarily be worked to maintain safety and smooth operation with the help of Line Side Signals provided at each station / interlocking. When the Fall-Back Block working system is operated, it is necessary to check no other trains exist in the protection area to keep safety operation at first on priority.

11.9 ROOMS FOR SIGNALLING AT OCC & STATIONS

The OCC is composed of several rooms that have specific functions. In a basic configuration, four rooms are directly concerned by the Signalling System: The Operation Room, the Central Signalling Equipment room, the maintenance room and power supply room.

A) Operation Room:

The Operational Room is the place from where the operators can monitor and control the traffic on the Line, using dedicated workstations and Direct Line large projection Display.

B) Central Signalling Equipment Room

This room includes all equipment managing the Signalling System included in the OCC control area. As per site requirement, additional devices (other than Signaling i.e. Telecom and AFC System) can be considered in the Central signalling room. Also, this room shall be available at Central location as well as interlocking stations (SER, Station Equipment Room).

C) Maintenance room

All signalling devices information and technical alarms are displayed on workstations and manual or automatic commands are possible from these workstations. This room shall be available at Central location as well as interlocking stations.

D) Power supply room

The room contains Uninterrupted Power Supply (UPS) necessary for the signalling technical room, the maintenance room and the operation room. The power supply arrangement is designed in order to provide uninterrupted power in case of general power breakdown. It includes all the equipment that provides power supply for OCC rooms (Signaling, Telecom, AFC equipments). UPS room should be available adjacent to Signalling Equipment rooms at Stations and OCC. UPS room shall be available at Central location at all stations. UPS system will be provided by Electrical department.

The minimum surface areas required at Interlocking stations for Signalling and other Equipment Rooms shall be as given below. UPS Room shall be common for Signalling, Telecommunication and AFC systems at all stations,

- The signalling equipment room : $40m^2$
- The telecom & maintenance room : $30m^2$
- The power supply room* : $50m^2$

*(Common for Signalling, Telecom. and AFC and provided by Electrical wing)

At Non-interlocking stations, signalling & telecom equipment shall be accommodated and installed in a common room of minimum area of $30m^2$ or wall /cabinet at the suitable space available at the station platform as per design.

At the OCC, BCC and the Depot, the areas required shall be as per final configuration of the equipment and network configuration keeping space for further expansion.

11.10 BACK UP OF THE OCC (BCC)

In order to decrease the risks of disruption due to a local disaster such as fire, flood, building collapse, etc., a Main CTC (OCC) and a fall back CTC (BCC) shall be provided & both shall be located in different areas.

The OCC may be located at terminal station inside the premises of the station or in Depot. The BCC could be located around other terminal station / locations / Depot. The BCC shall be similar to OCC, and also, BCC shall provide full redundancies of all systems and communications.

- The OCC is normally on-line and used by the Operators to control the Metro Line traffic. Operation & Maintenance Control.
- The BCC is normally off-line. It will be used to control the Line only in case the OCC is accidentally unavailable. Besides this BCC being normally off-line, will be also available for other purposes such as training, testing, replay without disturbing the live traffic.

11.11 POWER SUPPLY

Uninterrupted Power Supply provision is must for the Signalling System to have high availability. The concept of the power supply system is of immense importance, because the availability of the Signalling System entirely depends on its power supply.

All devices along the line are computerized devices and therefore need to be fed with low-voltage power supply. The low-voltage power supply shall be designed in a way to ensure the quality and reliability of the supply to all components of the Signalling System. The Uninterrupted Power Supply System shall have sufficient backup time and in-built redundancies to ensure very high of Availability and reliability.

The solutions that are usually implemented on metro rail include:

- Redundancy of mains feeder (delivery from multiple cables/sources),
- Back-up of the AC supply by means of uninterrupted power supplies and associated batteries,
- Batteries capacity based on system consumption and autonomy with Back-up time requirements.
- Architecture and dimension of the system allowing failures and/or maintenance without service disruption (possibility to switch off one or several converters or other modules without impact).

The Uninterrupted Power Supply system shall be designed for use of Signalling equipments, Telecom equipments, AFC equipment & PSD equipments as per requirement. UPS system will be provided by Electrical department.

11.12 STANDARDS

The following standards will be adopted with regard to the Signalling system.

Table 11.1

Description	Standards
Train protection system	Train Protection system shall be based on CBTC (Communication based Train Control) System. The system architecture shall provide in redundancy. The system will conform to IEEE 1474 standards.
Interlocking	Computer based Interlocking adopted for station having switches and crossing. All related equipment as far as possible will be centralised in the equipment room at the station. The depot shall be interlocked except for lines mainly used for workshop lines etc.
Block Working	Moving Block working concept may be followed in CBTC System and Fixed Block working in failure of CBTC system.
Default Mode of Operation	The system shall be capable of Automatic Train Operation (ATO), however, the mode of operation may be decided / finalized by metro at detail design stage.
Maximum Safe Speed of Operation	90 Km/h
Grade of Automation	GOA2(ATO) / GOA1(ATP)
Operation of Points	Non-Trailable Electrical Point Machine capable of operating with 3-phase, 50 Hz. 380V AC will be used on main line and the depot point machine will be trailable/ non -trailable type electrical point machine capable of operating with either 3 phase, 50 Hz. 380V AC or 110V DC.
Track Vacancy Detection System	Primary mode for track vacancy detection system on main line and in depot (except workshop line) may be through radio (CBTC System) and secondary detection may be through Axle Counter.
Signals at Stations with point & crossings	Line Side signals to protect the points (switches). LED type signals for reliability and less maintenance cost.
Uninterrupted power Supply at stations as well as for OCC	Uninterrupted Power Supply System is Common for Signalling, Telecommunications, AFC and PSD systems.
Train Describer System	Automatic Train Supervision system. Movement of all trains to be logged on to a central computer and displayed on workstations in the Operational Control Centre and at the SCR. Remote control of stations from the OCC. The system architecture shall provide in redundancy.
Fall Back CTC	Backup OCC (BCC)

Description	Standards
On board CCTV Stream	Display of CCTV images from Train to OCC on Large Video Screen and MMIs
Cables	Outdoor cables will be steel armoured as far as possible.
Fail Safe Principles	SIL-4 safety levels as per CENELEC standard for Signal and Train Control System.
Immunity to External Interface.	All data transmission on telecom cables/OFC/Radio. All Signalling and telecom cables will be separated from power cables as per standard. CENELEC standards to be implemented for EMC.
Train Working under emergency	Running on site with line side signal with speed automatically restricted between 15-25 Kmph.
Environmental Conditions	Air-conditioners for all equipment rooms.
Maintenance philosophy	Philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling equipment shall be followed. Card / module / sub-system level replacement shall be done in the field and repairs under taken in the central laboratory/ manufacturer's premises.

11.13 SPACE REQUIREMENT FOR SIGNALLING INSTALLATIONS

Adequate space for proper installations of all Signalling equipment and Platform screen doors at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system.

The areas required at Interlocking stations for Signalling Equipment Room shall be generally 40 sqm. For UPS Room (common for Signalling, Telecommunication, AFC and PSD systems) at all stations, the area required shall be approximately minimum 50 sqm. UPS room will be provided by Electrical wing.

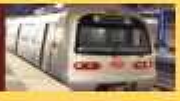
At Non-interlocking stations, Signalling & PSD Equipments shall be installed in the Telecommunication Equipment Room (TER) available at the station.

At the OCC and the Depot, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion.

11.14 MAINTENANCE PHILOSOPHY FOR SIGNALLING SYSTEMS

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and Telecommunication equipment shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to a centralized S&T repair lab suitably located in the section/depot. This lab will be equipped with appropriate diagnostic and test equipment to rectify the faults and undertake minor repairs. Cards / modules / equipment requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.



CHAPTER 12 - TELECOMMUNICATION AND AUTOMATIC FARE COLLECTION

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CHAPTER - 12

TELECOMMUNICATION AND AUTOMATIC FARE COLLECTION

TELECOMMUNICATION SYSTEM

12.1 INTRODUCTION

The Telecommunication system acts as the communication backbone for Signalling Systems and other systems such as SCADA, AFC etc. and provides Telecommunication services to meet operational and administrative requirements of the metro network.

12.2 OVERVIEW

The Telecommunication facilities proposed are helpful in meeting the requirements for operation of trains:

1. Supplementing the Signalling System for efficient train operation.
2. Exchange of managerial information
3. Crisis management during emergencies
4. Passenger information system

This chapter is prepared for the proposed Telecom system for North- South Corridor i.e. from Ambabari to India Gate (SIA) and of Jaipur Metro Rail Corridor.

North- South Corridor of Jaipur Metro Phase -2 i.e. from Ambabari to India Gate (SIA) is a separate corridor which connects/interchanges with operational Phase-1 corridor at chandpole. It is 23 km long with all 21 elevated stations along with depot at Sitapur area.

The proposed Telecom system will cater to the following requirements:

- Radio System
- Backbone network using Optical Fiber Cable (OFC)
- Ethernet & WAN Network.
- Station to Station dedicated communication
- Telephone System with Telephone Exchanges (IPPBX), Telephones and their Recording
- Centralized Recording System (CDRS)
- Centralized Clock System
- Closed Circuit Television (CCTV) System
- Passenger Information & Display System within the station from Central Control to each station, Integrated Passenger Announcement System

- Central Telecommunication Fault Reporting System
- Train Traffic Control, Maintenance Control, Emergency Control, Assistance to Train Traffic Control.
- Data Channels for Signalling, SCADA, Automatic Fare Collection
- Power Supply of Telecommunications, and
- Cables for Telecommunications etc.

12.3 TELECOMMUNICATION SYSTEM AND TRANSMISSION MEDIA

12.3.1 Fibre Optic System (FOTS) - Main Telecommunication Bearer

The main bearer of the bulk of the Telecommunication network is proposed with optical fiber cable system. An OFC system shall provide a transmission network of Voice, Data, Ethernet, Video, and Signals among all Stations, Depot and OCC with sufficient transmission bandwidth to cater for the operational need of Metro line. The size of the OFC will fully meet with the applications need of the Metro line and commercial exploitation of the Telecommunication Network of Metro line. A minimum 96 / 144 Fibers optical fiber cable with redundancy (cable on both side of track) is proposed to be laid. The optical fiber cable shall provide common transmission backbone network for Telecom and other systems which are formed by the two outdoor single mode optical fiber cables, one laying along the up-track and other one along the down-track. Additional 144 fiber optical fiber cables may be laid along track as per present commercial requirement for revenue.

12.3.2 Gigabit Ethernet Network (WAN)

A totally IP Based High Capacity, highly reliable and fault tolerant, MPLS Ethernet Network shall be provided. IP network shall have important data therefore Ethernet requires high reliability. Considering the rapidly increased demand during the operation for top-level backbone network 10Gbps Equipment is proposed. The communications network shall be configured as LAN and WAN – LAN shall be responsible for train operations and maintenance tasks within each passenger station and WAN shall be responsible for mutual communications between the stations and between depot and the central computer system. To maximize the reliability and survivability, each equipment and transmission line are configured as a dual system.
Redundant Layer-3, Layer-2 switches and Routers at each station, depot & OCC shall be provided to meet requirement of other Telecom systems (like CCTV, AFC system, maintenance management system and Wi-Fi network at station, PA, Clock, PIDS , Telephone System, SCADA etc.) and to support comparatively unimportant facilities for the operation.

Layer-3 Core switch at OCC shall be provided to cover all requirements for Centralized Management and Control facility of all equipment used in line. Data lines of sufficient quantity and bandwidth shall be provided to other systems between Central Terminal Unit and Remote Terminal Unit.

12.4 TELEPHONE EXCHANGE (IPPBX)

The System shall be IP Based with some of the extensions being Analog. For an optimized cost-effective solution small exchanges of 30 port each shall be planned at each station and a 45 Port Exchange at the Terminal Stations and 200 port at Depot/OCC shall be provided. The station exchanges will be connected to the Centre OCC/BCC main exchange. The Exchanges will serve the subscribers at all the stations and Central Control. The exchanges will be interconnected at the channel level on optical backbone. The exchanges shall be software partitioned for IPPBX and Direct Line Communication from which the phones shall be extended to the stations. For the critical control communication, the Availability & Reliability should be high.

12.5 MOBILE RADIO COMMUNICATION

Mobile Radio communication system having minimum 8 logical channels is proposed for on-line emergency communication between Motorman (Front end and Rear end) of moving train and the Central Control. The system shall be based on Digital Trunk Radio Technology to International standard. All the stations, depots and the OCC will be provided with fixed radio sets. Mobile communication facility for maintenance parties and Security Personnel will be provided with handheld sets. These persons will be able to communicate with each other as well as with central control.

The frequency band for operation of the system will be in 400/800 MHz band, depending on frequency availability. The system shall provide instant mobile radio communication between the Driver of the moving cars from any place and the Central Control. The Driver can also contact any station in the network through the central control, besides intimating the approaching trains about any emergency like accident, fire, line blocked etc., thus improving safety performance.

To provide adequate coverage, based on the RF site survey to be carried out during detailed Design stage, base stations for the system will be located at sites conveniently selected after detailed survey.

12.6 PASSENGER ANNOUNCEMENT SYSTEM (PAS)

The PAS shall be provided to broadcast voice messages to passengers /staff in all stations/ Depot from the locally as well as from OCC. It includes a network of amplifier and speakers linked to the station. The system capable of announcements from Station level will have over-riding priority in case of emergency announcements. The System shall be linked to Signalling System for automatic train actuated announcements.

The PAS and Passenger Information Display System (PIDS) shall be coordinated automatically to provide real time passenger audio broadcast and visual information at each station. Live audio broadcast relating to emergency, fire and evacuation messages from OCC and Station Control Room shall be recorded in the Centralised digital recording system at OCC. FOTS WAN network shall be used for transportation of data from Station/Depot to OCC vice versa.

12.7 PASSENGER INFORMATION DISPLAY SYSTEM (PIDS)

These shall be located at convenient locations at all stations to provide bilingual visual indication of the status of the running trains and will typically indicate information such as destination, arrival/departure time, and also special messages in emergencies. The boards shall be provided at all platforms and concourses of all stations. The System shall be integrated with the PA system and available from same MMI. For the Platform Area, high intensity LED Boards will be used in Evaluated Section. For all the concourses and Platform Area of underground Stations, HDLED Panels shall be used, which can also provide Audio/Visual Advertisements apart from Trains running status.

12.8 CENTRALIZED CLOCK SYSTEM

This will ensure an accurate display of time through a synchronization system of slave clocks driven from the GPS Based Master Clock at the Operation Control Center. The Master Clock signal shall also be required for synchronization of FOTS, Exchanges, Radio, Signaling, etc. The System will ensure identical display of time at all locations. Clocks are to be provided at platforms, concourse, Station Master's Room, Depots and other service establishments.

The Master Clock system can be extension of existing system or additional system with using timing source of existing system for proposed Phase-2 networks of Jaipur Metro.

12.9 CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM

The CCTV system shall provide video surveillance and recording function for the operations to monitor each station. The monitoring shall be possible both locally at each station and remotely from the OCC on the Video Wall.

The CCTV System shall be end to end IP based Full HD IP cameras using backbone of FOTS WAN network and shall consist of a mix of Fixed Cameras and Pan/Tilt/Zoom (PTZ) Cameras. Cameras shall be extended /located at areas where monitoring for security, safety and crowd control purpose is necessary. All Videos shall be extended at Video Wall located at security control room at OCC.

Intelligent Video Analytic (Track protections, abandoned object detection, Perimeter protection, Movement detection, Platform track protection from falling object, Camera Tempering, Overcrowding / Consation detection, Excessive Queuing, Rule based detection, Face detection & tracking features etc) shall be provided in cameras of specific locations like Platforms, Vulnerable locations, etc. Alarm shall be generated and relevant data and video shall be transfer to OCC/Stations/Security Rooms through optical fiber network.

12.10 VOICE RECORDING SYSTEM

A Centralized Digital Voice Recording System (CDRS) shall be provided at OCC to record all telephone conversations of all dispatchers at OCC & Depot. Live audio broadcast relating to emergency, fire & evacuation messages from OCC and Station Control Room shall be recorded in the Centralized digital recording system at OCC. Radio conversation shall be recorded at OCC. Emergency announcement on Train borne PA system initiated from Radio console at OCC shall also be recorded. The interface/Tapping shall be at IP network or over unified link.

The CDRS shall be of sufficient channels and shall be equipped with sufficient recording capacity for minimum four weeks continuous operation.

12.11 POWER SUPPLY FOR TELECOM SYSTEM

All telecom system equipment should be AC operated. UPS system shall provide the redundant supply to each subsystem as per their requirement.

12.12 ACCESS CONTROL SYSTEM

An Access Control System shall be provided for entering into important areas like SCR, SER, TER, OCC, DCC, TOM Rooms, etc. The System shall provide the Access only to the Authorized Personnel in operational rooms and shall not allow the same Card for Travel in metro. The System Shall be controlled and monitored centrally from the OCC.

12.13 CENTRAL TELECOM FAULT MONITORING SYSTEM

For efficient and cost-effective maintenance of the entire communication network, it is proposed to provide an Integrated Network Control System, which will help in diagnosing faults immediately from a central location and attending the same with least possible delay, thus increasing the operational efficiency and reduction in manpower requirement for maintenance. The proposed Central Fault Monitoring System will be covering Radio communication, Optical Fiber Transmission, Telephone Exchange, PA/PIDS, CCTV System and Clock System etc. The Integrated 48v DC NMS will collect and monitor status and alarms from the individual NMS of the respective sub-systems and display on a common Work Station.

12.14 TECHNOLOGY

The Technologies proposed to be adopted for Telecommunication systems are shown in Table below:

Table 12.1 Technologies for Telecommunication Systems

System	Standards
Transmission Media	Optical Fiber system as the main bearer for bulk of the Telecommunication network

System	Standards
Telephone Exchange	IPPBX of minimum 30 ports are to be provided at all Stations, an Exchange of 45 Ports to be provided at Terminal Station and 200 port at Depot/OCC
Train Radio System	Digital Train radio communication between motorman of moving cars, stations, maintenance personnel and central control.
Train Destination Indicator System	LED based boards with adequate visibility on Elevated and LED Panels in concourse to be provided at convenient location at all stations to provide bilingual visual indication of the status of the running trains, and also special messages in emergencies.
Centralized clock System	Accurate display of time through a synchronization system of slave clocks driven from a GPS master clock at the OCC and sub – master clock in station. This shall also be used for synchronization other systems.
Passenger Announcement System	Passenger Announcement System covering all platform and concourse areas with local as well as Central Announcement.
Central Voice Recording System	Centralized digital voice recording system at OCC to record all telephone conversation of all dispatchers.
Central Telecom Fault Monitoring System	CTFMS will help in diagnosing faults immediately from a central location and attending the same with least possible delay, thus increasing the operational efficiency and reduction in manpower requirement for maintenance.
CCTV System	IP based full HD CCTV system for video surveillance and recording functions.
Redundancy (Major System)	Redundancy on Radio's in the Base Stations, Path Redundancy for Optical Fiber Cable by provisioning in ring configuration.
Fiber cable	Fiber cable laid by Telecommunication wing shall be used by Signalling, SCADA, CCTV, Radio, AFC, Networking, LAN, ESS, SAP, GSM/CDMA etc. as per requirement, if required.
Environmental Conditions	All equipment rooms to be air-conditioned.
Maintenance Philosophy	System to have, as far as possible, automatic switching facility to alternate routes/circuits in the event of failure. Philosophy of preventive checks of maintenance to be followed. System networked with NMS for diagnosing faults and co-ordination. Card/module level replacement shall be done in the field and repairs undertaken in the central laboratory/manufacture's premises.

12.15 SPACE REQUIREMENT FOR TELECOM INSTALLATIONS

Adequate space for proper installations of all Telecommunication equipment at each station has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations for Telecommunication equipments shall be approximately 40 sqm. The Telecommunication Room shall be used for Signaling, Telecommunication, AFC & PSD systems equipments at non- interlocking stations. In interlocking station, Telecommunication Room shall be used for Telecommunication, AFC & PSD systems equipments. Uninterrupted Power Supply (UPS) System shall be common for Signaling, Telecommunication, AFC & PSD systems equipments at input stage and installed in UPS room at every station, depot and OCC which is approximately 50 sqm at station. These areas shall also cater to local storage and space for maintenance personnel to work.

At the OCC, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion.

12.16 MAINTENANCE PHILOSOPHY FOR TELECOM SYSTEMS

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and Telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to the existing centralized S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to rectify the faults and undertake minor repairs. Cards / modules / equipment requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

AUTOMATIC FAIR COLLECTION

12.17 INTRODUCTION

Metro System handles large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use / operate and maintain, easy on accounting facilities, capable of issuing single / multiple journey tickets, amendable for quick fare changes and require overall less manpower. In view of the above computer based automatic fare collection system is proposed**.** Seamless ticketing is now being thought of for Jaipur Metro Rail.

Automatic Fare Collection system is recommended to be adopted as this will enable the commuters to travel hassle free by different modes of transport viz. Metro, suburban trains, buses, water transport (whenever introduced) and even taxies without purchasing multiple tickets for each mode separately.

Automatic fare collection systems have the following advantages:

1. Less number of staff required.
2. Less possibility of leakages of revenue due to 100% ticket check by control gates.
3. Recycling of ticket fraudulently by staff avoided.
4. Efficient and easy to operate.
5. System is amenable for quick fare changes.
6. Management information reports generation is easy.
7. System has multi operator capabilities. Same Smart Card can be used for other applications also.
8. AFC systems are the world wide accepted systems for Metro environment.

The proposed AFC system shall be of Contactless Smart Token / Card type. For multiple journeys, the stored value smart card shall be utilized and for the single journey, the smart media shall be as utilized as contactless smart token (or media used on existing operational corridor of Jaipur Metro).

For extension corridor, the system should be compatible with the contactless smart chip supplied by at least 2 chip OEMs. The system needs to support the smart cards and single journey ticket working on existing operational line. The AFC system shall be seamlessly integrated with existing Phase 1 network of Jaipur Metro.

The equipments for the same shall be provided at each station counter / booking offices and at convenient locations and will be connected to a local area network with a computer in the Station Master’s room. Equipment and installation cost of Contactless Smart Card / Token based AFC system is similar to magnetic ticket-based AFC system, but Contactless system proves cheaper due to reduced maintenance, less wear and tear and less prone to dusty environment.

The AFC System should support the following ticketing media:

a) NCMC (National Common Mobility Card) media for multiple Journey/Single Journey as per NPCI standard specifications.
b) Integrated QR Based ticketing solution
c) Type A DMRC Closed Loop Cards
d) Type A Token
e) NFC (Near Field Communication)

As a prescriptive, for acquiring and settlement of bank card transactions, DMRC will select a financial institution. The scope of services may be defined based on industry best practices and suitable Business requirements.

12.18 GATE

Retractable Flap Type/Paddle Type Control Gates are proposed which offer high throughput, require less maintenance and are latest in modern systems internationally. All these gates will have a functionality of Auto Top on smart cards in case balance goes below the threshold value (as per choice / business rule).

The gate should also capable to NFC enabled Mobile Tickets or any latest type of Ticket media at the time of procurement/installation. The AFC system shall provide access control solutions, offering both access control devised and hardware which can be tailored to accept any ticket media readily available in market (Barcode, QR code, NFC, etc.).

12.18.1 Gate Function

a) Gate arrays shall be the normal-means of controlling entry to and exit from the paid areas. Control shall be by means of actuating a physical barrier on recognition of a valid ticket or card by the gate. The barrier may be a bi-parting leaves, centre flaps, end flaps or other configuration however the use of tripod or turnstile type gates is not acceptable. The gate shall be capable of operating either in normally open or normally closed mode.

b) Where required, barriers shall be provided to separate paid and unpaid areas of the concourse. The barriers shall meet local public safety requirements and be aesthetically merged with station engineering.

12.18.2 Features

a) **Power Failure** - In the event of a total power failure to the gates, the gates shall open to allow unrestricted user access. All latch gates shall automatically unlatch where electric locks are installed.

b) **Concourse Emergency Mode** - All AFC gates shall open whenever the Concourse Operating Mode is in emergency. An Emergency Push Button independent of the SC shall be provided in each Excess Fare Office.

c) **Ergonomics** - The engineering of the gate arrays should be such that the passenger uses reader placed on the right hand side while passing through the gate. The display and Contact less Smart Card (CSC) reader associated with each gate shall be grouped such that they bias the passenger towards the aisle through which the passenger should pass.

12.18.3 Types of Gates

(a). **Passenger Entry Gate**: - The Passenger Entry Gate shall control the entry of passengers into the paid area by validating the fare media.

(b). **Passenger Exit Gate**: - The Passenger Exit Gate shall control the exit from the paid area by validating the fare media.

(c). **Swing Gates/Barriers**: - Situated in each entry array or centre of the Z-type array, for movement of handicapped (wheelchair), the motorized Swing Gates can be operated from EFO (Excess Fair Office) through customer care system.

12.18.4 Tail Gating Prevention:

Minimum distance for detection shall be less than 20 cm and methodology shall be in accordance with that being used in AFC operations.

12.19 TICKET VENDING MACHINE (TVM)

The TVM should provide the convenience for the passengers to procure ticket on their own, without the need to queue at the ticket sale counter.

At all stations, Passenger Operated Ticket Vending Machines (Automatic Ticket Vending Machines) are proposed. The TVM's will provide convenience to passengers to avoid standing in queues at ticket booths and provide them international standard service. This will be used for

1. Dispensing single journey Ticket (Token/QR)
2. Add Value in Smart card
3. Payment options available will be: Cash, Credit/Debit cards, UPI

12.20 TYPES OF TICKET

(a) The system shall provide, or be capable of processing, the following types of ticket:

- Single Journey Ticket (SJT)
- Daily Pass
- Staff/Employee Pass (EP)
- Stored Value (SV) (at least 16 configurable types)
- Period Pass (PP)

(b) Each ticket type shall be capable of being associated with at least four fare tables (One full fare and two concession fares).

12.20.1 Ticket Media

(a) CSC (for Stored Value, Employees Pass etc.)

Contactless media shall be to ISO/IEC 14443 & ISO 18092 standard (minimum EAL4 Security Criteria for CSC) and also to support common mobility card specifications of Ministry of Urban Development (GOI).

The system must support minimum standard & specification for CSC & devices and recommendations to be used for the implementation of National Common Mobility program in the multimodal and multi operator environment within the practical limits of transport.

(b) Other Media (for Single Journey Tickets)

Media for Single Journey Tickets shall be determined at design stage, which can be a token. Choice of SJT media shall take financial and usage constraints into account.

12.20.2 Ticket Reader/Add Value Machines

These machines will be used to know the Card/Token balance and can also be used as Add value device in case payment for Card top up is made through alternate Internet based channel like net banking, Credit/Debit card (Payment gateway) etc.

12.20.3 Recharge Card Terminal Machine (RCTM)

RCTM will be used to recharge the Card using Credit Card /Debit card /Pre Paid card as well as bank Note.

12.21 SECURITY

12.21.1 Revenue Protection

The AFC machines shall resist tampering by either passengers or unauthorized staff.

12.21.2 Revenue Security

(a) The AFC machines and system shall provide a complete audit trail of all transactions, transfers of cash and other payments.

(b) Cash handling equipment and systems shall be an integral part of the audit trail.

(c) Data & Revenue Security shall be ensured by a Key Management System (KMS) which needs to issue a Hardware SAM for each AFC equipment in use in the system. The SAM shall be used to authenticate the equipment and the transaction integrity.

12.21.3 Data Security

(a) In the event the SC fails, each item of equipment shall be able to operate autonomously without loss of data.

(b) Security of communications between the AFC equipment, SC and CC system shall ensure no loss of data in transmission.

12.22 STATION COMPUTER (SC)

a) Station Computer (SC) enables the overall control and monitoring of each item of AFC equipment within the station and transfer of data to the Central Computer (CC).

b) The SC shall include the power and data communication links to each item of AFC equipment and CC system interface.

c) It shall enable printing of reports at stations. The reports shall include accounting and statistical information. It shall include any other reports required for AFC operation.

d) The SC shall be able to download data to the AFC machines individually or as groups.

e) The SC shall receive maintenance data from AFC equipment and transmit the same to CC for monitoring and use of the same as an effective maintenance tool.

f) The SC shall be able to monitor certain critical functions of the AFC system and collect data for warnings and alarms.

g) If there is loss of communication between the SC and AFC equipment (Gates, TOM etc.) then the equipment shall operate in stand-alone mode utilizing the most recent data from the SC. AFC equipment (Gates, TOM etc.) shall store data up to seven days for transmission when SC communication is restored.

h) In the event of loss of communication with the CC the SC shall utilize the most recent operational data received from the CC and shall be capable of storing at least thirty days of transaction data.

12.22.1 Equipment Control

The normal method of control of the equipment shall be by the SC. The SC shall enable all AFC equipment control (put in service, taken out of service and initiated etc.) without the requirement for communication with the CC.

12.23 CENTRAL COMPUTER SYSTEM

Central Computer System shall be redundant configuration and placed at OCC. It is connected to Station Computer and equipments via redundant secured link provided in Telecom portion.

a) The Central Computer System (CC) shall collect and analyze information received from the station computers. It shall produce network-wide revenue and traffic data and monitor the performance of all AFC equipment.

b) A Central Computer (CC) System shall generate the necessary management reports from the CST, CSC and transaction information received from the Station Computer Systems.

c) The CC shall hold and download CST and CSC parameters, Configuration Data (CD), AFC device software and fare table information to each SC from where they shall be distributed to the station AFC equipment.

d) The CC shall automatically collate all CST, CSC and usage data (UD) from the SC to provide accurate audit and traffic statistics for the line.

e) The CC shall be located in a dedicated computer room in the Administration Building or Operations Control Centre.

f) The CC shall maintain a blacklist of invalid tickets. Blacklisted tickets shall be rejected by the AFC Gates.

g) The CC shall support a Fare Table with adequate number of stations.

12.24 CENTRAL CLEARING HOUSE SYSTEM (CCHS)

The CCHS system shall be installed at OCC for sharing revenue between different operators. The Central Clearing House System (CCHS) shall handle all transactions for multiple applications and seamlessly integrate AFC System with different operators. The CCHS shall have all the functionalities required, thereof, for clearing and settlement between different registered Operators.

The CC should be able to interface with Central clearing house system (CCHS). The CCHS system already proposed for Jaipur Metro Phase -1 may be used for Jaipur Metro Phase -2 also.

12.25 AFC EQUIPMENT REQUIREMENT

The AFC equipment required at various locations of Jaipur Metro Phase -2 Corridors, North- South Corridor i.e. from Ambabari to India gate (SIA) is tabulated at Annexure 1 for projection years 2023, 2031, 2041 & 2051.

Calculations have been done on the basis of traffic projections provided by consultancy wing for projections years 2023, 2031, 2041 & 2051 considering the following assumptions:

A. Each Station has only 2 access.
B. Minimum AFC equipment at a station with "2 access-1 for entry,1 for exit": 2 entry gates, 2 exit gates, 2 EFO, 2 TOM, 4 AVM/TR, 2 TVM.
C. Throughput of gate: 25 passengers per minute, TOM: One per access/ 10 passengers per minute.
D. 50% passenger are assumed on Smart card and 50% on single journey token.

However, the exact number and type shall depend on the final station layout and traffic being catered to.

12.26 STANDARDS

The standard proposed for AFC systems are as under:

Table 12.2

Standards	Description
Fare media	The AFC System should support the following ticketing media: a) NCMC (National Common Mobility Card) media for multiple Journey/Single Journey as per NPCI standard specifications. b) Integrated QR Based ticketing solution c) Type A DMRC Closed Loop Cards d) Type A Token e) NFC (Near Field Communication)
Gates	Computer controlled retractable flap type automatic gates at entry and exit. There will be following types of gates : - Entry - Exit - Reversible The System shall support the EMV and RuPay based open loop ticketing following the NCMC standard model for interoperability.
Station computer, central computer and AFC Network	All the Fare Collection Equipment shall be connected in a local area network with a station server controlling the activities of all the machines. The station servers will be linked to the AFC central computer situated in the operational control center through the optic fiber communication channels. The centralized control of the system shall provide real time data of earnings, passenger flow analysis, blacklisting of specified cards etc.
Ticket office machine (TOM/	Manned Ticked Office Machines shall be installed in the station for selling cards / token to the passengers.

Standards	Description
EFO)	Also TVM's shall be provided for Automatic Ticket Vending.
Ticket Readers	Ticket Reader shall be installed near EFO for passengers to check information stored in the token / cards.
Portable ticket decoder (PTD)	PTD will be used to check the card/token during travel
Recharge card terminal machine	RCTM will be used to recharge the card using bank note/debit card/credit card/pre paid card
UPS	Common UPS of S&T system will be utilized.
Maintenance philosophy	Being fully Contactless system, manpower requirement for maintenance is much less compared to system with magnetic tickets. However, adequate facilities to be provided similar to that of S & T systems.

12.27 INTEGRATION OF AFC WITH OTHER LINES AND MODES OF TRANSPORT

In Jaipur, different mode of transport is being constructed and operated by different operators. In view of passenger convenience and operational efficiency, it is proposed that AFC for different metro lines should be integrated and smart card based fare products should be inter-operable. AFC system shall take into account revenue sharing mechanism among different operators based on journeys performed at each system. The single ride tickets (tokens) may not be inter-operable and may be limited to each operator's system.

The proposed AFC system shall provide interfaces to other operators such as Suburban Rail, Bus, Waterway, Parking, Toll etc. so that these systems may also be integrated with common smart card based fare products. This will facilitate the passengers as they need not carry different cards for different applications.

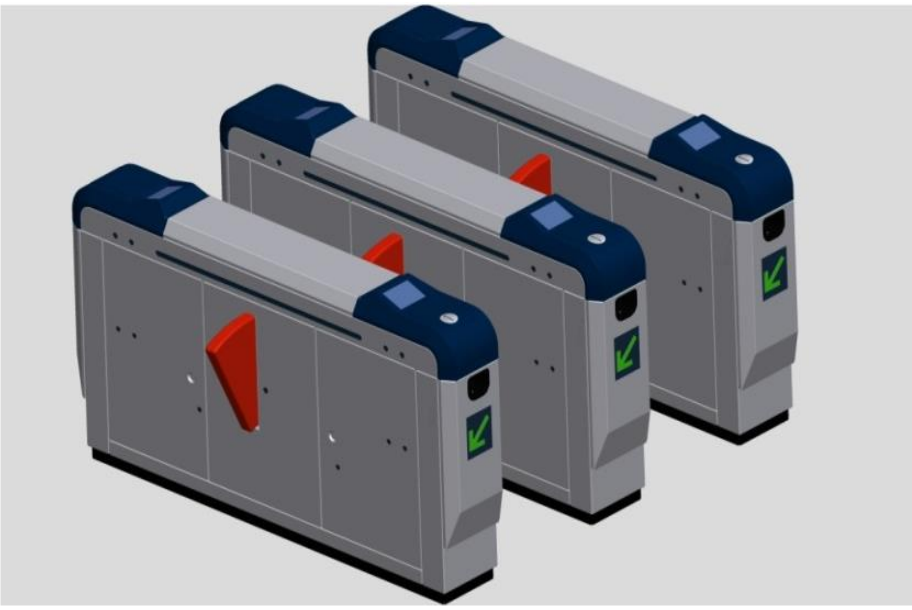


Fig 12.1 Entry/Exit Gates

Fig 12.2: Ticket Office Machine

Fig 12.3: Ticket vending machine

Fig. 12.4 Ticket Reader/Add Value Machine

Annexure1

Table 12.3: AFC Equipment for Jaipur Metro from Ambabari to India Gate (SIA) (Year 2023)

Sr. No.	Station Name	Hourly Boarding	Hourly Alighting	Peak min. Boarding	Peak min. Alighting	Gate		TOM	EFO	TR	TVM	RCTM
						Entry	Exit					
1	Ambabari	1000	994	17	17	2	2	2	2	4	2	2
2	Pani Petch	320	330	5	6	2	2	2	2	4	2	2
3	Subhash Nagar	251	262	4	4	2	2	2	2	4	2	2
4	Collectorate	461	458	8	8	2	2	2	2	4	2	2
5	Chandpole	2875	2910	48	49	2	2	2	2	4	2	2
6	Government Hostel	431	463	7	8	2	2	2	2	4	2	2
7	Ashok Marg	392	427	7	7	2	2	2	2	4	2	2
8	SMS Hospital	430	446	7	7	2	2	2	2	4	2	2
9	Narayan Singh Circle	498	529	8	9	2	2	2	2	4	2	2
10	Ram Bagh Circle	818	845	14	14	2	2	2	2	4	2	2
11	Tonk Phatak	718	731	12	12	2	2	2	2	4	2	2
12	Gandhi Nagar Railway Stn.	340	337	6	6	2	2	2	2	4	2	2
13	Dev Nagar	484	482	8	8	2	2	2	2	4	2	2
14	Mahaveer Nagar	540	521	9	9	2	2	2	2	4	2	2
15	Durgapura	370	366	6	6	2	2	2	2	4	2	2
16	B2 Bypass	509	459	8	8	2	2	2	2	4	2	2
17	Sanganer Sethu	406	358	7	6	2	2	2	2	4	2	2
18	Pinjarapole Gaushala	409	367	7	6	2	2	2	2	4	2	2
19	Haldi Ghati Gate	468	427	8	7	2	2	2	2	4	2	2
20	Kumbha Marg	240	229	4	4	2	2	2	2	4	2	2
21	India Gate (SIA)	111	127	2	2	2	2	2	2	4	2	2
	TOTAL					**42**	**42**	**42**	**42**	**84**	**42**	**42**

Table 12.4: AFC Equipment for Jaipur Metro from Ambabari to India Gate (SIA) (Year 2031)

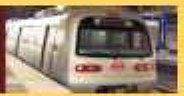
Sr. No.	Station Name	Hourly Boarding	Hourly Alighting	Peak min. Boarding	Peak min. Alighting	Gate		TOM	EFO	TR	TVM	RCTM
						Entry	Exit					
1	Ambabari	1904	1906	32	32	2	2	2	2	4	2	2
2	Pani Petch	571	594	10	10	2	2	2	2	4	2	2
3	Subhash Nagar	441	465	7	8	2	2	2	2	4	2	2
4	Collectorate	764	772	13	13	2	2	2	2	4	2	2
5	Chandpole	4718	4828	79	80	3	3	4	2	4	2	2
6	Government Hostel	759	830	13	14	2	2	2	2	4	2	2
7	Ashok Marg	658	718	11	12	2	2	2	2	4	2	2
8	SMS Hospital	688	711	11	12	2	2	2	2	4	2	2
9	Narayan Singh Circle	851	901	14	15	2	2	2	2	4	2	2
10	Ram Bagh Circle	1316	1351	22	23	2	2	2	2	4	2	2
11	Tonk Phatak	1229	1249	20	21	2	2	2	2	4	2	2
12	Gandhi Nagar Railway Stn.	573	569	10	9	2	2	2	2	4	2	2
13	Dev Nagar	756	741	13	12	2	2	2	2	4	2	2
14	Mahaveer Nagar	828	804	14	13	2	2	2	2	4	2	2
15	Durgapura	645	638	11	11	2	2	2	2	4	2	2
16	B2 Bypass	927	833	15	14	2	2	2	2	4	2	2
17	Sanganer Sethu	756	664	13	11	2	2	2	2	4	2	2
18	Pinjarapole Gaushala	795	707	13	12	2	2	2	2	4	2	2
19	Haldi Ghati Gate	961	872	16	15	2	2	2	2	4	2	2
20	Kumbha Marg	472	448	8	7	2	2	2	2	4	2	2
21	India Gate (SIA)	285	295	5	5	2	2	2	2	4	2	2
	TOTAL					**43**	**43**	**44**	**42**	**84**	**42**	**42**

Table 12.5: AFC Equipment for Jaipur Metro from Ambabari to India Gate (SIA) (Year 2041)

Sr. No.	Station Name	Hourly Boarding	Hourly Alighting	Peak min. Boarding	Peak min. Alighting	Gate		TOM	EFO	TR	TVM	RCTM
						Entry	Exit					
1	Ambabari	3740	3738	62	62	2	2	3	2	4	2	2
2	Pani Petch	1059	1110	18	19	2	2	2	2	4	2	2
3	Subhash Nagar	805	848	13	14	2	2	2	2	4	2	2
4	Collectorate	1274	1308	21	22	2	2	2	2	4	2	2
5	Chandpole	7760	8010	129	134	5	5	6	2	4	2	2
6	Government Hostel	1394	1562	23	26	2	2	2	2	4	2	2
7	Ashok Marg	1166	1264	19	21	2	2	2	2	4	2	2
8	SMS Hospital	994	1020	17	17	2	2	2	2	4	2	2
9	Narayan Singh Circle	1512	1586	25	26	2	2	2	2	4	2	2
10	Ram Bagh Circle	1687	1743	28	29	2	2	2	2	4	2	2
11	Tonk Phatak	2248	2269	37	38	2	2	2	2	4	2	2
12	Gandhi Nagar Railway Stn.	443	425	7	7	2	2	2	2	4	2	2
13	Dev Nagar	1144	1083	19	18	2	2	2	2	4	2	2
14	Mahaveer Nagar	2085	2007	35	33	2	2	2	2	4	2	2
15	Durgapura	1193	1179	20	20	2	2	2	2	4	2	2
16	B2 Bypass	1821	1647	30	27	2	2	2	2	4	2	2
17	Sanganer Sethu	1529	1363	25	23	2	2	2	2	4	2	2
18	Pinjarapole Gaushala	1849	1632	31	27	2	2	2	2	4	2	2
19	Haldi Ghati Gate	1172	1114	20	19	2	2	2	2	4	2	2
20	Kumbha Marg	974	923	16	15	2	2	2	2	4	2	2
21	India Gate (SIA)	573	589	10	10	2	2	2	2	4	2	2
	TOTAL					**45**	**45**	**47**	**42**	**84**	**42**	**42**

Table 12.6: AFC Equipment for Jaipur Metro from Ambabari to India Gate (SIA) (Year 2051)

Sr. No.	Station Name	Hourly Boarding	Hourly Alighting	Peak min. Boarding	Peak min. Alighting	Gate		TOM	EFO	TR	TVM	RCTM
						Entry	Exit					
1	Ambabari	5383	5481	90	91	4	4	5	2	4	2	2
2	Pani Petch	1886	1977	31	33	2	2	2	2	4	2	2
3	Subhash Nagar	1403	1475	23	25	2	2	2	2	4	2	2
4	Collectorate	2098	2163	35	36	2	2	2	2	4	2	2
5	Chandpole	13217	13622	220	227	9	9	11	2	4	2	2
6	Government Hostel	2351	2649	39	44	2	2	2	2	4	2	2
7	Ashok Marg	2046	2223	34	37	2	2	2	2	4	2	2
8	SMS Hospital	1392	1410	23	24	2	2	2	2	4	2	2
9	Narayan Singh Circle	2558	2655	43	44	2	2	2	2	4	2	2
10	Ram Bagh Circle	2729	2786	45	46	2	2	2	2	4	2	2
11	Tonk Phatak	4053	4055	68	68	3	3	3	2	4	2	2
12	Gandhi Nagar Railway Stn.	771	730	13	12	2	2	2	2	4	2	2
13	Dev Nagar	1879	1745	31	29	2	2	2	2	4	2	2
14	Mahaveer Nagar	1719	1623	29	27	2	2	2	2	4	2	2
15	Durgapura	2253	2214	38	37	2	2	2	2	4	2	2
16	B2 Bypass	2805	2562	47	43	2	2	2	2	4	2	2
17	Sanganer Sethu	1871	1663	31	28	2	2	2	2	4	2	2
18	Pinjarapole Gaushala	4223	3768	70	63	3	3	4	2	4	2	2
19	Haldi Ghati Gate	2162	2068	36	34	2	2	2	2	4	2	2
20	Kumbha Marg	1793	1704	30	28	2	2	2	2	4	2	2
21	India Gate (SIA)	955	976	16	16	2	2	2	2	4	2	2
	TOTAL					**53**	**53**	**57**	**42**	**84**	**42**	**42**



CHAPTER 13- FRIENDLY FEATURES FOR DIFFERENTLY ABLED

CHAPTER -13

FRIENDLY FEATURES FOR DIFFERENTLY ABLED

13.1 INTRODUCTION

The objective of making this chapter is to create a user-friendly mass transport system in India which can ensure accessibility to persons with disabilities, people travelling with small children or are carrying luggage, as well as people with temporary mobility problems (e.g. a leg in plaster) and the elderly persons.

The design standards for universal access to Public Transport Infrastructure including related facilities and services, information, etc. would benefit people using public transport.

The access standards given here are extracted from Indian Roads Congress Code, IRC 103: 2012, Guidelines for Pedestrian Facilities; Model Building Bye-Laws, 2011 and National Building Code, 2005. Central Public Works Department's (CPWD) "Harmonised Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disabled and Elderly Persons", 2016 (by MoUD), and international best practices / standards.

Further, it has also been attempted to provide guidelines/ standards for alighting and boarding area, approach to station, car parking area, drop-off and pick-up areas, taxi/auto rickshaw stand, bus stand/stop, footpath (sidewalk), kerb ramp, road intersection, median/pedestrian refuge, traffic signals, subway and foot over bridge etc. to achieve a seamless development around Metro stations.

13.2 CONTENT

1. Metro Rail Station
   - Way finding
   - Signage
   - Automated Kiosks
   - Public Dealing Counters
   - Audio-visual Displays
   - Public Telephones
   - Rest Areas/Seating
   - Tactile Paving - Guiding & Warning
   - Doors
   - Steps & Stairs
   - Handrails

- Ramps
- Lifts/Elevators
- Platform/Stair Lift
- General and Accessible toilets
- Drinking Water Units
- Visual Contrasts
- Emergency Egress/Evacuation

2. Street Design
   - Footpath (Sidewalk)
   - Kerb Ramp
   - Road Intersection
   - Median/Pedestrian Refuge
   - Traffic Signals
   - Subway and Foot Over Bridge

3. Alighting and Boarding Area
   - Approach
   - Car Park
   - Drop-off and Pick-up Areas
   - Taxi/Auto Rickshaw Stand
   - Bus Stand/Stop

13.3 METRO RAIL STATION

1. General
   - Whether over-ground or underground, rail travels is a highly effective mode of transport.
   - Every train should contain fully accessible carriages.
   - Staff should be trained in methods of assistance and be at hand on request.
   - Stations for all rail travel should be fully accessible with extra wide turnstiles where possible alongside wheelchair accessible doorways
   - Staff should be on hand to assist persons with disabilities and elderly to enter or exit through convenient gates.
   - All new railway stations should be designed to be fully accessible.
   - For persons with hearing impairments, an electronic sign board (digital display) should be displayed on each platform at conspicuous location for all announcements made by the railways.
   - For persons with visual impairments audio system announcing the station names and door location should be available.

2. Accessible Metro Rail Cars

   The railway cars should have the following features:
   - Railway car doors should be at least 900 mm wide;
   - The gap between the car doors and the platform should preferably be less than 12 mm;

- Identification signage should be provided on the doors of wheelchair accessible coach.
- If the car door and the platform cannot be at the same level, then at least one car doors should have apparatus such as a hydraulic lift or pull-out ramp installed in the doorway for wheelchair users.

3. Wheel Chair Space
   - Space for a wheel chair should be available at the side of the door:-
   - The space should be indicated inside and outside the car by using the international symbol of access; and
   - Wheel stoppers and ring-strap or other appropriate safety grip should be provided for wheelchair users.

4. Seats
   - An appropriate number of designated seats for passengers with disabilities and elderly people should be provided near the doors.

5. Aisles
   - Aisles should be at least 900 mm wide.

13.4 INFORMATION SIGNS AND ANNOUNCEMENTS

A map of train routes should be installed. This should be in Braille/raised numbers as well. In each car, there should be an announcement and provision of a visual display of the names of stations route. This display should be in raised numbers with sharp contrast from the background.

13.5 METRO STATION AREA

1. LEVEL APPROACH
   - Approach route should not have level differences. If the station is not on the same level as the walkway or pathway, it should have a ramp.
   - Walkway surfaces should be non-slip.
   - Approach walkway should have tactile pavements for persons with visual impairments.

2. STATION ENTRANCES AND EXITS
   - These should have a minimum width of 1800mm and is level or ramped.

3. RESERVATION AND INFORMATION COUNTERS
   - Should have clear floor space of at least 900 mm x 1200 mm in front of the counters;
   - There should be at least one low counter at a height of 750 mm to 800 mm from the floor with clear knee space of 750 mm high by 900 mm wide by 480 mm deep.
   - At least one of the counters should have an induction loop unit to aid people with hearing impairments; and

- The counters should have pictographic maps indicating all the services offered at the counter and at least one of the counter staff should be sign language literate.

4. TOILET FACILITIES
   - There should be at least one unisex accessible toilet
   - Ticket Gates

   At least one of the ticket gates should:
   - Be minimum 900 mm wide to allow a wheelchair user through; and
   - Have a continuous line of guiding paver for people with visual impairments.

5. PLATFORMS

   The Platforms should:
   - Have a row of warning paver installed 600mm before the track edge (fig 13.4);
   - Have non-slip and level flooring;
   - Have seating areas for people with ambulatory disabilities;
   - Be well illuminated lux level 35 to 40;
   - There should be no gap or difference in level between the train entry door and the platform.
   - All platforms should inter-connect by means of an accessible routes or lifts; and provide accessible level entrance to the train coach.

6. WAY FINDING
   - Way finding references should be available at decision points.
   - Colour can be used to identify routes and provide assistance in locating doors, walls and hazards. Proper colour contrast between different elements greatly improves visibility for all users and is critical for persons with low vision. For example, colour contrasting of door frames can assist in locating doors, and likewise floors should be contrasted with walls. In addition, furniture should contrast with walls and floors so as not to create an obstacle.
   - Structural elements such as columns should be colour contrasted or brightly marked so as to be visible to those who may have a visual disability.
   - Generally, patterns on flooring should be avoided or else should be minimal and small to avoid visual confusion.
   - In addition to identifying hazards or warnings, tactile floor surfaces can also be used to inform that there is a change in area (e.g. leaving a corridor and entering a boarding area).
   - Tactile systems should be consistent throughout the building. For example, terminals should not have carpeting in some boarding areas and tile in others as this may create confusion for those who rely on tactile surfaces to guide them to their destination.
   - Good lighting assists those with a visual disability to see better and allows people who have a hearing impairment to lip read easier. However, care should be taken to properly direct lighting and to use matte finishes on floors, walls and signage, so as not to create glare which may create difficulties for all travellers.
   - Blinds can be used to adjust lighting levels in areas where the natural lighting changes significantly throughout the day.

7. SIGNAGE

- Signs must be clear, concise, and consistent. All travelers need clear information about the purpose and layout of terminals to maintain a sense of direction and independent use of all facilities. Using internationally and nationally established symbols and pictograms with clear lettering and Braille ensures universal accessibility cutting across regional/cultural and language barriers. A cohesive information and signage system can provide visual (e.g. signs, notice boards), audible (e.g. public address and security systems, induction loops, telephones, and infrared devices), and/ or tactile information (e.g. signs with embossed lettering or Braille)

8. SIGN DESIGN SPECIFICATIONS

- The sign should be in a prominent position.
- The face of the sign should be well-illuminated by natural or artificial light.
- Letters should be simple such as Arial, Helvetica medium, and san serif or similar and numbers should be Arabic.
- The colour of the text should be in a colour that contrasts with the sign board.
- The sign board should also contrast with the wall on which it is mounted.
- The surface of the sign should not be reflective.
- Some signs such as those adjacent to or on a toilet door may be embossed so that they can be read by touch.
- Illuminated signs should not use red text on a dark background.
- Signs should be supplemented by Braille where possible.

Fig. 13.1 - Way finding signage

Fig. 13.2 - International Symbol of Accessibility

9. AUTOMATED KIOSKS

- Automated kiosks should be accessible for wheelchair users.
- Should be clearly marked with international symbol of accessibility.
- Should have Braille buttons and audio announcement system for persons with vision impairments.
- Operations should be easy to understand and operate for persons with learning disabilities, intellectual disabilities, and elderly persons.

10. PUBLIC DEALING COUNTERS
    - Ticketing, Information, Check-in, Help desk, Restaurants, Shops, etc. should have public dealing counters.
    - Information or help desks should be close to the terminal entrance, and highly visible upon entering the terminal. In addition, they should be clearly identified and accessible to both those who use wheelchairs and those who stand.
    - It should provide information in accessible formats, viz. Braille leaflets for persons with vision impairments.
    - Ideally, these desks should have a map of the facility that desk attendants can view with passengers, when providing directions.
    - Staff manning the counters should know sign language.
    - Information desk acoustics should be carefully planned and controlled as a high level of background noise is confusing and disorienting to persons with hearing impairment.
    - Lighting should be positioned to illuminate the receptionist/person manning the counter and the desk top without creating glare.
    - Lighting should not create shadows over the receptionist staff, obscuring facial detail and making lip reading difficult.
    - There should be a hearing enhancement system such as a loop induction unit, the availability of which is clearly indicated with a symbol.
    - One of the counters should not be more than 800mm from the floor, with a minimum clear knee space of 650mm high and 280mm- 300mm deep.

11. AUDIO-VISUAL DISPLAYS
    - Terminal maps should be placed so that they are readily visible to persons who are standing and persons who use wheelchairs. They should also be accessible to persons with a visual disability (i.e. tactile maps). Other alternatives include electronic navigation systems or audio maps.
    - Enable captioning at all times on all televisions and other audio-visual displays that are capable of displaying captions and that are located in any portion of the terminal.
    - The captioning must be in high contrast for all information concerning travel safety, ticketing, check-in, delays or cancellations, schedule changes, boarding information, connections, checking baggage, individuals being paged by bus railway or airlines, vehicle changes that affect the travel of persons with disabilities, and emergencies (*e.g.*, fire, bomb threat).

12. REST AREAS/SEATING
    - Seating area / benches should be provided along the circulation path at regular intervals so that passengers do not need to walk more than 50 to 60 metres before being able to sit and rest.
    - Where seating is provided, designated seating for passengers with disabilities is to be provided at boarding gates and departure areas within viewing distance of communication boards and/or personnel and identified by the symbol of access.
    - Public transit operators should provide seating in passenger service areas where there may be long waiting lines or times, including at ticket sales counters, check-in counters, secured screening and during inter-country travel in customs areas and baggage retrieval areas.

- Designated seating should be provided for at boarding gates and departure areas within viewing distance of communication boards, and within hearing range of audio announcements as well. Such seating areas should be identified by the symbol of accessibility and shelter should be provided where this seating is outdoors.
- In outdoor settings, seating should be provided along with the planned hawker spaces.
- At waiting lounges for persons with disabilities chairs should have armrests and backrest.

13. TACTILE PAVING- GUIDING & WARNING

(a) Tactile Guiding Paver (Line-Type)

It is recommended to install a row of tactile guidance paver along the entire length of the proposed accessible route for visual impaired persons. Care must be taken to ensure that there are no obstacles, such as wall, pillar, uneven surfaces, Soffit (underside /open area under the stairs, along the route traversed by the guidance paver. Also, there should be clear headroom of at least 2.1 meters height above the tactile guidance paver, free of protruding objects such as overhanging advertisement panel and signage, along the entire length of the walk.

(b) Tactile Warning Paver (Dot-Type)

Indicate an approaching potential hazard or a change in direction of the walkway, and serve as a warning of the approaching danger to persons with visual impairments, preparing them to tread cautiously and expect obstacles along the travel path, traffic intersections, doorways, stairs, etc. They are used to screen off obstacles, drop-offs or other hazards, to discourage movement in an incorrect direction, and to warn of a corner or junction. Two rows of tactile warning paver should be installed across the entire width of the designated accessible passenger pathway at appropriate places such as before intersections, terminal entrances, obstacles such as signage, and each time the walkway changes direction.

14. PLACES TO INSTALL WARNING PAVER

- In front of an area where traffic is present.
- In front of an entrance/exit to and from a staircase or multi-level crossing facility.
- Entrances/exits at public transport terminals or boarding areas.

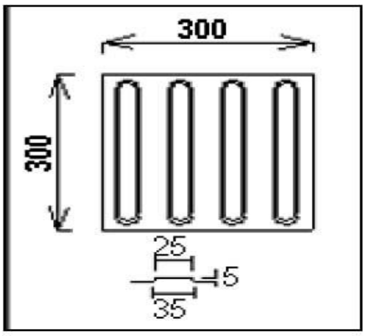


Fig. 13.3 - Guiding paver

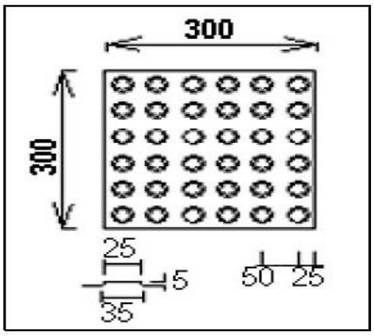


Fig. 13.4 - Warning paver

15. DOORS

Whatever the type of entrance door, it must be wide enough to accommodate passenger traffic comfortably.

- The recommended minimum clear opening width of an internal door is 900mm minimum.
- Where doors comprise two leaves (i.e. double doors), each leaf should be 900mm min. wide, so that persons carrying large items and people using wheelchairs do not have to open both leaves.
- Manual doors should incorporate kick plates 300-400mm high to withstand impact of wheelchair footrest (this is especially important where doors are glazed).

  - Also be fitted with vision panels at least between 900mm and 1500mm from floor level.
  - Be color contrasted with the surrounding wall and should not be heavier than 22N to open.
  - Lever handles and push type mechanisms are recommended. When a sliding door is fully open, handles should be usable from both sides.

- Where revolving doors or turnstiles are used, an alternative wheelchair-
- Accessible entrance must also be provided.
- A distance of 400mm should be provided beyond the leading edge of door to enable a wheelchair user to maneuver and to reach the handle.
- To ensure maximum clarity for persons with visual impairments, the entrance should be easily distinguishable from its surroundings by the effective use of landscaping, signage, colour (preferably yellow/orange), tonal contrast and tactile surfacing.
- Door hardware should be positioned between 900-1000mm above floor (figure 28).
- Operable devices such as handles, pulls, latches and locks should:
  - Be operable by one hand
  - Not require fine finger control, tight grasping, pinching or twisting to operate

- Glazed doors and fixed glazed areas should be made visible by use of a clear, colour and tone contrasted warning or decorative feature that is effective fromboth inside and outside and under any lighting conditions, e.g. a logo, of minimum dimensions 150mm by 150mm (though not necessarily square), set at eye level.

16. STEPS & STAIRS

- Steps should be uniform with the tread not less than 300mm and the risers 150mm.
- The risers should not be open.
- The steps should have an unobstructed width of 1200mm minimum.
- All steps should be fitted with a permanent colour and tone contrasting at the step edge, extending the full width of the step, reaching a minimum depth of 50mm on both tread and riser.
- Have continuous handrails on both sides including the wall (if any) at two levels
- Warning paver to be placed 300mm at the beginning and at the end of all stairs.
- Nosing to be avoided.
- The staircase should be adequately and uniformly illuminated during day and night (when in use). The level of illumination should preferably fall between 100-150 lux.
- The rise of a flight between landings must be no more than 1200mm.
- There should be no more than 12 risers in one flight run.
- The stair covering and nosing should be slip-resistant, non-reflective, firmly-fixed and easy to maintain.
- Soffit (underside /open area under the stairs) of the stairs should be enclosed or protected.

17. HANDRAILS

- Handrails should be circular in section with a diameter of 38-45mm and formed from materials which provide good grip such as timber, nylon or powder coating, matt finish metal finishes.
- The handrail should contrast in colour (preferably yellow/orange) with surrounding surfaces.
- At least 50mm clear of the surface to which they are attached and should be supported on brackets which do not obstruct continuous hand contact with the handrail.
- The handrail should be positioned at two levels- 760mm and 900mm above the pitch-line of a flight of stairs.
- Handrail at foot of the flight of stairs should extend 300mm beyond the stairs in the line of travel and returning to the wall or floor or rounded off, with a positive end that does not project into the route of travel.

18. RAMPS

- Ramps gradient should ideally be 1 in 20 and no greater than 1 in 12.
- Width of the ramp should not be less than 1200mm and preferred width is 1800mm.
- The steeper the gradient, the shorter the length of ramp between landings.
- On long ramps, a horizontal resting space should be provided every 6 meters.

- Surface materials should be slip-resistant, non-reflective, firmly-fixed and easily maintained
- The edge of the ramp should have an edge protection with a minimum height of 100mm.
- Landings every 750mm of vertical rise.
- A tapping or lower rail should be positioned so that its bottom edge is no higher than 200mm above ground level.
- Handrails on the ramps should be on both sides at two levels: upper at 900mm and lower at 760mm; both end to be rounded and grouted; extend 300 mm beyond top and bottom of ramp .
- A row of tactile warning paver should be placed 300mm beginning and end of each run.
- Landings should be provided at regular intervals as indicated in the table (Table 13.1).

Table 13.1 - Specifications for Ramps

Level difference	Minimum Gradient.of Ramp	Ramp Width	Handrail on both sides	Comments
≥ 150 mm ≤ 300 mm	1:12	1200 mm	√	
≥ 300 mm ≤ 750 mm	1:12	1500 mm	√	Landings every 5 meters of ramp run.
≥ 750 mm ≤ 3000mm	1:15	1800 mm	√	Landings every 9 meters of ramp run.
≥ 3000 mm	1:20	1800 mm	√	Landings every 9 meters of ramp run.

19. LIFTS/ELEVATORS

- A carefully designed lift makes a huge contribution to the accessibility of a multi-storied terminal building for persons with disabilities.
- Lift locations should be clearly signposted from the main pedestrian route and recognizable through design and location.
- The colour and tone of the lift doors should contrast with the surrounding wall finish to assist in their location. Lift doors with metallic finishes such as steel grey and silver should be avoided as they are difficult to identify by persons with low vision.
- The lift lobby shall be of an inside measurement of 1800mm X 2000mm or more. A clear landing area in front of the lift doors of minimum dimensions 1500mm x 1500mm should be provided.
- By making the landing area distinguishable by floor surface and contrast, it will aid location and recognition of core areas. This could comprise a change in floor finish from thin carpet to vinyl/PVC, or cement/mosaic floor to carpet.
- Changes in floor finish must be flushed. There should be no level difference between lift door and the floor surface at each level; the gap if unavoidable should not be more than 12mm.
- The floor level/location should be indicated on the wall adjacent to or just above the call buttons, and opposite the lift doors where possible.

20. Lift Dimensions

- Provisions of at least one lift shall be made for people using wheelchairs with the following car dimensions:
  - Clear internal depth -1500 mm minimum
  - Clear internal width - 1500 mm minimum
  - Entrance door width - 900 mm minimum

21. LIFT CONTROLS

- The lift call button should be wall-mounted adjacent to the lift and should contrast with wall finish, either by using a contrasting panel, or a contrasting border around the button panel.
- The call buttons should be located within the range 800-1000mm above floor finish.
- Buttons should not be touch sensitive, but should require a light positive pressure and should ideally be large enough to be operable by the palm of the hand if required.
- The control buttons inside the lift should be positioned on the side wall rather than front wall to allow access from the back and front of the lift car, by mobility aid users like wheelchair users.
- The control buttons should contrast with their surroundings and illuminate when pressed and should incorporate highly visible tactile embossed (NOT engraved) characters and in Braille.
- Time of closing of an automatic door should be more than 5 seconds and the closing speed should not exceed 25 meters per second. There should be a provision of censor enabled closing.
- In larger lifts, controls should be positioned on both side walls, at least 400mm from front wall and between 800-1000mm above floor level.

22. CAR DESIGN

- Internal walls should have a non-reflective, matt finish in a colour and tone contrasting with the floor, which should also have a matt, non-slip finish.
- Use of reflective materials such as metal (stainless steel for example) can be problematic in creating sufficient contrast with control buttons, emergency telephone cabinet, etc. for persons with low vision and the use of such materials should be avoided wherever possible.
- A mirror (750mm above floor level) on the rear wall can be useful to persons using wheelchairs and other mobility aids should they need to reverse safely outof the lift car or view the floor numbers.
- Internal lighting should provide a level of illumination of minimum 100 lux (approximately 50-75 lux at floor level), uniformly distributed, avoiding the use of spotlights or down lighters.
- A grab bar should be provided along both sides and the back wall, 900mm above floor level.
- Handrails should be of tubular or oval cross section, in order to be easily gripped and capable of providing support.
- Handrails should be positioned so that there is a clear space behind the handrail to allow it to be grasped i.e. knuckle space should be 50mm.

13.6 INFORMATION SYSTEMS

- Lifts should have both visual and audible floor level indicators
- Audible systems are also usually capable of incorporating additional messages, such as door closing, or, in the case of an emergency, reassurance (with manual over-ride allowing communication with lift occupants).
- Announcement system should be of 50 decibel.
- The display could be digital or segmented LED, or an appropriate alternative. A yellow or light green on black display is preferred to a red on black display as it is easier to read.

13.7 GENERAL ACCESSIBLE TOILETS

1. SIGNAGES
   - All signage of general toilets should be in bold and contrasting colors.
   - For persons with low vision and vision impairments: male pictogram in triangle and female pictogram in circle, marked on plates along with Braille & raised alphabets, to be mounted on wall next to door near the latch side, at a height between 1400mm-1600mm.
   - Warning strip/ thin rubber door mat to be provided 300mm before and after the toilet entrance.
   - Tactile paver to be provided for urinals, WC and washbasins for persons with vision impairments.

2. ACCESSIBLE TOILETS
   - Should have the international symbol of accessibility displayed outside for wheelchair access.
   - The toilet door should be an outward opening door or two way opening or a sliding type and should provide a clear opening width of at least 900mm.
   - It should have a horizontal pull-bar, at least 600mm long, on the inside of the door, located so that it is 130mm from the hinged side of the door and at a height of 1000mm.

3. WC COMPARTMENT DIMENSIONS
   - The dimensions of a unisex toilet are critical in ensuring access. The compartment should be at least 2200mm and 2000mm. This will allow use by both manual and motorized wheelchair users.
   - Layout of the fixtures in the toilet should be such that a clearing maneuvering space of 1500mm x 1500mm in front of the WC and washbasin.

4. WATER CLOSET (WC) FITTINGS
   - Top of the WC seat should be 450-480mm above finished floor level, preferably be of wall hung or corbel type as it provides additional space at the toe level.
   - An unobstructed space 900mm wide should be provided to one side of the WC for transfer, together with a clear space 1200mm deep in front of the WC.
   - WC should be centred 500mm away from the side wall, with the front edge of the pan 750mm away from the back wall. Have a back support. The WC with

a back support should not incorporate a lid, since this can hinder transfer.

- L-shape grab bar at the adjacent wall and on the transfer side (open side) swing up grab bar shall be provided.
- The cistern should have a lever flush mechanism, located on the transfer side and not on the wall side and not more than 1000mm from the floor.

5. GRAB BARS
   - Grab bars should be manufactured from a material which contrasts with the wall finish (or use dark tiles behind light colored rails), be warm to touch and provide good grip.
   - It is essential that all grab rails are adequately fixed, since considerable pressure will be placed on the rail during maneuvering. Grab bars should sustain weight of 200kgs minimum.
   - A hinged type moveable grab bar should be installed adjacent to the WC on the transfer side. This rail can incorporate a toilet tissue holder. A distance of 320mm from the centre line of the WC between heights of 200-250mm from the top of the WC seat. It should extend 100-150mm beyond the front of the WC.
   - A fixed wall-mounted L- shape grab bar (600mm long horizontal and 700mm long vertical) on the wall side should be provided. It should be placed at a height of 200-250mm above the WC seat level.

6. WASHBASINS
   - Hand washbasins should be fitted on cantilevered brackets fixed to the wall.
   - The basin should be fixed no higher than 750mm above the finished floor level.
   - Be of dimensions 520mm and 410mm, mounted such that the top edge is between 800- 900mm from the floor; have a knee space of at least 760mm wide by 200mm deep by 650-680mm high.
   - The position of the basin should not restrict access to the WC i.e. it should be located 900mm away from the WC.
   - A lever operated mixer tap fitted on the side of the basin closest to the WC is useful as it allows hot and cold water to be used from a seated position on the WC.
   - The hand drying facilities should be located close to the hand washbasin between 1000-1200mm.
   - Lever type handles for taps are recommended.
   - Mirror’s bottom edge to be 1000mm from the floor and may be inclined at an angle.

7. FIXTURES AND FITTINGS

- Contrast between fittings and fixtures and wall or floor finishes will assist in their location. For example, using contrasting fittings, or dark tiles behind white hand washbasins and urinals, contrasting soap dispensers and toilet roll holders.
- Contrast between critical surfaces, e.g. floors, walls and ceilings helps to define the dimensions of the room.
- Towel rails, rings and handrails should be securely fixed to the walls and positioned at 800-1000mm from the floor.

- The mirror should be tilted at an angle of 300 for better visibility by wheelchair users.
- It should have lower edge at 1000mm above floor finish and top edge around 1800mm above floor finish.
- Hooks should be available at both lower-1200mm and standard heights-1400mm, projecting not more than 40mm from the wall.
- Where possible, be equipped with a shelf of dimensions 400mm x 200mm fixed at a height of between 900mm and 1000mm from the floor.
- Light fittings should illuminate the user's face without being visible in the mirror. For this reason, most units which have an integral light are unsatisfactory.
- Large, easy to operate switches are recommended, contrasting with background to assist location, at a maximum height of 1000mm above floor finish.
- All toilet facilities should incorporate visual fire alarms.
- Alarms must be located so that assistance can be summoned both when on the toilet pan i.e. at 900mm height and lying on the floor i.e. at 300mm, from floor surface. Alarms should be located close to the side wall nearest the toilet pan, 750mm away from rear wall and at 900mm and 200mm above floor finish

8. SIGNAGE OF ACCESSIBLE TOILETS

- All unisex accessible toilets to have access symbol in contrast colours. A distinct audio sound (beeper/clapper) may be installed above the entrance door for identification of the toilets.

Fig. 13.5 - Signage for accessible washroom

9. ACCESSIBLE URINAL

   - At least one of the urinals should have grab bars to support ambulant persons with disabilities (for example, people using mobility aids like crutches).
   - A stall-type urinal is recommended.
   - Urinals shall be stall-type or wall-hung, with an elongated rim at a maximum of 430mm above the finish floor. This is usable by children, short stature persons and wheelchair users.
   - Urinal shields (that do not extend beyond the front edge of the urinal rim) should be provided with 735mm clearance between them.
   - Grab bars to be installed on each side, and in the front, of the urinal.
   - The front bar is to provide chest support; the sidebars are for the user to hold on to while standing.

13.8 DRINKING WATER UNITS

- Drinking water fountains or water coolers shall have up front spouts and control.
- Drinking water fountains or water coolers shall be hand-operated or hand and foot-operated.

- Conventional floor mounted water coolers may be convenient to individuals in wheelchairs if a small fountain is mounted on the side of the cooler 800mm above the floor.
- Fully recessed drinking water fountains are not recommended.
- Leg and knee space to be provided with basin to avoid spilling of water. This allows both front and parallel access to taps for persons using mobility aids like wheel chair, crutches etc.

13.9 VISUAL CONTRASTS

- Visual contrasts means adequate contrast created by difference of at least 30 LRV (Light Reflectance Value) of the two surfaces/ objects and it helps everyone especially persons with vision impairments.
- Visual contrast should be provided between:
  - Critical Surfaces (walls, ceiling and floor),
  - Signage and background sign frame/ wall,
  - Step edges and risers/ treads on steps,
  - Handrails and background walls,
  - Doors and surrounding walls,
  - Switches/ sockets and background wall,
  - Toilet fixtures and critical surfaces in toilet.

- Barriers and hazards should be highlighted by incorporating colours and luminance contrast.

13.10 EMERGENCY EGRESS/EVACUATION

- Placement (accessibility) and visibility of such devices is very important. The following is to be considered for the installation of such alarm devices; fire alarm boxes, emergency call buttons and lit panels should be installed between heights of 800mm and 1000mm from the furnished floor surface. These should be adequately contrasted from the background wall and should be labelled with raised letters and should also be in Braille.
- A pre-recorded message, alerting an emergency to the control room or reception should be installed in the telephone and this should be accessible by a ‘hotkey’ on the phone keypad. This ‘hotkey’ should be distinct from the rest of the keypad.

13.11 ALERTING SYSTEMS

- In emergency situations, it is critical that people are quickly alerted to the situation at hand, for persons with disability the following needs to be considered.
- Consider having audible alarms with ‘voice instructions’ that can help guide them to the nearest emergency exit. As an alternative to the pre-recorded messages, these alarms may be connected to the central control room for on-the-spot broadcasts.
- Non-auditory alarms (visual or sensory) to alert persons with hearing impairments should be installed at visible locations in all areas that the passengers may use (including toilet areas, etc).

Non-auditory alarms include:

- Flashing beacons
- Vibrating pillows and vibrating beds.
- Pagers or mobile phones that give out a vibrating alarm along with a flashing light (these may be issued to persons with vision or hearing impairments at the time of check-in or boarding the vehicle.)

13.12 WRITTEN EVACUATION PROCEDURE

A written evacuation procedure that details the egress plan for people with disability should be installed behind the entrance door in the accessible rest rooms. The evacuation procedure should be detailed in large print letters that contrast strongly against the background. Where possible, it should also incorporate raised letters and Braille. The evacuation route should be displayed on a high contrast tactile map for benefit of persons with vision impairments.

13.13 EMERGENCY EVACUATION ROUTE

- Designate routes that are at least 1200mm wide, to ensure that a person using a wheelchair and a non-disabled person are able to pass each other along the route. The route should be free of any steps or sudden changes in level and should be kept free from obstacles such as furniture, coolers, AC units and flower pots.

- Use Exit signage along the route. Orientation and direction signs should be installed frequently along the evacuation route and these should preferably be internally illuminated. The exit door signage should also be internally illuminated.

- A 'way guidance lighting system' consisting of low mounted LED strips to outline the exit route (with frequent illuminated direction indicators along the route) should be installed along the entire length of the evacuation route. Way guidance systems allow persons with vision impairments to walk significantly faster than traditional overhead emergency lighting. Moreover, emergency exit lights in green color and directional signals mounted near the floor have been found to be useful for all people in cases where a lot of smoke is present.

13.14 WAY GUIDENCE SYSTEM

- Luminance on the floor should be 1lux minimum provided on along the centre line of the route and on stairs.

- Install clear illuminated sign above exit and also directional signage along the route.

- The directional exit signs with arrows indicating the way to the escape route should be provided at a height of 500mm from the floor level on the wall and should be internally illuminated by electric light connected to corridor circuits.

13.15 FIRE RESISTANT DOORS

- Fire resistant doors and doors used along the emergency evacuation route are generally heavy and the force required to open these is much higher than 25 Newton, making it difficult for people with disability to negotiate these doors independently. There are, however, magnetic and other types of door holders available that can be connected to fire alarms so that they will hold the doors open normally but will release the doors when the fire alarm is activated.

13.16 STREET DESIGN

(a) Footpath (Sidewalk)

Footpaths should be regarded as a transportation system which is connected and continuous, just like roadways and railways. They should not be sporadically placed where ever convenient, but instead should be provided consistently between all major attractions, trip generators, and other locations where people walk.

Footpath should

- Be along the entire length of the road;
- Have height of a standard public step riser i.e. 150 mm maximum;
- Be at least 1800 mm wide;
- Have non-slip surface;
- Have tactile guiding paver for persons with visual impairments;
- Preferably have well defined edges of paths and routes by use of different colours and textures;
- Have no obstacles or projections along the pathway. If this is unavoidable, there should be clear headroom of at least 2200 mm from the floor level;
- The minimum 1.8m (width) x 2.2m (Height) Walking Zone should be clear of all obstructions – both horizontally and vertically.

Footpath should have:

- Have kerb ramps where ever a person is expected to walk into or off the pathway; and
- Have tactile warning paver installed next to all entry and exit points from the footpath.

(b) Kerb Ramp

- Kerb should be dropped, to be flush with walk way, at a gradient no greater than 1:10 on both sides of necessary and convenient crossing points. Width should not be less than 1200mm. If width (X) is less than 1200mm, then slope of the flared side shall not exceed 1:12.
- Floor tactile paving- Guiding & Warning paver shall be provided to guide persons with vision impairment so that a person with vision impairment does not accidentally walk onto the road.
- Finishes shall have non-slip surface with a texture traversable by a wheel chair.

(c) Road Intersections

- Pedestrian crossings should be equipped with traffic control signal.
- Traffic islands to reduce the length of the crossing are recommended for the safety of all road users.
- Warning pavers should be provided to indicate the position of pedestrian crossings for the benefit of people with visual impairments.
- Table tops (raised road level to the sidewalk height) are helpful in reducing the speed of traffic approaching the intersection.

(d) Median/Pedestrian Refuge

Raised islands in crossings should:

- Cut through and level with the street; or
- Have kerb ramps on both the sides and have a level area of not less than 1500 mm long in the middle; and
- A colored tactile marking strip at least 600 mm wide should mark the beginning and end of a median/ pedestrian refuge to guide pedestrian with visual impairments to its location.

13.17 TRAFFIC SIGNALS

- Pedestrian traffic lights should be provided with clearly audible signals for the benefit of pedestrians with visual impairments;
- Acoustic devices should be installed on a pole at the point of origin of crossing and not at the point of destination;
- The installation of two adjacent acoustic devices such as beepers is not recommended in order to avoid disorientation;
- The time interval allowed for crossing should be programmed according to the slowest crossing persons; and
- Acoustical signals encourage safer crossing behavior among children as well.

13.18 SUBWAY AND FOOT OVER BRIDGE

Subways and foot over bridges should be accessible for people with disabilities. This may be achieved by:

- Provision of signage at strategic location;
- Provision of slope ramps or lifts at both the ends to enable wheelchair accessibility ;
- Ensuring that the walkway is at least 1500 mm wide;
- Provision of tactile guiding and warning paver along the length of the walkway;
- Keeping the walkway; free from any obstructions and projections; and
- Providing for seats for people with ambulatory disabilities at regular intervals along the walkway and at landings.

13.19 ALIGHTING AND BOARDING AREAS

- All areas and services provided in the Mass Rapid Transit System (Metro/subway), bus terminuses, etc. that are open to the public should be accessible.

13.19.1 Approach

- Passenger walkways, including crossings to the bus stops, taxi stands, terminal / station building, etc. should be accessible to persons with disabilities.
- Uneven surfaces should be repaired and anything that encroaches on corridors or paths of travel should be removed to avoid creating new barriers. Any obstructions or areas requiring maintenance should be white cane detectable.
- Access path from plot entry and surface parking to terminal entrance shall have even surface without any steps.
- Slope, if any, shall not have gradient greater than 5%. The walkway should not have a gradient exceeding 1:20. It also refers to cross slope.
- Texture change in walk ways adjacent to seating by means of tactile warning paver should be provided for persons with vision impairment.
- Avoid gratings in walks.

13.19.2 Car Park

(A) SIGNAGE

- International symbol of accessibility (wheelchair sign) should be displayed at approaches and entrances to car parks to indicate the provision of accessible parking lot for persons with disabilities within the vicinity.
- Directional signs shall be displayed at points where there is a change of direction to direct persons with disabilities to the accessible parking lot.
- Where the location of the accessible parking lot is not obvious or is distant from the approach viewpoints, the directional signs shall be placed along the route leading to the accessible parking lot.
- Accessible parking lot should be identifiable by the International Symbol of Accessibility. The signs should not be obscured by a vehicle parked in the designated lot.
- Vertical signs shall be provided, to make it easily visible, the sign should be at a minimum height of 2100 mm.

(B) SYMBOL

International Symbol of Accessibility should be clearly marked on the accessible parking lot for drivers/riders with disabilities only.

- A square with dimensions of at least 1000 mm but not exceeding 1500 mm in length;
- Be located at the centre of the lot; and
- The colour of the symbol should be white on a blue background.

(C) CAR PARK ENTRANCE

The car park entrance should have a height clearance of at least 2400 mm.

LOCATION

- Accessible parking lots that serve a building should be located nearest to an accessible entrance and / or lift lobby within 30 meters. In case the access is through lift, the parking shall be located within 30 meters.
- The accessible route of 1200 mm width is required for wheelchair users to pass behind vehicle that may be backing out.

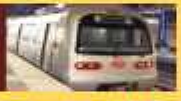
(D) ACCESSIBLE CAR PARKING LOT

The accessible car parking lot should:

- Have minimum dimensions 5000 mm × 3600 mm;
- Have a firm, level surface without aeration slabs;
- Wherever possible, be sheltered;
- Where there are two accessible parking bays adjoining each other, then the 1200 mm side transfer bay may be shared by the two parking bays. The transfer zones, both on the side and the rear should have yellow and while cross-hatch road markings;
- Two accessible parking lots shall be provided for every 25 no of car spaces.

(E) DROP OFF AND PICK UP AREAS

- Designated drop-off and pick-up spaces, to be clearly marked with international symbol of accessibility.
- Kerbs wherever provided, should have kerb ramps.



CHAPTER 14 – ENVIRONMENT & SOCIAL IMPACT ASSESSMENT

14.20 Impacts Due To Project Construction

14.21 Impacts Due To Project Operation

14.22 Impacts Due To Depot

14.23 Positive Environmental Impacts

14.24 Checklist Of Impacts

14.25 Analysis of Alternatives and Public Consultation and Information Disclosure

14.26 Environmental Management Plan

14.27 Disaster Management

14.28 Emergency Measures

14.29 Environmental Monitoring Plan

14.30 Cost Estimates

14.31 Conclusion

CHAPTER - 14

ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

14.1 LEGAL, POLICY AND INSTITUTIONAL FRAME WORK

The need for a well-developed legal mechanism to conserve resources, protect the environment and ensures the health and well being of the people in India is more than ever before. Keeping pace with international laws, the Ministry of Environment and Forest enacted Environmental Protection Act in 1986. The Government of India has laid down various policy guidelines, regulations, acts and legislations pertaining to sustenance and protection of environment and its various components. Following Environmental laws are applicable to this MRTS project:

Table 14.1: Environmental Legislations Applicable to the Project

S. No.	Act/Regulation	Objectives	Implementing /Responsible Agency
1.	Air (Prevention and Control of Pollution) Act, 1981 amended 1987.	To control and monitor air pollution as per prescribed limits set by CPCB.	Rajasthan State Pollution Control Board
2.	The Water (Prevention and Control of Pollution) Act, 1974 amended 1988.	To control and monitor water pollution as per prescribed limits	Rajasthan State Pollution Control Board
3.	The Forest Conservation Act, 1980 amended 1988	To check deforestation by restricting conversion of forested areas into non-forested areas	• Forest Department, Govt. of Rajasthan - up to 5 Ha and < 40% canopy closure) • Regional Chief Conserva-tor of Forest - 5 - 20 Ha. • MoEFCC - Above 20 Ha and > 40% canopy closure)
4.	National Forest Policy, 1988	To preserve and restore biological diversity	Forest Department, GoI and Government of Rajasthan
5.	Hazardous And Other Wastes(Management and Transboundary Movement Rules, 2016	Handling of Hazardous wastes generated in the project during construction and operations	Rajasthan State Pollution Control Board
6.	National Environmental Appellate Authority Act, 1997	For grievance redressal	Ministry of Environment and Forests
7.	Ancient Monuments and Archaeological Sites and Remains Act, 1958 amended 2010	Preservation of culture and historical remains.	Archeological Survey of India (ASI), State Archeological Department
8.	The National Environment	Liability for damages due to	Chairperson, National

S. No.	Act/Regulation	Objectives	Implementing /Responsible Agency
	Tribunal Act, 1995 (27 of 1995)	any accident while handling hazardous substances	Environmental Tribunal
9.	The Explosives Act (& Rules), 1884 (revised in 1983). Other relevant codes of BIS and National Building Codes. issued in 1983)	Regulations regarding the use of explosives and precautionary measures while blasting and quarrying	State Revenue Department
10.	The Public Liability Insurance Act & Rules, 1991	Imposes liability on the owner to provide immediate relief in respect of death/injury or damage to any person/property arising out of accident/activity implementation	All project proponents including the State Public Works Department
11.	Indian Motor Vehicles Act, 1988 (1989)	To check vehicular air and noise pollution	Motor Vehicles Department, Govt. of Rajasthan
12.	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Rules for acquisition of land by Government	Department of Settlement and Land Records, Revenue Department of State Government.
13.	Noise Pollution Rules 2000 amended 2002 & 2006	Regulation regarding control and management of Noise	CPCB, Rajasthan State Pollution Control Board
14.	The Building and other construction Workers Act, 1996	Employing Labour and Workers	Labour Commissioner
15.	Municipal Solid Waste Management Rules 2016	Managing the solid wastes generated at the project	Local Authorities
16.	C&D Waste Management Rules, 2016	C & D Waste generated during construction	Rajasthan State Pollution Control Board
17.	E waste Management Rules, 2016	Handling of e waste generated during construction and operation	Rajasthan State Pollution Control Board
18.	Fly ash Notification, 2016	Use of flyash in construction	Rajasthan State Pollution Control Board
19.	CGWA Guidelines	Construction Rainwater harvesting system	CGWA
20.	EIA Notification (January 1994 and New EIA Notification dated 14th September, 2006	For all Development Projects	Rajasthan State Pollution Control Board

14.2 PERMISSIONS/ CLEARANCES

For the proposed project, required clearances/ permissions related to environment have been summarized below in Table 14.2:

Table 14.2: Permissions/Clearances Required for the Project

S. No.	Permissions/ Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				
1	Permission for felling of trees and diversion of National Park/ forest area for nonforest use.	Forest Conservation Act (1980) Procedural Guidelines developed by the Department of Environment, GoM; Tree removal will be guided as per state government rules.	District Forest Office/State Forest Department/ District Collector	JMRC
2	Consent to establish and consent to operate batching plant/casting yard	The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and The Air (Prevention and Control of Pollution) Act 1981, amended 1987	Rajasthan State Pollution Control Board	Contractor
B. Implementation Stage				
3	Consent to establish and operate STP and ETP	The Water (Prevention and Control of Pollution) Act, 1974, amended 1988	Rajasthan State Pollution Control Board	Contractor
4	Consent to operate hot mix plant, crushers, batching plant	Air (Prevention and Control of Pollution) Act 1981	Rajasthan State Pollution Control Board	Contractor
5	Permission for withdrawal of groundwater	Environment (Protection) Act, 1986	Central Ground Water Authority	Contractor
6	Permission for sand mining from river bed	Environment (Protection) Act, 1986	Mining Department/ MoEF	Contractor
7	Authorization for Generation, handling, storage and transportation of hazardous waste	Hazardous Waste (Management and Handling) Rules 1989	Rajasthan State Pollution Control Board	Contractor
8	Disposal of bituminous and other wastes	Hazardous Waste (Management and Handling) Rules 1989	Local civic body to use local solid waste disposal site	Contractor
9	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act 1974	Rajasthan State Pollution Control Board	Contractor
10	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Department of Transport, Govt. of Rajasthan authorised testing centres	Contractor
11	Roof Top Rain Water Harvesting	Central Groundwater Authority (CGWA) Guidelines	Central Ground Water Authority	Contractor
10	Permission for groundwater extraction for drinking purpoes	Environment (Protection) Act, 1986	CGWA	Contractor

S. No.	Permissions/ Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency	Responsibility
11	Employing Labour/ workers	The Building and Other Construction Workers (Regulation of Employmentv and Conditions of Service) Act, 1996	District Labour Commissioner	Contractor

14.3 OBJECTIVE AND SCOPE OF THE STUDY

The objective of the study is to facilitate the Jaipur Metro Rail Corporation (JMRC) evaluate the environmental impacts of its proposed activity. The objective of the study is to conduct Environmental Impact Assessment as per requirement of FIs. The scope of EIA includes the impacts resulting from pre-construction, during construction and operation phases of India Gate (SIA) - Ambabari Metro corridor at Jaipur. In addition, it is proposed to establish environmental baseline and safeguard measures for protection of environment for sustainable development during project cycles.

14.4 APPROACH AND METHODOLOGY

The JMRC has considered different alternative corridors. The final alternative was fixed based on Technical Feasibility, Socio-economic acceptability, and Environmental sustainability for Metro Corridors. The environmental study is carried out for the alignment proposed by JMRC. The approach is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The analysis of assessment depends upon the reliable data generated/ available on environmental attributed. This study has documented the baseline data for various parameters of physical, ecological and environmental pollution (air, water and noise). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,
- Impacts due to project design,
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs were estimated and budgeted for.

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The national acts, legislation and laws along with guidelines were consulted with a view to ensuring compliance with various requirements. Environmental baseline data for environmental attributes from primary and secondary sources were collected and compiled. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the following paragraphs.

14.5 PROJECT DESCRIPTION

14.5.1 Project Area

Jaipur is the capital and largest city of Rajasthan. Jaipur is also known as Pink City. It was founded by Sh. Jai Singh-II, the ruler of Amer. It is one of the earliest planned cities of Moern India designed by Vidyadhar Bhattacharya. The metro project in Jaipur is proposed between Sitapur Industrial Area and Ambabari and Badi Chaupar to Transport Nagar. The proposed alignment would serve the city by providing connectivity between the main city and suburb areas of Jaipur. The project area also includes the maintenance depot and construction depots in addition to viaduct and station areas. Entire corridor will be elevated on India Gate (SIA) to Ambabari and The Metro corridor will have standard Guage alignment.

14.5.2 Route Alignment

The alignment between India Gate (Sitapur Industrial Area) and Ambabari has 21 stations. The depot is proposed near Dravyavati River front Park on Tonk Road in Sitapura Industrial Area.

14.5.3 Route Length and Stations

An elevated option has been adopted on the entire stretch of the proposed corridor at the centre verge of road (wherever possible) to minimize the adverse effects on the existing properties and the road network. At places, the alignment steers off the road. The details of stations have been given in respective chapter**.**

14.5.4 Boarding and Alighting

Traffic projections for different horizon years have been worked out in traffic chapter.

14.5.5 System Requirement

The entire corridor will be elevated. The issue of Broad Gauge vs. Standard Gauge for Metro in India has been debated for quite some time and the decision is in favour of Standard Gauge. On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths. Train Operation Plan has following Salient Features:

- Running of services for 19 hours of the day (5 AM to Midnight) with a station dwell time of 30 seconds,
- Make up time of 5-10% with 8-12% coasting.
- Scheduled speed for these corridors has been considered as 33 kmph

The basic unit of 3-car train comprising of DMC-TC-DMC configuration has been selected for the corridor Ambabari to India Gate for the year 2023, 2031, 2041 & 2051. Train Composition: DMC+TC+DMC

14.5.6 Construction Methodology

The segmental construction has been proposed. The superstructure of a large part of the viaduct comprises of simply supported spans. It is proposed to provide Double U or Box girders as superstructure for the viaduct as per site conditions.

14.5.7 Maintenance Depot

Depot shall be developed adjacent to Dravyavati Riverfront park on Tonk Road in an area of 27 ha. The stabling and maintenance facilities will be provided in Depot for smooth operation of the metro system. The area proposed for depot is devoid of any habitation.

14.6 ENVIRONMENTAL BASELINE DATA

Baseline environmental status in and around the proposed project depicts the existing environmental conditions of the location. Baseline data was collected for various/environmental attributes so as to compute the impacts that are likely to arise due to proposed project. Environmental Attributes and Frequency of Baseline Survey is presented in **Table 14.3.**

Table 14.3: Environmental Attributes and Frequency of Monitoring

S. No	Attribute	Parameter	No. of Samples	Source
LAND ENVIRONMENT				
1	Geology	Geological Status	---	Literature review
2	Seismology	Seismic Hazard	---	Literature review
WATER ENVIRONMENT				
3	Ground Water	Physical, Chemical and Biological parameters	10	Sampling/ Monitoring locations
4.	Surface Water	Physical, Chemical and Biological parameters	4	Sampling/ Monitoring locations
AIR, NOISE AND METEOROLOGY				
5	Ambient Air Quality	PM_{10}, SO_2, NO_x	21	Sampling/ Monitoring locations
6	Noise	Noise levels in dB (A) Leq, Lmax, Lmin, L_{10}, L_{50}, L_{90}	21	Sampling/ Monitoring locations
7	Soil Quality	Physico-chemical parameters	10	Sampling/ Monitoring locations
SOCIO-ECONOMIC				
8	Socio-economic aspects	Socio-economic profile	Once	Field Studies, Literature review.
Ecology				
9	Trees	Number	Once	Filed Studies

Sampling / Monitoring locations have been summarized in **Table 14.4 and depicted in Fig. 14.1**

Figure 14.1: Sampling and Monitoring Sites

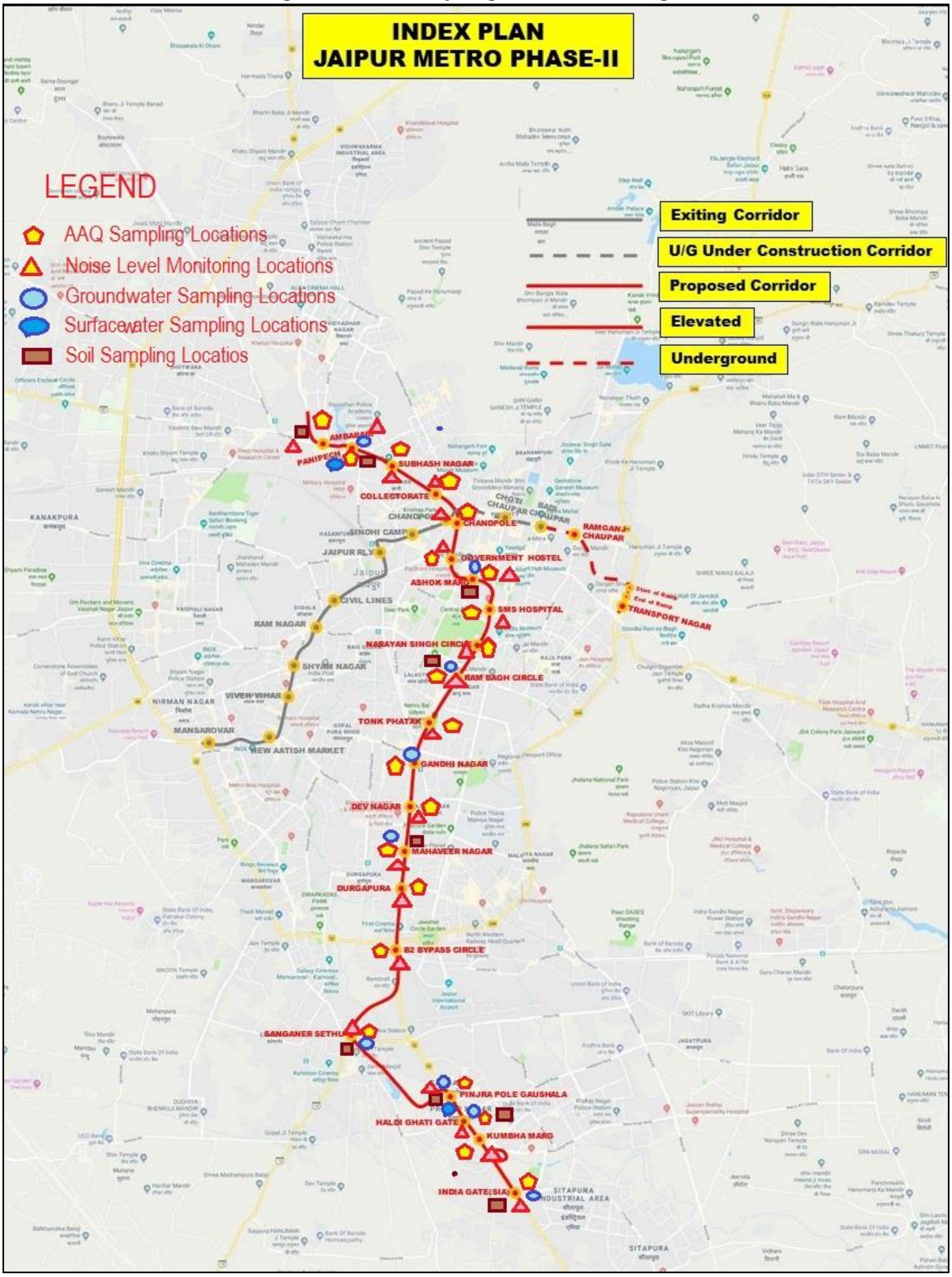


Table 14.4: Sampling / Monitoring Locations

S. No.	Air, Noise	Ground water	Surface Water	Soil
1	India Gate (SIA)	India Gate (SIA)		India Gate (SIA)
2	Kumbha Marg			
3	Haldi Ghati Gate	Haldi Ghati Gate	Dravyavati River	Depot Area
4	Pinjara Pole Gaushala	Pinjara Pole Gaushala		Pinjra Pole Gaushala
5	Sanganer Sethu	Sanganer Sethu		Sanganer Sethu
6	B2 Bypass Circle			
7	Durgapura			
8	Mahaveer Nagar	Mahaveer Nagar		Mahaveer Nagar
9	Dev Nagar			
10	Gandhi Nagar	Gandhi Nagar		
11	Tonk Phatak			
12	Ram Bagh Circle	Ram Bagh Circle		Ram Bagh Circle
13	Narayan Singh Circle			
14	SMS Hospital			
15	Ashok Marg	Ashok Marg		Ashok Marg
16	Government Hostel			
17	Chandpol			
18	Collectorate			
19	Subhash Nagar			
20	Panipech	Panipech	Dravyavati River	Panipech
21	Ambabari			Ambabari

14.7 LAND ENVIRONMENT

The Project area is situated in Jaipur. The elevation of the project area is ranging between 300 to 450 m above the mean sea level (a-MSL). Parameters involved in land environment are, physiography, geology and soils, and seismicity. These are discussed in the following paragraphs.

14.7.1 Geography, Geology and Soil

The terrain around Jaipur constitutes the southern part of Alwar basin. The Alwar and Ajabgarh Groups of the Delhi Supergroup comprising dominantly quartzites and their variants are exposed in the form of narrow ridges elongated in a NNE-SSW direction, and as isolated hills rising 300-450 mts above the surrounding alluvial and Aeolian deposits. The quartzites at places are interbedded with mica-schist. In addition, some unmapable horizons of intraformational oligomictic conglomerate and quartz veins showing different trends are also present in the area. The general strike of the rocks is NNE-SSW to NNW-SSE with dips towards east and west.

14.7.2 Seismicity

Jaipur lies very close to the seismically active zone around Koyna Dam, about 100 km south of the city, and has been rated in Zone 2 (on a scale of 2 to 5, with 5 being the most prone to earthquakes) by the India Meteorological Department.

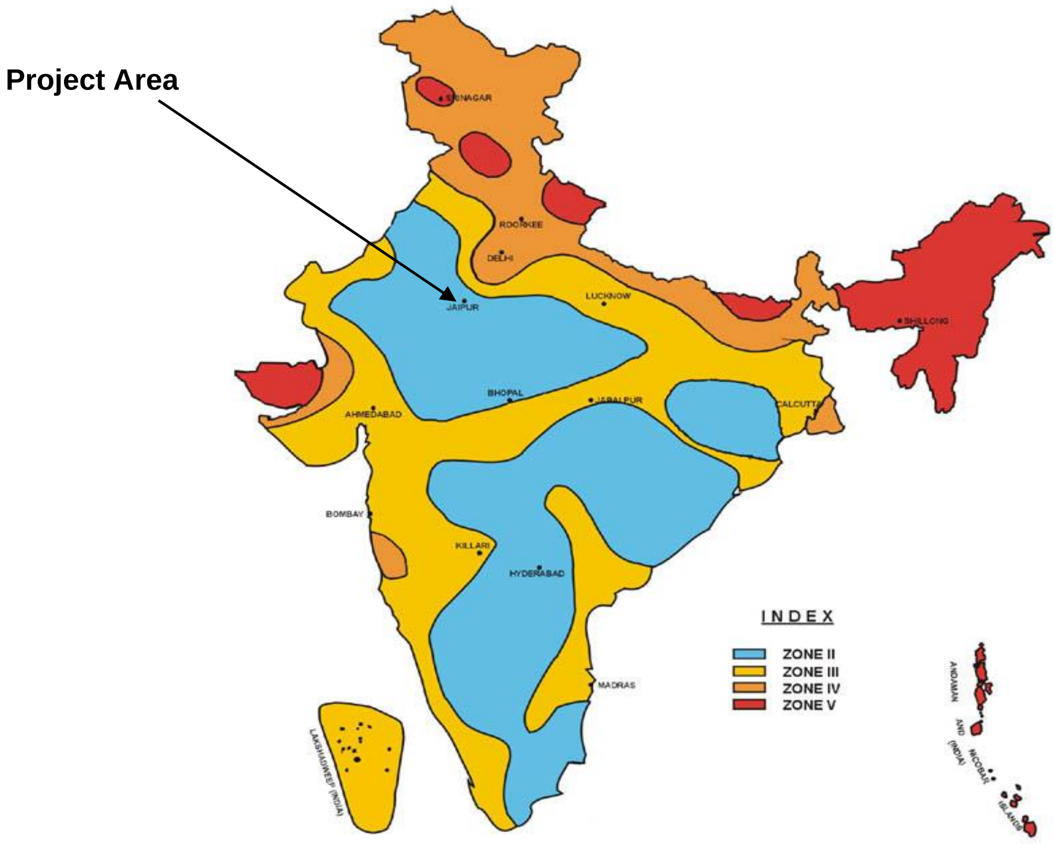


Figure 14.2

14.8 WATER ENVIRONMENT

Water environment consists of water resources and its quality. Its study is important from the point of view of assessing the sufficiency of water resources for the needs of the project in its various stages of the project cycle and also to assess the impact of the project on water environment. In the proposed project, ground water is proposed to be used during operations to meet out domestic water requirements of the project in case water is not made available by Jaipur Municipal Corporation (JMC). Hence its quality has been tested to evaluate its suitability for the intended purpose. Anticipated impacts of the proposed project on water environment have also been addressed.

14.8.1 Water Resources

Jaipur, the capital of Rajasthan is one of India's modern cities with 3.1 million (Census 2011) residents. Jaipur is largely dependent on groundwater for its drinking water supply: 90% of the total drinking water demand of the city is dependent on groundwater, while 10% is supplied from the Ramgarh Lake situated 35 km from the city. The water supply in the city is maintained by Public Health Engineering Department (PHED) Rajasthan. The depth of the ground water table varies from 15 to 40 m with seasonal variations of 1 to 3m. There are 990 tube wells over the city through which 276 million litres per day (mld) of raw water is fetched.

Ramgarh Lake is the only surface water source of the city. It is an impounded reservoir located 35 km northeast of the city. The lake is dependent on rainfall for its water supply. It was constructed in 1903 with a gross storage capacity of 2650 million cubic feet. Due to the semi-arid climate zone, rainfall is sparse. Thus the lake almost dried up. Presently about 0.13 mld water is taken from the lake due to erratic rainfall.

14.8.2 Hydrogeology and Ground Water

Gneisses and schists of Bhilwara Super Group are the oldest rock types overlain by quartzites, schists, conglomerates, dolomitic limestone etc belonging to Alwar and Ajabgarh Groups of Delhi Super Group along with granite, pegmatite and amphibolite intrusives of Post Delhi age. Hard rocks in major parts of the Jaipur district are covered by Quaternary fluvial and aeolian deposits mainly composed of sand, silt, clay, gravel and kankar. Alluvial thickness is less in southern and southwestern parts of the district i.e. in Naraina, Sakhun, Dudu, Mozamabad, Phagi, Chaksu areas etc. Alluvial thickness between 90 and 100m has been observed at Chomu, Jairampura, Nangal Bharra, Dhaunauta areas whereas its thickness over 100m has been found at Risani village (104m).

In the northern part of the Jaipur district, altitude of bedrock ranges from 426.72 mamsl at Mairh to 276.82 mamsl at Kotputli indicating northerly sloping bed rock. In the north-western and western parts, altitude of bedrock varies from 446 mamsl at Kariri (Shahpura) to 337 mamsl at Dhani Boraj (Sambhar block) showing south-westerly sloping bed rocks. Around Jaipur urban area, altitude is higher at Harmada area (417.11 mamsl) with southerly and southeasterly sloping bedrock and low altitudes of bedrock have been observed as 310.79 mamsl at Chandlai and 273.47 mamsl at Kotkaoda in Chaksu block.

Groundwater in the district occurs both in unconsolidated Quaternary formations and consolidated formations of Bhilwara and Delhi Super Groups and also Post Delhi Granites. In greater part of the district, alluvial deposits comprising of mainly fine sand and silt serve as potential aquifers in addition to gravel zones as encountered at Sanganer, Ambabari, Bajaj Nagar (Jaipur city) and Shahpura, Dhanauta, Nayan, Kalyanpur, Mohana and Chandalai. Groundwater at shallow depth occurs under water table condition and under semi-confined conditions at depth. Talus and scree deposits at foothills form potential aquifer at places including Banskho in Bassi block and parts of Amber, Jamwa Ramgarh and Govindgarh blocks. Yield of wells in these formations ranges from 100 to 500 m3/day. Hard rocks of Bhilwara Super Group, comprising of granulitic gneisses, quartz mica schist, phyllite along with granite and pegmatite intrusives, form main aquifers in southern and south western parts of the district in Dudu, Phagi and Chaksu blocks. Similarly, quartzite, schist and phyllite of Delhi Super Group form aquifers in Jamwa Ramgarh, Bairath, Kotputli, Shahpura, Amer and Bassi blocks. Movement of groundwater in these hard rocks is controlled by size, continuity and interconnectivity of weathered and fractured parts and other secondary porosities. Depth of wells in the district generally varies from 50 to 100m in alluvium and 50 to 200m in combination/consolidated formation areas. Specific capacity of wells varies from 58 to 500 lpm/m. Transmissivity value and storage coefficient varies from 10 to 850m2/d and 4.70 x 10-5 to 1.05x 10-3 respectively. A map depicting hydrogeological features is presented as **Figure 14.3**.

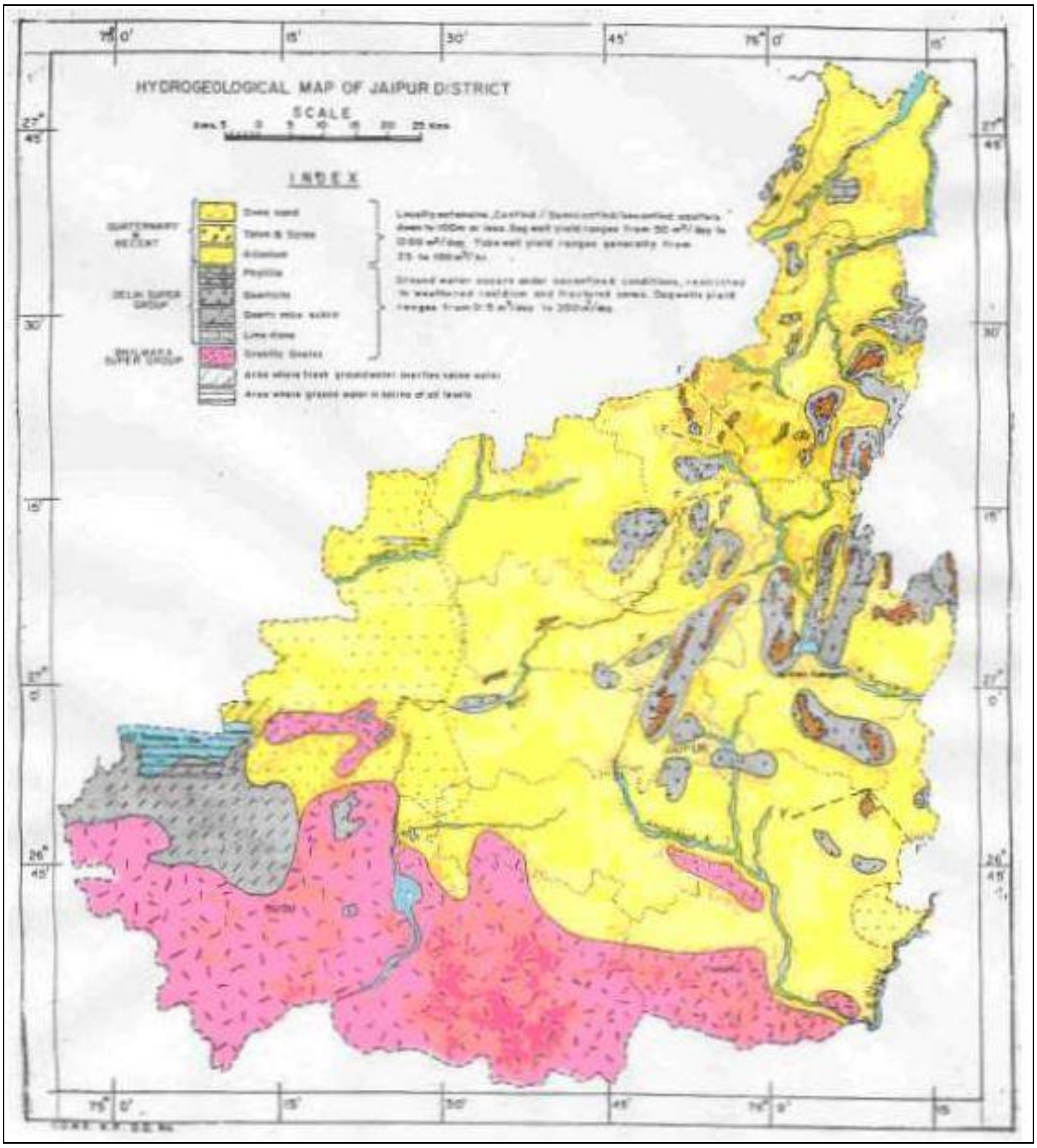


Fig 14.3 Hydrogeological Map of Jaipur District

14.8.3 Water Quality

Water quality is the physical, chemical and biological characteristics of water. Water quality has been given in **Table 14.5 (A, B and C).** Groundwater quality is quite good. However, total dissolved solids are a little higher than the desirable limits but within permissible limits. All other parameters are well within the desirable limits.

Table 14.5 A: Ground Water Quality at Project Site (India Gate, Haldi Ghati Gate and Pinjra Pole Gaushala)

Physical Parameters	Results			*Limits*
Sample	**India Gate**	**Haldi Ghati Gate**	**Pinjra Pole Gaushala**	
Colour, Hazen	Colourless	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity, NTU	3.6	3.5	3.3	1 (5) Max
pH	7.87	7.86	7.59	6.5-8.5 Max
Total Hardness as $CaCO_3$, Mg/l	258	266	256	200 (600) Max
Chloride as Cl, Mg/l	161	149	164	250 (1000) Max
Total Iron as Fe, Mg/l	0.08	0.09	0.07	0.3 Max
Total Dissolved Solids, Mg/l	1288	1357	1425	
Sulphates as SO_4, Mg/l	179	111	98	
Nitrates as NO_3, Mg/l	41.1	37.7	34.9	45 Max
Fluorides as F, Mg/l	3.22	2.35	2.39	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	BDL	0.01 Max
Copper as Cu, Mg/l	BDL	BDL	BDL	0.05 (1.5) Max
Manganese as Mn, Mg/l	BDL	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C_6H_5OH, Mg/l	BDL	BDL	BDL	0.001 (0.002) Max
Mercury as Hg, Mg/l	BDL	BDL	BDL	0.001 Max
Cadmium as Cd, Mg/l	BDL	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	BDL	0.01 Max
Arsenic as As, Mg/l	BDL	BDL	BDL	0.05 Max
Cyanide as Cn, Mg/l	BDL	BDL	BDL	0.05 Max
Zinc as Zn, Mg/l	1.74	1.32	1.23	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6, Mg/l	BDL	BDL	BDL	0.05 Max
Total Alkalinity as $CaCO_3$, Mg/l	189.3	181.2	191.7	200 (600) Max
Aluminum as Al, Mg/l	BDL	BDL	BDL	0.03(2) Max
Boron as B, Mg/l	BDL	BDL	BDL	0.5(1) Max
Bacteriological Analysis Coliform, MPN/100Ml E-Coli/Ml	Nil Negative	Nil Negative	Nil Negative	10 Max Negative

Table 14.5 B: Ground Water Quality at Project Site (Sanganer Sethu, Mahavir Nagar and Gandhi Nagar)

Physical Parameters	**Results**			***Limits***
Sample	**Sanganer Sethu**	**Mahavir Nagar**	**Gandhi Nagar**	
Colour, Hazen	Colourless	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity, NTU	3.6	3.5	3.3	1 (5) Max
pH	7.87	7.86	7.59	6.5-8.5 Max
Total Hardness as $CaCO_3$, Mg/l	258	266	256	200 (600) Max
Chloride as Cl, Mg/l	161	149	164	250 (1000) Max
Total Iron as Fe, Mg/l	0.08	0.09	0.07	0.3 Max
Total Dissolved Solids, Mg/l	1226	1137	1342	
Sulphates as So4, Mg/l	165	129	107	
Nitrates as NO_3, Mg/l	61.1	47.7	43.6	45 Max
Fluorides as F, Mg/l	2.92	2.78`	2.51	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	BDL	0.01 Max
Copper as Cu, Mg/l	BDL	BDL	BDL	0.05 (1.5) Max
Manganese as Mn, Mg/l	BDL	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C_6H_5OH, Mg/l	BDL	BDL	BDL	0.001 (0.002) Max
Mercury as Hg, Mg/l	BDL	BDL	BDL	0.001 Max
Cadmium as Cd, Mg/l	BDL	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	BDL	0.01 Max
Arsenic as As, Mg/l	BDL	BDL	BDL	0.05 Max
Cyanide as Cn, Mg/l	BDL	BDL	BDL	0.05 Max
Zinc as Zn, Mg/l	1.63	1.43	1.74	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6, Mg/l	BDL	BDL	BDL	0.05 Max
Total Alkalinity as $CaCO_3$, Mg/l	185.1	173.2	182.4	200 (600) Max
Aluminum as Al, Mg/l	BDL	BDL	BDL	0.03(2) Max
Boron as B, Mg/l	BDL	BDL	BDL	0.5(1) Max
Bacteriological Analysis Coliform, MPN/100Ml E-Coli/Ml	Nil Negative	Nil Negative	Nil Negative	10 Max Negative

Table 14.5 C: Ground Water Quality at Project Site (Ram Bagh Circle, Ashok Marg and Panipech)

Physical Parameters	Results			*Limits*
Sample	**Ram Bagh Circle**	**Ashok Marg**	**Panipech**	
Colour, Hazen	Colourless	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity, NTU	4.6	3.2	3.8	1 (5) Max
pH	7.92	7.94	7.77	6.5-8.5 Max
Total Hardness as $CaCO_3$, Mg/l	358	296	251	200 (600) Max
Chloride as Cl, Mg/l	178	156	159	250 (1000) Max
Total Iron as Fe, Mg/l	0.07	0.09	0.11	0.3 Max
Total Dissolved Solids, Mg/l	1425	1098	1393	
Sulphates as SO_4, Mg/l	179	132	128	
Nitrates as NO_3, Mg/l	39.9	37.8	42.1	45 Max
Fluorides as F, Mg/l	2.92	2.29	2.52	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	BDL	0.01 Max
Copper as Cu, Mg/l	BDL	BDL	BDL	0.05 (1.5) Max
Manganese as Mn, Mg/l	BDL	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C_6H_5OH, Mg/l	BDL	BDL	BDL	0.001 (0.002) Max
Mercury as Hg, Mg/l	BDL	BDL	BDL	0.001 Max
Cadmium as Cd, Mg/l	BDL	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	BDL	0.01 Max
Arsenic as As, Mg/l	BDL	BDL	BDL	0.05 Max
Cyanide as Cn, Mg/l	BDL	BDL	BDL	0.05 Max
Zinc as Zn, Mg/l	1.79	1.42	1.38	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6, Mg/l	BDL	BDL	BDL	0.05 Max
Total Alkalinity as $CaCO_3$, Mg/l	179.3	172.1	181.4	200 (600) Max
Aluminum as Al, Mg/l	BDL	BDL	BDL	0.03(2) Max
Boron as B, Mg/l	BDL	BDL	BDL	0.5(1) Max
Bacteriological Analysis Coliform, MPN/100Ml E-Coli/Ml	Nil Negative	Nil Negative	Nil Negative	10 Max Negative

14.9 METEOROLOGY

14.9.1 General

Jaipur has a monsoon influenced hot semi-arid climate (Köppen climate classification *Bsh*) with long, extremely hot summers and short, mild to warm winters. Annual precipitation is over 63 cm, falling mostly in July and August due to monsoon, causing the average temperatures in these two months to be lower compared to drier May and June. During the monsoon, there are frequent, heavy rains and thunderstorms, but flooding is not common. The highest temperature ever recorded was 48.5 °C, in May. The city's average temperature remains below 20 °C between December and February. These months are mild, dry and pleasant, sometimes chilly. Jaipur, like many other major cities of the world, is a significant urban heat island zone with surrounding rural temperatures occasionally falling below freezing in winters.

14.9.2 Temperature

The temperature data for Jaipur has been taken. The month-wise minimum & maximum temperatures have been given in **Table 14.6**.

Table 14.6: Temperature at Jaipur Airport in ºC

Month	Average Max	Maximum	Average Low	Minimum
January	22.4	31.7	8.4	(-) 2.2
February	25.0	36.7	10.8	(-) 2.2
March	31.0	42.8	16.0	3.3
April	37.1	44.9	21.8	9.4
May	40.3	48.5	25.9	15.6
June	39.3	47.2	27.4	19.1
July	34.1	46.7	25.8	20.6
August	32.4	41.7	24.7	18.9
September	33.8	41.7	23.2	15.0
October	33.6	40.0	19.4	11.1
November	29.2	36.1	13.8	3.3
December	24.4	31.3	9.2	0.0
Annual	31.9	48.5	18.9	(-) 2.2

Source: Indian Meteorological Department

14.9.3 Rainfall

The detail of rainfall at Jaipur is shown in following **Table 14.7**

Table 14.7: Rainfall in mm

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
2005	1.8	3.6	13.6	13.9	16	148.4	226.4	22.1	139.7	0	0	0	585.5
2006	0	0.2	7.1	0.2	24.9	36.4	159.7	41.8	38.3	0.9	0	0	309.5
2007	0.6	8.2	10	0.4	2.5	25.1	113	160	100.1	0	0	0.2	420.1
2008	0	0	0	7	13	166.3	120.1	132.7	114.3	0.2	0	0	553.6
2009	0	0	1.6	0.3	3	33.6	114.2	102.2	36.6	3.5	3.1	0	298.1
2010	1.8	2.6	0	2.1	1.3	15.9	204.3	325	165.3	0.4	73.1	4.1	795.9

Source: Indian Meteorological Department

14.10 AIR ENVIRONMENT

The atmospheric concentrations of air pollutants were monitored at 21 locations near each station of the proposed alignment during January 2020. Air Monitoring was carried out for PM_{10}, NOx, SO_2 and CO. Results of the air quality monitoring are presented in **Table 14.8.**

Table 14.8: Ambient Air Quality Results µg/m³

S. No.	Location	$PM_{2.5}$	PM_{10}	NOx	SO_2	CO
	Regulatory Standards 24 Hrs	**60**	**100**	**80**	**80**	**2000**
1	India Gate	40	88	25.2	31.6	845
		43	86	23.7	29.4	922
2	Kumbha Marg	39	75	23.5	33.6	1214
		42	87	26.1	33.5	939
3	Haldi Ghati Gate	48	112	24.2	36.1	1230
		42	90	21.5	33.5	995
4	Pinjra Pole Gaushala	52	120	26.3	31.7	1110
		53	124	27.5	33.2	1149
5	Sanganer Sethu	53	125	28.5	31.2	1155
		47	112	24.6	34.1	1139
6	B2 Byepass Circle	42	101	25.6	25.4	1211
		49	123	28.4	35.1	1044
7	Durgapura	43	107	20.6	26.4	1117
		46	113	22.3	30.4	1210
8	Mahaveer Nagar	48	119	18.5	27.2	970
		45	108	19.2	26.4	920
9	Dev Nagar	40	89	21.4	29.6	1010
		42	92	23.7	30.2	1124
10	Gandhi Nagar	38	77	17.4	25.1	1112
		38	82	16.3	25.6	1221
11	Tonk Phatak	37	77	18.4	23.9	960
		36	72	15.3	21.7	990
12	Ram Bagh Circle	44	80	17.2	22.4	1072
		44	85	18.3	26.1	930
13	Narayan Singh Circle	46	98	22.2	31.4	1204
		47	96	22.4	32.2	1127
14	SMS Hospital	43	91	24.1	31.2	1223
		44	95	24.7	33.6	1310
15	Ashok Marg	45	99	25.4	32.3	1202
		44	93	21.7	31.5	1123
16	Government Hostel	43	89	22.8	24.2	1032
		44	92	21.7	22.3	1126
17	Chandpole	37	78	17.8	23.1	1112
		39	83	15.8	22.6	1215
18	Collectorate	35	76	18.7	23.4	916

S. No.	Location	$PM_{2.5}$	PM_{10}	NOx	SO_2	CO
		37	72	16.3	20.7	940
19	Subhash Nagar	45	83	17.7	22.7	1079
		45	84	18.6	24.1	838
20	Panipech	48	89	23.2	31.1	1118
		47	94	26.4	31.2	1273
21	Ambabari	43	96	23.1	32.2	1209
		41	99	24.5	34.6	1301

The results show that the concentration of Respirable Suspended Particulate Matter (PM_{10}) is higher at all the locations whereas all other parameters are within permissible limits.

14.11 NOISE ENVIRONMENT

Noise is responsible for adverse impacts on physical and mental health of the people. The other impacts are:

- Physiological effects,
- Hearing impairment,
- Communication interference, and
- Sleep disruption

Noise level survey was conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. Noise levels were measured at four locations in January 2019 for 24 hours. The noise levels so obtained are summarized in **Table 14.9.**

Table 14.9: Noise Levels

Location	Day/ Night	L Max	L Min	Leq	L_{10}	L_{50}	L_{90}
India Gate	Day	80.5	58.7	73.2	76.5	64.7	61.4
	Night	72.3	45.5	59.4	67.9	53.2	50.8
Kumbha Marg	Day	81.5	58.3	69.1	74.5	63.9	61.1
	Night	72.9	46.6	57.5	61.2	56.2	53.9
Haldi Ghati Gate	Day	83.8	58.6	70.5	73.2	69.1	61.4
	Night	74.1	54.6	66.9	73.4	64.2	59.3
Pinjra Pole Gaushala	Day	92.2	56.0	71.8	75.3	66.3	62.5
	Night	84.5	51.9	62.3	69.2	60.4	55.2
Sanganer Sethu	Day	85.7	67.3	77.3	80.9	74.0	70.2
	Night	79.4	51.2	63.2	71.9	59.3	54.0
B2 Byepass Circle	Day	84.0	59.3	73.1	78.7	65.4	61.9
	Night	80.7	46.8	61.9	75.6	54.8	51.1
Durgapura	Day	87.9	53.5	71.4	67.8	66.5	61.7
	Night	79.5	48.4	63.2	69.6	61.3	56.1
Mahaveer Nagar	Day	85.7	57.8	70.5	79.7	66.5	61.6
	Night	71.6	46.2	55.9	67.2	54.2	51.7

Location	Day/ Night	L Max	L Min	Leq	L_{10}	L_{50}	L_{90}
Dev Nagar	Day	81.6	56.9	74.1	78.9	67.6	62.7
	Night	77.5	51.8	69.9	73.2	65.2	59.7
Gandhi Nagar	Day	89.7	53.5	69.2	75.6	62.9	59.0
	Night	78.9	46.4	60.1	73.5	57.7	52.1
Tonk Phatak	Day	86.3	58.1	75.5	81.8	68.7	63.6
	Night	78.0	43.9	57.4	65.9	51.3	49.1
Ram Bagh Circle	Day	85.6	56.3	73.7	82.6	64.9	60.8
	Night	73.5	44.6	52.0	63.3	49.8	46.1
Narayan Singh Circle	Day	92.2	51.0	71.4	86.2	67.4	59.6
	Night	85.2	45.4	56.7	61.7	53.0	47.9
SMS Hospital	Day	86.7	63.1	78.9	83.4	76.4	66.9
	Night	79.7	46.5	61.7	66.3	59.1	53.9
Ashok Marg	Day	83.5	52.1	62.4	76.3	59.8	58.8
	Night	78.7	48.9	59.6	63.7	55.7	51.7
Government Hostel	Day	87.7	53.5	69.2	75.6	62.9	59.0
	Night	72.9	46.4	60.1	73.5	57.7	52.1
Chandpole	Day	86.3	58.1	75.5	81.8	68.7	63.6
	Night	68.0	43.5	56.4	62.9	53.3	46.3
Collectorate	Day	85.1	51.3	70.7	81.6	62.9	57.8
	Night	67.5	44.1	52.1	60.3	49.7	45.6
Subhash Nagar	Day	83.2	51.0	70.4	81.2	64.4	55.6
	Night	70.2	45.9	54.7	61.9	53.1	47.7
Panipech	Day	86.7	63.1	78.9	83.4	76.4	66.9
	Night	79.7	46.5	61.7	66.3	59.1	53.9
Ambabari	Day	83.5	52.1	62.4	76.3	59.8	58.8
	Night	78.7	48.9	59.6	63.7	55.7	51.7

Allowable Noise Levels dB (A):

Category of Area/Zone	Day Time	Night Time	
Industrial Area	75	70	EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition
Commercial Area	65	55	
Residential Area	55	45	
Silence Area	50	40	

Day Time (6.00 Am-10.00 Pm); Night Time (10.00 PM-6.00AM)

The observed noise level is higher than the permissibble limits at all locations which may be due to heavy traffic movement and other activities on the roads.

14.12 TREES

Tree survey has been carried out along the proposed alignment. Tree with Girth at Breast Height (GBH) 30 cm have been counted. The alignment does not pass through any forest area. A total of 485 trees are located along the alignment, station area and Depot land. Thus, there is likelihood of felling of 485 trees. No endangered species of trees have been noticed during field survey. Trees have been found of indigenous and common species like Pipal, Mango, Jamun, Neem, Palm, Babool, Ber, Gulmohar etc. Details of Trees at different locations are given in Table 14.10.

Table 14.10 Details of Trees in ROW of India Gate- Ambabari Metro Corridor

S.No.	Location	No. of Trees
1	India Gate (SIA) to Pinjara Pole Gaushala	3
2	Pinjara Pole Gaushala	43
3	Gaushala to STP	49
4	STP to Tonk Road (Estimated)	40
5	Dev Nagar to Ashok Marg	14
6	Ashok Marg to Parmanand Hall	81
7	Chandpole to River	25
8	River Bank to Dead End	35
9	Depot Area	195
	Total	**485**

14.13 FLORA AND FAUNA

The ecological study was undertaken to understand the present status of ecosystem of the area, to predict changes as a result of proposed activities and to suggest measures for maintaining the conditions. This carried through secondary data collected from secondary sources like literature of Forest Department, Agriculture Department etc. List of Flora and Fauna in Jaipur is given in **Table 14.11.**

Table 14.11: List of Flora and Fauna

Common Name	Scientific Name	Family
A. FLORA		
Amba	Mangifera indica	Anacardiaceae
Sitaphal	Annona squamosa L.	Annonaceae
Ashok	Polyalthia longifolia	Annonaceae
Saptaparni	Alstonia scholaris	Apocynaceae
Kaner	Nerium indicum	Apocynaceae
Sadaphuli	Vinca rosea	Apocynaceae
Tad	Borassus fabellifer	Arecaceae
Rui	Calotropis gigantea	Asclepiadaceae
Dagadipala	Tridax procumbens	Asteraceae
Cassia	Cassia javanica	Caesalpiniaceae
Cassia	Cassia siamea	Caesalpiniaceae
Gulmohar	Delonix regia	Caesalpiniaceae
Chinch	Tamarindus indica	Caesalpiniaceae
Suru	Casuarina equisetifolia	Casuarinaceae
Palash	Butea monosperma	Fabaceae
Gokarna	Clitoria ternatea	Fabaceae
Shisham	Dalbergia sisso	Fabaceae

Common Name	Scientific Name	Family
Karanj	Pongamia pinnata	Fabaceae
Mehndi	Lawsonia inermis	Lythraceae
Jaswand	Hibiscus rosasinensis	Malvaceae
Bakan neem	Melia azedarach	Meliaceae
Kala shirish	Albizia lebbeck	Mimosaceae
Vad	Ficus benghalensis	Moraceae
Umbar	Ficus glomerata	Moraceae
Pipal	Ficus religiosa	Moraceae
Shevga	Moringa oleifera	Moringaceae
Nilgiri	Eucalyptus globulus	Myrtaceae
Jambhul	Eugenia jambolana	Myrtaceae
Boganvel	Bouganvillea spectabilis	Nyctaginaceae
Surwal	Andropogan contortus	Poaceae
Rohis	Andropogon martinii	Poaceae
Dub	Cynodon dactylon	Poaceae
Bordi	Zizyphus jujuba	Rhamnaceae
Bor	Zizyphus mauritiana	Rhamnaceae
Bakul	Mimusops elengi	Sapotaceae
B. FAUNA		
a. Birds		
Sparrow hawk	Accipitter nisus	Accipitridae
Pariah Kite	Milvus migrans	Accipitridae
Common Blue Kingfisher	Alcedo atthis	Alcedinidae
Common Sandpiper	Tringa hypoleucos	Cacanidae
Redwattled Lapwing	Vanellus indicus	Cacanidae
Indian Ring Dove	Streptopelia decaocta	Columbidae
Blue Rock Pigeon	Columba livia	Columbidie
House Crow	Corvus splendens	Corvidae
Crow pheasnt	Centropus sinensis	Cuculidae
Koel	Eudynamys scolopacea	Cuculidae
Swallow	Hirundo rustica	Hirundinidae
Magpie robin	Copsychus saularis	Muscicapinae
Indian Robin	Saxicoloides fulicata	Muscicapinae
House Sparrow	Passer domesticus	Ploceidae
Baya	Ploceus philippinus	Ploceidae
Rose-ringed Parakeet	Psittacula krameri	Psittacidae
Redvented Bulbul	Pycnonotus cafer	Pyconotidae
Common Myna	Acridotheres tristis	Sturnidae
b. Mammals		
Common Langur	Presbetis entellus	Cercopithecidae
Five stripped Squirrel	Funambulus penanti	Sciuridae
c. Reptiles		
Common garden lizard	Calotes versicolour	Agamidae

14.14 SOCIO- ECONOMIC CONDITIONS

Socially and culturally this area is cosmopolitan in nature. According to provisional report of 2011 census, Jaipur city had a population of 3,073,350. The overall literacy rate for the city is 84.34%. 90.61% males and 77.41% females were literate. The sex ratio was 898 females per 1,000 males. The child sex ratio stood at 854. According to the 2011 census, Hindus form the majority religious group comprising 77.9% of the city's population, followed by Muslims (18.6%), Jains (2.4%) and others (1.2%).

Jaipur Municipal Corporation is responsible for maintaining the city's civic infrastructure and carrying out associated administrative duties. The Municipal Corporation is headed by a mayor. There are 91 wards and each ward is represented by an elected member. Jaipur Development Authority (JDA) is the nodal government agency responsible for the planning and development of Jaipur.

Jaipur is a major tourist destination in India forming a part of the Golden Triangle. Jaipur Exhibition & Convention Centre (JECC) is Rajasthan's biggest convention and exhibition centre. It is famous for organising events such as Vastara, Jaipur Jewellery Show, Stonemart 2015 and Resurgent Rajasthan Partnership Summit 2015. Visitor attractions include the Hawa Mahal, Jal Mahal, City Palace, Amer Fort, Jantar Mantar, Nahargarh Fort, Jaigarh Fort, Birla Mandir, Galtaji, Govind Dev Ji Temple, Garh Ganesh Temple, Moti Dungri Ganesh Temple, Sanghiji Jain temple and the Jaipur Zoo. The Jantar Mantar observatory and Amer Fort are one of the World Heritage Sites. Hawa Mahal is a five-storey pyramidal shaped monument with 953 windows that rises 15 metres (50 ft) from its high base. Sisodiya Rani Bagh and Kanak Vrindavan are the major parks in Jaipur. Raj Mandir is a notable cinema hall in Jaipur.

Jaipur has many cultural sites like Jawahar Kala Kendra formed by Architect Charles Correa and Ravindra Manch. Government Central Museum hosts several arts and antiquities. There is a government museum at Hawa Mahal and an art gallery at Viratnagar. There are statues depicting Rajasthani culture around the city. Jaipur has many traditional shops selling antiques and handicrafts. The prior rulers of Jaipur patronised a number of arts and crafts. They invited skilled artisans, artists and craftsmen from India and abroad who settled in the city. Some of the crafts include bandhani, block printing, stone carving and sculpture, tarkashi, zari, gota-patti, kinari and zardozi, silver jewellery, gems, kundan, meenakari and jewellery, Lakh ki Chudiya, miniature paintings, blue pottery, ivory carving, shellac work and leather ware.

14.15 SOCIO-ECONOMIC SURVEY

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed metro alignment on their conditions. There can be two types of impacts on the PAPs. One is the displacement of residential house and another is displacement of commercial establishments. The survey has been undertaken on the corridors using structured questionnaire in December 2019 and January 2020.

There are 11 residential Pucca buildings along Dravyavati River near Gaushala and Ambabari. Additionally, there are 6 small shops having 15 employees. Another 9 small tin structures and two sheds are there at different locations. Part of 1 Kapda mill is also likely to be affected by the proposed alignment between between India Gate SIA) and Ambabari. Parmanand Hall near Government Hostel is also likely to be acquired and dismantled. The valuation of all the properties will be done by PWD. Additionally, these shall be compensated as per the provision of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resttlement Act, 2013.

14.16 ARCHAEOLOGICAL SITES

There are many state protected monuments and National Monuments in Jaipur. None of them is likely to be affected directly by the alignment. They are very far off from the corridor alignment. **Table 14.12** gives the List of Achaeological monuments in Jaipur. These monuments are located away from the proposed alignment between India Gate (SIA) and Ambabari.

Table 14.12 A: List of Archaeological Monuments in Jaipur District

SL. No.	Description	Location
State Protected Monuments		
S-RJ-48	Jal Mahal	Jaipur
S-RJ-91	Albert Hall, Ram Niwas Bagh	Jaipur
S-RJ-92	Jyotish Yantralaya, also known as Jantar Mantar	Jaipur
S-RJ-93	Sudarshana/Nahar Garh	Jaipur
S-RJ-94	Isarlat	Jaipur
S-RJ-95	Hawa Mahal	Jaipur
S-RJ-96	Cenotaphes of Gaitore	Jaipur
S-RJ-97	Temples of Galta	Jaipur
S-RJ-98	Bala Nand ji Temple	Jaipur
S-RJ-99	Queens Cenotaphs (Amer road)	Jaipur
S-RJ-100	Brijnand ji Temple	Jaipur
S-RJ-101	Charan Mandir	Jaipur
S-RJ-102	Rampart including all gates of old Jaipur City	Jaipur
S-RJ-103	Sanganer Temple	Jaipur
S-RJ-104	Cenotaphs at Station Road	Jaipur
S-RJ-105	Wall Paintings of Samod Haveli Purani Basti	Jaipur
S-RJ-106	Wall Paintings of Purohit Ji ki Haveli Purani Basti	Jaipur
S-RJ-107	Sun Temple Galta Hill	Jaipur

SL. No.	Description	Location
State Protected Monuments		
S-RJ-108	Kalki Temple Sirehdeorhi Bazar	Jaipur
S-RJ-109	Bhawani Rao Bohara's House Ghat ki Gooni	Jaipur
S-RJ-110	Sisodia Maharani Temple Ghat ki Gooni	Jaipur
S-RJ-111	Wall Paintings of Janana Ghat Galta	Jaipur
S-RJ-112	Sun Temple Galta	Jaipur
S-RJ-113	Krishna Deva Payahari Ki Gufa Galta	Jaipur
S-RJ-114	Akabar Ke Kos Chinha	Jaipur
S-RJ-115	Wall Paintings of Chhatari near Prachin Govind Devaji ka Temple Amber Ghati	Jaipur
S-RJ-116	Prachin Govind Devaji ka Temple Amber Ghati	Jaipur
S-RJ-117	Kalyan ji Temple Amber	Jaipur
S-RJ-118	Sun Temple, Amber	Jaipur
S-RJ-119	Amber Palace on Hill, Amber	Jaipur
S-RJ-120	Cenotaphs at Shahpur Road, Amber	Jaipur
S-RJ-121	Prachin Mahal below Hill, Amber	Jaipur
S-RJ-122	Panna Miyan Ka Kund, Amber	Jaipur
S-RJ-123	Dalaram Garden, Amber	Jaipur
S-RJ-124	Mohan Bari, Amber	Jaipur
S-RJ-125	Sanghi Temple, Amber	Jaipur
S-RJ-126	Narisingha Temple, Amber	Jaipur
S-RJ-127	Rampart of old Amber town, Amber	Jaipur
S-RJ-128	Mughal Gate	Jaipur
S-RJ-129	Sheesh Mahal of Samod Palace	Jaipur
S-RJ-130	Jamwa Mata Temple	Jaipur
S-RJ-131	Wall Paintings of Chhatri	Jaipur
S-RJ-132	Prachin Baori	Jaipur
S-RJ-133	Chomu Fort	Jaipur
S-RJ-134	Nakati Mata Temple	Jaipur
S-RJ-135	Nayala Fort	Jaipur
S-RJ-136	Nayala Palace	Jaipur
S-RJ-137	Town hall	Jaipur

Table 14.12 B: Monuments of National Importance

SL. No.	Description	Location
N-RJ-79	Sun Temple	Amber
N-RJ-80	Jama Masjid	Amber
N-RJ-81	Laxmi Narain's Temple	Amber
N-RJ-82	Sri Jagat Siromani ji temple	Amber
N-RJ-83	Pundrik ji-ki-Haveli Paintings in a room	Brahmpuri
N-RJ-84	Temple containing Fresco paintings	Gulta ji
N-RJ-85	Excavated Site	Sambhar
N-RJ-86	Excavated Site	Bairat
N-RJ-163	Fortress known as Medhaji-ka-Mahal	Jamwa Ramgarh

14.17 ENVIRONMENTAL IMPACTS ASSESSMENT

14.17.1 General

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible. Negative impacts likely to result from the proposed development have been listed under the following headings:

- Impacts due to Project Location;
- Impacts due to Project Design;
- Impacts due to Construction; and
- Impacts due to Project Operation.

14.17.2 Environmental Impacts

This section identifies and appraises the negative impacts on various aspects of the environment likely to result from the proposed development. It is pertinent to mention that the negative environmental impacts listed below are based on the assumption that no negative impact mitigation measure or benefit enhancements are adopted.

- Land Environment
- Water Environment
- Air Environment
- Noise Environment
- Biological Environment
- Socio-Economic Environment

The impacts on the above environmental components have been further assessed during various phases of project cycle namely project location, project design, construction and operation.

14.18 IMPACTS DUE TO PROJECT LOCATION

During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed. These impacts are:

- Project Affected People (PAPs)
- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems,
- Socio-economic impacts;
- Impact on Historical and Cultural Monuments;

14.18.1 Project Affected People (PAPs)

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed metro alignment on their conditions. There can be two types of impacts on the PAPs. One is the displacement of residential house and another is displacement of commercial establishments. The survey has been undertaken on the corridors using structured questionnaire in December 2019.

There are 11 residential Pucca buildings along Dravyavati River near Gaushala and Ambabari. Additionally, there are 6 small shops having 15 employees. Another 9 small tin structures and two sheds are there at different locations. Part of 1 Kapda mill is also likely to be affected by the proposed alignment between between India Gate SIA) and Ambabari. Parmanand Hall near Government Hostel is also likely to be acquired and dismantled. The valuation of all the properties will be done by PWD. Additionally, these shall be compensated as per the provision of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resttlement Act, 2013.

14.18.2 Change of Land Use

The details of land required (permenant and temporary) and change in land use are presented in **Table 14.13.** The required land (permenant & temporary) for the construction of the proposed alignment is both government as well as private land which shall be allotted by JDA. Private land will be acquired as per the provisions of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013 (Act 30 of 2013) and Resettlement and Rehabilitation Policy for Rajasthan Govt. GRs.

Table 14.13: Change in Land Use (m^2)

S.No	Corridor	Total Land Requirement (m^2)
1.	Station & facilities	4788
2.	Running Sections	93352
3.	Depot	270000
4.	Staff Quarters	0
5.	Office Complex and OCC	0

S.No	Corridor	Total Land Requirement (m^2)
6.	**Total Permanent**	**368140**
7.	Temporary Office/ Site Office	8000
8.	Segment Casting Yards	80000
9.	**Total Temporary**	**88000**

Source: Chapter-5

14.18.3 Loss of Forests/ Trees

The proposed metro lines are in urban/ city area and will not pass through any forests. Hence no loss to forest is anticipated due to the project. However, trees do exist in patches in the corridor selected for the project. There are about 485 trees which are likely to be felled during construction. Trees are assets in purification of urban air, which by utilizing CO_2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

i)	Total number of Trees	:	485
ii)	Decrease in CO_2 absorption @ 21.8 Kg/ year tree for 8 years	:	84.6 tonnes
iii)	Oxygen production @ 49 kg/ year tree For 8 years	:	190.12 tonnes

The average consumption of oxygen for a person is about 182 kg/ year. It means these trees will meet the requirement of about 1044 people round the year. Trees help carbon sequestration acting as a carbon sink. By removing the carbon and storing it as cellulose, trees release oxygen back into the air.

Additionally, inside the Pinjarapole Gaushala the alignment passes through the crop of Aloe Vera and other organic/ herbal farming which is being used for training of Farmmers from the neighbouring villages of Jaipur Districts by joint venture of Pinjarapole Gaushala, Heniman Charitable Scince Society, Jaipur and M/s Sunrise Organic Park, Jaipur. It is anticipated that during construction the crop along the ROW of the alignment may damage despite taking all care to avoid disturbance to the crop. Moeover, the training of Farmers will also be affected during the construction period. The crop compensation will have to be paid to the Gaushala and their partners.

14.18.4 Utility/ Drainage Problems

Metro lines are mostly planned to run through the urban area. The alignment will cross many properties, drains/ nalas, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, roads, traffic signals etc. These utilities/ services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

14.18.5 Socio-Economic Impact on PAPs

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed metro alignment on their conditions. There can be two types of impacts on the PAPs. One is the displacement of residential house and another is displacement of commercial establishments. The survey has been undertaken on the corridors using structured questionnaire in December 2019 and January 2020.

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14.18.6 Impact on Pinjrapole Gaushala

The alignment is proposed to pass through the Pinjarapole Gaushala where it will affect the main gate, Open and covered enclosures of cows, trees and crop area of Gaushala. During construction the enclosures of cows will have to be shifted away from the alignment. The working of heavy machinery and launching of viaduct etc will disturb the cows in Gaushala. Even during operations, the behaviour of cows may change due to intermittent Noise due to running of Metro trains.

14.18.7 Impact on Archaeological Sites

There is no historical monument having any archeological value in the vicinity of the proposed alignment. All the monuments of Jaipur are quite away from the proposed alignment. Thus on this aspect there would be no impact.

14.18.8 Impact on Sensitive Receptors

There are many sensitive receptors along the alignment like hospitals, schools and religious places but care has been taken to keep safe distance between the alignment and sensitive receptors. However, during operation stage care would be taken to provide engineered noise barriers of suitable design between scools/ hospitals and the alignment to minimize the impact.

Table 14.14 List of Sensitive Receptors along the Alignment

S.No.	Receptor	Side	Chainage (m)
1	Star Hospital	LHS	2430
2	Pinjara Pole Gaushala	LHS, RHS	3500
3	Chandra Hospital	RHS	9550
4	Jaipur Hospital	LHS	10075
5	Surya Hospital	LHS	15800
6	SMS Hospital	LHS, RHS	16000

S.No.	Receptor	Side	Chainage (m)
7	Anchal Institute of Medical Sciences	RHS	19600
8	Asian Superspeciality Hospital	RHS	20000
9	Diwakar Orthopaedic & General Hospital	LHS	21700

14.19 IMPACTS DUE TO PROJECT DESIGN

Considered impacts, due to project designs are:

- Lighting,
- Risk Due to Earthquake.

14.19.1 Lighting

The platforms, concourse, staircase and escalator areas for the elevated stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. It is proposed to adopt the norms prevailing in Metro for illumination. It is pertinent to note that care has been taken at design stage itself to avoid too much illuminating the stations. Maximum illumination level proposed is 200Lux which provides normal lighting.

14.19.2 Risk Due to Earthquake

The project area lies in Zone II of Bureau of Indian Standards (BIS) Seismic Zoning Map (**Fig. 14.2**). Seismic factor proposed by India Meteorological Department (IMD) for the purpose of design of Civil Engineering structures shall be incorporated suitably while designing the structures.

14.20 IMPACTS DUE TO PROJECT CONSTRUCTION

Although environmental hazards related to construction works are mostly of temporary nature. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are:

- Top Soil erosion, pollution and health risk at construction site,
- Traffic diversion and risk to existing building,
- Excavated soil disposal problems,
- Dust Generation,
- Increased water demand,
- Impact due to Supply of Construction Material,
- Disposal of Construction and Demolition Waste,
- Impacts due to batching plant and casting yard,
- Noise Pollution,

14.20.1 Soil Erosion, Pollution and Health Risk at Construction Site

Every care has to be taken to avoid damage to the top soil. It has to be preserved and utilized. Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc causing surface and ground water pollution. However, it is proposed to have mix concrete directly from batching plant for use at site. Health risks include disease hazards due to lack of sanitation facilities in labour camps (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities. In addition to these, efforts need to be made to avoid water spills, adopt disease control measures and employment of local labour. Problems could arise due to difference in customs of workers from outside and local residents. These risks could be reduced by providing adequate facilities in worker's camps, raising awareness amongst workers and by employment of preferably local labour.

14.20.2 Traffic Diversions and Risk to Existing Buildings

During construction period, complete/ partial traffic diversions on road will be required, as most of the construction activities are on the central verge of road. Traffic would get affected on the roads. Rather than completely blocking the roads it will be advisable to make the narrow portions of roads as one way to allow for operation of traffic together with construction activities. Advance traffic updates/ information on communication systems will be an advantage to users of affected roads. The metro rail corridor does not pose any serious risk to major existing buildings since there is safe distance between buildings and proposed corridor except at a few places where shops are affected due to the alignment. Moreover, at places adjacent to overbridge the distance between alignment and buildings will be lesser. Special care has to be taken for safety of the structures during construction.

14.20.3 Problems of Excavated Soil and Bentonite Disposal

The proposed alignment is elevated and thus the excavation would be limited to piers and their piling. The soil would be used for refilling at station site. If there would be some residual soil, it would be utilized by JMRC for internal use for refilling Depot sites and, if surplus, it would be disposed off at designated locations as per Jaipur Authority directions. Some Bentonite muck would also be generated in the project. Disposal of Bentonite would be at designated land fill site.

14.20.4 Dust Generation

Transportation of earth and establishment of the material will involve use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. Movement of trucks and other heavy equipments at construction site would generate dust during construction phase.

14.20.5 Increased Water Demand

The water demand will increase during construction phase for meeting out drinking and domestic water requirement of workers. Sufficient water for construction purpose would be made available by JMC as it is responsible for water supply in Jaipur. Water requirement for construction of Metro will be met through the public supply. It is suggested to use treated STP water for the purpose of Construction. Proper care shall be taken while drawing water from public facilities to avoid any negative impact on the residents living in the vicinity of project whose water demand is, in any case, met by JMC supplied water.

14.20.6 Impact due to Supply of Construction Material

Metro construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of metro corridor. These shall be sourced from the nearest source. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. Although quarry operation is out of perview of the metro construction but, the construction material shall be sourced only from legalized and approved quarries.

14.20.7 Generation of Construction and Demolition Waste

Construction and demolition (C&D) debris is defined as that part of the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste includes concrete, stones and dirt generated during excavation (sometimes collectively referred to as "fill material" or rubble). C& D Waste may be generated from Pile caps, residual cement bags, residual steel scrap, excess construction material stacked at site etc. It is a waste stream that is separate and distinct from residential and commercial waste, commonly called municipal solid waste (MSW).

About 10-15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/ spoils. Dumping of construction waste/spoil in haphazard manner may cause surface and ground water pollution near the construction sites. The C& D waste would be handled and disposed off to C&D waste processing facility or for back filling of low lying areas, leaving no significant impact on environment.

14.20.8 Impacts due to Casting Yard and Batching Plant

During construction phase there would be establishment and operation of Batching Plant and Casting Yard which would be located in an area designated and allotted by JDA away from habitation. There would be requirement to get NOC (Consent to establish) and Consent to operate under water and air Acts from Rajasthan Pollution Control Board at the time of establishing the facilities. Simultaneously, there would be requirement to get the authorization for storage and handling of hazardous chemicals to store and handle used oils and other such materials. The Application forms for seeking Consent to Establish, Consent to Operate and Authorization for storage of Hazardous chemicals are available from the office of Rajasthan Pollution Control Board at Jaipur.

There would be significant movement of men, material and machinery in batching plant and casting yard. It is expected that both batching and casting yard would be located at same complex. Huge quantity of Cement, aggregetes and other construction materials would be used in batching plant and casting yard. There would be generation of dust, noise, flue gases and other contaminants from the working of heavy machinery for handling and transporting the construction materials. The mitigation measures have been elaborated in EMP.

14.20.9 Noise Pollution

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material to the construction site and the noise generating activity at the construction site itself. The Metro construction is equipment intensive.

14.20.10 Loss of Historical and Cultural Monuments

No historical/ cultural monuments will be lost as a result of the proposed development. All the monuments are located away from the proposed alignment.

14.21 IMPACTS DUE TO PROJECT OPERATION

Along with many positive impacts, the project may cause the following negative impacts during operation of the project due to the increase in the number of passengers and trains at the stations:

- Noise pollution,
- Water supply and sanitation at Stations,
- Station refuse disposal and sanitation,
- Pedestrianization and visual issues

14.21.1 Noise Pollution

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from elevated structures. The noise level at 2 m distance from the rail alignment is about 73 dB(A) as per the experience in operating metro systems. The noise level reduces with distance logarithmically. At places, the alignment is likely to be passing close to the buildings which may affect the residents. At such places noise barriers would be used to minimize the noise impact in the vicinity of the alignment.

14.21.2 Water Supply and Sanitation at Stations

Public facilities such as water supply, sanitation and wash rooms are very much needed at the stations. The water requirement for stations would be for drinking, toilets, cleaning and also for other purpose like AC. Water Demand as per existing Metro corridors is calculated and presented in **Table 14.15**. It is assumed that there would be similar water requirements in Jaipur Metro as well. Raw water should be treated and brought to national drinking water standards, before used for consumption. In addition, water will be required for contractor's camps during construction. The water requirement for the stations will be met through the public water supply system or purpose built tubewells after taking necessary approvals from CGWA. However, as an environmental conservation measure, rainwater harvesting structure will also be constructed at stations and along the via-duct.

Table 14.15: Water Requirement at Stations

S. No.	Particular	Water Demand for each station KLD
1	At Stations for Drinking Purpose	6

Thus, there would be total water requirement of 126 KLD in 21 elevated stations. However, arrangement of water will have to be made at each station separately.

14.21.3 Station Refuse

The collection and removal of refuse from stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from station includes Garbage, Rubbish, and Floor Sweepings.

As per the available data from Delhi Metro Phase I and II and other operational metros, the solid waste generation is about 0.4 – 0.6 cum/day at elevated stations. At elevated stations, the solid waste generation is more due to airborne dust. Thus about 9 to 13 cum of solid waste will be generated from the twenty seven stations of these two corridors of Jaipur metro. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authorities. The storage containers for this purpose need to be designed. However, it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

14.21.4 Visual Impacts

The introduction of MRTS implies a change in streets through which it will operate. An architecturally well-designed elevated section can be pleasing to the eyes of beholders. Recent MRTS projects have attempted to incorporate this objective in their designs. Since a low profile would cause the least intrusion, the basic elevated section has been optimised at this stage itself.

14.21.5 Vibrations

This corridor is elevated throughout the alignment between Sitapur Industrial Area and Ambabari. As per the experience from working metros particularly Delhi Metro it is found that the problem of ground vibration is not felt in case of Elevated sections. In elevated corridors there has been no complaint of vibration in the vicinity of alignments. Therefore, the vibration impact is not considered significant.

14.22 IMPACTS DUE TO DEPOT

One Depot is proposed at Sitapura Industrial Area. It will have following facilities:

- Washing Lines,
- Operation and Maintenance Lines,
- Workshop, and
- Offices.

These facilities could generate water and noise issues. The depot area may have to be filled up. Problems anticipated at depot sites are:

- Water supply,
- Oil Pollution,
- Cutting of trees
- Sanitation,
- Effluent Pollution,
- Noise Pollution,
- Loss of livelihood,
- Impact due to filling of area, and
- Surface drainage.

14.22.1 Water Supply

Water supply will be required for different purposes in the depot. The water requirement for drinking will be 1000 litre per day and 100,000 litre per day for other requirements (Departments and Contractors office). The water after conventional treatment can be processed through Reverse Osmosis (RO) technology for specific use such as final washing of equipment/ trains.

14.22.2 Oil Pollution

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, is very common. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.

14.22.3 Noise Pollution

The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheels and train speed are the factors which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. Due to less activity, no impact on the ambient noise is anticipated.

14.22.4 Solid Waste

At per available data, it is estimated that about 2 Ton per month of solid waste may be generated from the Depot site which will be taken by the cleaning contractor weekly and disposed to the Municipal waste disposal sites.

Sludge is expected to be generated from the ETP/STP that will be stored in leak proof containers and disposed off as per State Pollution Control Board site. According to experience and observation at operational DMRC depots, Oil and grease will be produced in the Depot which will be disposed off through approved re-cyclers. Iron turning of the PWL for the wheel profiling is likely to be generated from the Depot.

14.23 POSITIVE ENVIRONMENTAL IMPACTS

Various positive impacts have been listed under the following headings:

- Employment Opportunities;
- Enhancement of Economy;
- Mobility, Safety and reduced accidents;
- Traffic Congestion Reduction;
- Reduced Noise Levels
- Reduced Fuel Consumption;
- Reduced Air Pollution;
- Reduction in Number of Buses/ Auto rickshaws

14.23.1 Employment Opportunities

The project is likely to be completed in a period of about 4 years. During this period manpower will be needed to take part in various activities. About 1500 persons are likely to work during peak period of activity. In operation phase of the project about 35 persons per kilo meter length of the corridor, ie (approx. 425 persons) will be employed for operation and maintenance of the proposed system in shifts. Thus the project would provide substantial direct employment. Besides, more people would be indirectly employed in allied activities and trades.

14.23.2 Enhancement of Economy

The proposed transport facility of JMRC will facilitate sub-urban population to move quickly. With the development of India Gate(SIA) - Ambabari corridor, it is likely that more people will be involved in trade, commerce and allied services. JMRC will, however, make it convenient for more people to move in the present suburban areas. This will reduce population pressure on transport facilities in the urban area.

14.23.3 Mobility Safety and Reduced Accidents

The metro network increases the mobility of people at faster rate. The proposed corridor will provide more people connectivity to other parts of the city. Metro journey is safe and result in reduced accidents on roads.

14.23.4 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2025, 2031, 2041 and 2051 it is estimated that the number of buses will have to be more. During this period personalised vehicles may also grow. Together, they will compound the existing problems of congestion and delay. The proposed metro development will reduce journey time and hence congestion and delay. There will be following substitution of passengers to Metro on India Gate (SIA) - Ambabari Metro corridor. Passenger Car Equivalent (PCE) units assumes a switchover of 4 Person per PCE.

Table 14.16: Ridership Summary for India Gate- Ambabri to Metro Corridorin Different Years (Optimistic Estimates)

Target Year	Route Length (km)	Daily Ridership (Passengers)	Passenger Equivalent Car Units	Average Trip Length/ Passenger Lead (km)
2021`	23.51	99602	24900	8.08
2023	23.51	120667	30167	8.37
2031	23.51	208926	52231	8.90
2041	23.51	364200	91050	9.46
2051	23.51	595440	148860	9.64

14.23.5 Reduced Noise Levels

It is estimated tha introduction of metro system between India Gate- Ambabari in Jaipur would substitute a mix of vehicles from the roads. Since the vehicular movement and more particularly engine operation, horns etc leads to heavy noise alon the corridor. The noise level is proportional to the number of vehicles. Noise level is already significantly higher along the corridor. Practically, the demand for vehicles on Jaipur roads will increase significantly due to increased population and developmental activities. The introduction of metro system is lkely to substitute the vehicles from the roads. This substitution of vehicles from road will reduce the noise significantly.

14.23.6 Reduced Fuel Consumption

The Asian Development Bank's "Transport Emissions Model" for the National Environment Commission has been used to predict/calculate the fuel consumption as well as the emissions of the harmful pollutants into the environment. On implementation of the project, it is estimated that both petrol and diesel consumption will get reduced. The saving will be due to two factors namely Reduction in vehicles and decongestion on roads. On the basis of assumption of vehicles and Average trip length for the corridor in different Horizon Years at the speed of 25 KM/hr at an averge altitude of 585m above MSL, the daily reduction in fuel consumption would be as follows:

Table 14.17 Savings of Fuel

Year	2021	2023	2031	2041	2051
Trip Length	8.08	8.37	8.9	9.46	9.64
Average Speed	35	35	35	35	35
Vehicles	24900	30167	52231	91050	148860
Petrol l	13615	17055	31327	57729	96178
Diesel l	2828	3626	6820	13182	21961

14.23.7 Reduced Air Pollution

Based on available data and assumptions, an attempt has been made to model the air quality scenario for future using Asian Devlopment Bank's "Transport Emissions Model". On the basis of abovereferred assumptions, daily reduction in pollutants would be as given below:

Table 14.18: Reduction in Emmissions Kg/ day

Year	2021	2023	2031	2041	2051
Vehicles	24900	30167	52231	91050	148860
CO Kg	934.8	1,051.2	1,749.1	2658.2	4428.6
CO_2 Kg	38188.0	48,294.0	89,489.7	167631.9	279280.5
NOx Kg	140.3	159.2	267.0	409.3	681.9
COV Kg	126.5	144.4	243.7	390.2	650.1
Particulates Kg	2.4	2.6	4.1	5.5	9.2
SO_2 Kg	4.7	6.0	11.1	20.7	34.6

14.23.8 Carbon Credits

Due to savings in fuel and reduction in airpollution etc carbon credit would be generated during operation of the metro rail similar to the experience with Delhi Metro Rail Corporation Ltd. However, at this stage calculation of carbon credits is not feasible which would be worked out after the system become operational.

14.23.9 Improvement of Quality of Life

Development of Metro rail in the city would lead to overall improvement of quality of life of local populace by virtue of availability of better transport facility at competitive rates, better road safety, reduced pollution, improved general health etc.

14.24 CHECKLIST OF IMPACTS

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation of the review of multiple environmental objectives into a single value or a ranking or projects is the final step in impact assessment. There are about hundred methods for carrying out impact assessment, which can be grouped into the following categories Ad-hoc method, Checklist, Matrix, Network, Overlays, Environmental Index and Cost Benefit analysis.

Each of the methods is subjective in nature and none of these is applicable in every case. Of the 7 methods listed above, checklist has been used and presented. Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A typical checklist identifying anticipated environmental impacts is shown in **Table 14.19**.

Table 14.19: Checklist of Impacts

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
A.	**Impacts due to Project Location**			
i.	Displacement of People	*		
ii.	Change of Land use and Ecology	*		
iii.	Loss of Cultural and Religious Structures		*	
iv.	Socio-economic Impacts	*		
v.	Loss of Trees	*		
vi.	Drainage & Utilities Problems	*		
B.	**Impact due to Project Design**			
i.	Platforms – Inlets and Outlets		*	
ii.	Ventilation and Lighting		*	
iii.	Station Refuse	*		
iv.	Risk due to Earthquakes		*	
C.	**Impact due to Project Construction**			
i.	Top Soil Erosion, Pollution and Health risk	*		
ii.	Traffic Diversions and	*		
iii.	Risk to Existing Buildings	*		
iv.	Problems of Soil Disposal and Seepage Risk	*		
v.	Dust Generation	*		
vi.	Increased Water Demand	*		
vii.	Supply of Construction Material	*		
viii.	Construction and Demolition Waste	*		
ix.	Batching Plant and Casting Yard	*		
x.	Noise	*		
D.	**Impact due to Project Operation**			
i.	Oil Pollution	*		
ii.	Noise	*		
iii.	Water supply and sanitation	*		
iv.	Pedestrian Issues		*	
v.	Visual Impacts		*	
vi.	Station Illumination		*	
vii.	Employment Opportunities			*
viii.	Enhancement of Economy			*
ix.	Mobility			*
x.	Safety			*
xi.	Traffic Congestion Reduction			*
xii.	Less Noise			*
xiii.	Less fuel Consumption			*
xiv.	Less Air Pollution			*
xv.	Carbon dioxide Reduction			*
xvi.	Reduction in Buses			*
xvii.	Reduction in Infrastructure			*

14.25 ANALYSIS OF ALTERNATIVES AND PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

14.25.1 Analysis of Alternatives

Historically, the alternative probable corridors were discussed with representatives of local authorities and finally a network comprising of 146.5 km was selected as Master Plan for Jaipur Metro. The most important criteria in finalizing the Master plan were:

- To serve areas of population and employment concentration not served hereto.
- To ensure regional linkages and connectivity to rail system proposed in adjoining regions like Pimpri, Chinchiwad.
- Maximum inter-modal integration with existing and committed suburban road network.
- Easy connectivity to depot sites.
- Feasibility of the minimum values for system parameters in terms of vertical curves, horizontal curves and gradients.

Various alternatives were explored by the DMRC before arriving at the preferred mode of transport and technical design. The project is unique in the sense that alternative alignments were not evaluated as it was the principal objective of the Comprehensive Mobility Plan to connect various parts of suburbs.

Need to Increase Public Transport Share

The proposed corridor is part of JMRC's Comprehensive Mobility Plan (CMP), which included strategies on motorized and non-motorized modes to enhance mobility and economic development. The metro was conceived in recognition to the heavy reliance of the population to private buses as public transport that is inadequate and routes are unregulated causing confusion and congestion.

14.25.2 Public Consultation and Disclosure

Public consultation and participation is a continuous twoway process, involving, promoting of public understanding of the processes and mechanisms through which developmental problems and needs are investigated and solved. The public consultation, as an integral part of environmental and social assessment process throughout the project preparation stage not only minimizes the risks and unwanted political propaganda against the project but also abridges the gap between the community and the project formulators, which leads to timely completion of the project and making the project people friendly. Public consultations with the people of different sections of the society along the project alignment, shopkeepers, and influential persons of the project area will be made. Attention shall be given to potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section (OBC) of society shall be consulted to make them aware and identify adverse impacts of the project.

A. **Consultation with Stakeholders:** As preliminary consultations were conducted at the early stage of EIA preparation, mostly involving local communities. Successive consultations shall be conducted by the JMRC after the finalization of this report that includes representatives of local communities and entities tasked with the regulation of the road development and environmental protection.

B. **Compliance with Regulatory and Funding Agency Requirement:** As per Indian Environmental Regulations, public hearing is not required, as railway projects do not attract EIA Notification 2006, amended 2009. Meaningful consultations will be undertaken consistent with the ADB requirements. All the five principles of information dissemination, information solicitation, integration, co ordination and engagement into dialogue will be incorporated in the consultation process.

C. **Disclosure of the EIA and Monitoring Reports: T**his report will be disclosed in the websites of JMRC. Further, semi-annual monitoring reports will be prepared by the JMRC will be disclosed in the websites of JMRC.

14.26 ENVIRONMENTAL MANAGEMENT PLAN

14.26.1 Management Plans

The Jaipur Metro Project will provide employment opportunity, quick mobility service and safety, traffic congestion reduction, less fuel consumption and air pollution on one hand and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand.

Protection, preservation and conservation of environment have always been a primary consideration in Indian ethos, culture and traditions. Management of Environment by provision of necessary safeguards in planning of the project itself can lead to reduction of adverse impacts due to a project. This chapter, therefore, spells out the set of measures to be taken during project construction and operation to mitigate or bring down the adverse environmental impacts to acceptable levels based on the proposed Environmental Management Plan (EMP).

14.26.2 Mitigation Measures

The main aim of mitigation measures is to protect and enhance the existing environment of the project. Mitigation measures have to be adopted during construction at all the construction sites including Batching Plant and Casting Yards on all the aspects.

14.26.3 Compensatory Afforestation

The objective of the afforestation program should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. According to the results of the present study, it is found that about 485 trees are likely to be lost due to the project. Three saplings are to be planted for felling a single tree. Hence 1455 trees need to be planted. Plantation program will be finalized in consultation with PMC and project proponent would provide the funds for compensatory afforestation as per government policy. The compensatory afforestation will be carrie out with and expenditure of Rs.49.47 Lakhs @ Rs. 3400/- per sapling including maintenance for three years.

14.26.4 Construction Material Management – Storage and procurement

The major construction material to be used for construction of the proposed corridor are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor. The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the JMRC Officer and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of such construction material during entire construction period of the project. Sufficient quantity of materials should be available before starting each activity. This is also the responsibility of the contractor, which would be clearly mentioned in the contractor's agreement. Care shall be taken to avoid spillage of material during construction. Procurement of material would be from environment friendly source. The materials shall be procured from nearest available source and shall be transported in coverd trucks. All the material would be stored in a manner to avoid multiple handling for use in construction activities.

14.26.5 Labour Camp

The Contractor during the progress of work will provide, erect and maintain the necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the JMRC. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force.

Sanitation Facilities: Construction sites and camps shall be provided sanitary latrines and urinals. Sewerage drains should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. Sheds shall be maintained in proper hygienic conditions.

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided.

Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 25 or more women are ordinarily employed, at least a hut shall be provided for use of children under the age of 6 years belonging to such women. Huts shall be provided with suitable and sufficient openings for light and ventilation. Size of crèches shall vary according to the number of women workers employed.

14.26.6 Energy Management

The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon JMRC request. Measures to conserve energy include but not limited to the following:

- Use of energy efficient motors and pumps,
- Use of energy efficient lighting, which uses energy efficient luminaries,
- Adequate and uniform illumination level at construction sites suitable for the task,
- Proper size and length of cables and wires to match the rating of equipment, and
- Use of energy efficient air conditioner.

The contractor shall design site offices maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be explored.

14.26.7 Hazardous Waste Management

The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file a 'Request for Authorization' with Rajasthan Pollution Control Board along with a map showing the location of storage area. Outside the storage area, the contractor shall place a 'display board', which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place. It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors. The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the JMRC.

14.26.8 Environmental Sanitation

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defense against accidents and injuries. Contractor shall understand and accept that improper environmental sanitation is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor and at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. The contractor shall employ a special group of environmental sanitation personnel to carry out following activities:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.
- The structure dimension of the barricade, material and composition, its colour scheme, JMRC logo and other details.
- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.
- All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.
- Water logging or bentonite spillage on roads shall not be allowed.
- Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
- Flammable chemicals / compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.

14.26.9 Utility Plan

The proposed Metro alignment runs along major arterial roads of the city, which serve Institutional, Commercial and Residential areas. A number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. exists along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule /costs, for which necessary planning / action needs to be initiated in advance. Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro alignment, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.
- The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed Metro alignment. In case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them.

14.26.10 Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in PM_{10} along haul roads and emission from vehicles and construction machinery. Though the estimation of air quality during construction shows some impact on ambient air quality, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimise fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimize or control of air pollution. He shall maintain evidence of such design and equipment and make these available for inspection by Employer.
- Contractor’s transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- The Contractor shall cover loads of dust generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards.
- The temporary dumping areas shall be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or as directed by Employer. Dust control activities shall continue even during any work stoppage.

- The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

14.26.11 Construction and Demolition Waste

Waste prevention, reuse and recycling can not only save money, but also generate broad environmental benefits, including the conservation of natural resources. Reuse and waste prevention reduce the air and water pollution associated with materials manufacturing and transportation. This saves energy and reduces attendant greenhouse gas production. The recycling of many materials requires less energy than production from virgin stock, and can also reduce transportation requirements and associated impacts. Opportunities for reducing C&D waste focus on three approaches, typically expressed as **Reduce-Reuse-Recycle**.

The source of C & D waste are pile caps, excess RMC and demolition material. An effort shall be made to recover embedded energy and to recycle the maximum quantity of C & D Waste to manufacture tiles, curb stones, paver block etc. The contractor shall store C&D waste separately at the site and sent to recycling facility periodically. There shall be no disposal of any waste along storm water drains, canals and/ or any other water body or depression. Rather C & D waste shall be collected and sent to any authorized waste recycling facility.

14.26.12 Noise Control Measures

There will be an increase in noise level in nearby ambient air due to construction and operation of the Metro corridor. During construction the exposure of workers to high noise levels especially near the machinery need to be minimized. This could be achieved by:

- Job rotation,
- Automation,
- Construction of permanent and temporary noise barriers,
- Use electric instead of diesel powered equipment,
- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment like DG sets,
- Scheduling and staggering truck loading, unloading and hauling operation,

- Schedule and stagger work to avoid simultaneous activities which generate high noise levels,
- Anti drumming floor and noise absorption material,
- Low speed compressor, blower and air conditioner,
- Mounting of under frame equipments on anti-vibration pad,
- Smooth and gradual control of door,
- Provision of sound absorbing material in the supply duct and return grill of air conditioner,
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and
- Sound proof compartments control rooms etc.

Special acoustic enclosures should be provided for individual noise generating equipments, wherever possible. Workers in sections where periodic adjustment of equipment/ machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. During construction, there may be high noise levels due to pile driving, use of compressors and drilling machinery. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers.

The pile driving operation can produce noise levels up to 100 dB (A) at a distance of 25-m from site. Suitable noise barriers can reduce the noise levels to 70 dB (A) at a distance of 15m from the piles. A safety precaution as stipulated in IS: 5121 (1969) '*Safety Code for Piling and other Deep Foundation'* need to be adopted. Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds.

14.26.13 Traffic Diversion/ Management

During construction, traffic is likely to be affected. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction of the corridor. Any reduction of road space during Metro construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads etc. Maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. They are:

- The requirement would be mainly along the central verge/ side of the road.
- As regards to the alignment cutting across a major traffic corridor, 'Box Girder Construction Technology' would be applied to prevent traffic hold-ups or diversions of any kind.

Only temporary diversion plans will be required during construction of the proposed Metro corridor. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities.

Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution stage.

Traffic Management Guidelines: The basic objective of the following guidelines is to lay down procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct and station works are on the right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.
- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

14.26.14 Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the JMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works are as applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction, bridges and/ or other structures across water courses, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion/sedimentation control on service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the project authority.

The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other watercourses. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Top soil shall be preserved by the contractor and stacked separately at designated place and utilize it to cover te refilled araea and to support vegetation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures. Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage or associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the project authority.

The JMRC may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule. Temporary erosion is sometimes caused due to the Contractor's negligence, care-lessness or failure to install permanent controls. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the project authority, and these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the project authority.

14.26.15 Water Supply, Sanitation and Solid Waste Management

During Construction

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to national drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The water carried sewerage solves the excreta disposal problems. The sewerage disposal systems should be adopted for sewage disposal. The water for domestic consumption shall be sourced from public water supply or alternatively designated borewells may be installed with due permission from statuatory authority prior to installation of borewell. For Construction activity, there is a restriction to utilize groundwater all over the nation as per order of National Green Tribunal (NGT). Thus, construction water shall be sourced from Jaipur Municipal Corporation which is responsible for sewage disposal in Jaipur. Alternatively, contractor shall arrange tie up for surface water supply or tanker water supply for construction activity. Best option is to use treated STP water for construction activity.

Solid waste shall be stacked at designated place and when sufficient quantity accumulates it shall be disposed off through covered trucks to land fill site designated and authorized by JMRC.

During Operations

Practically, public facilities at stations have to be operated by regular staff or may be designated to any NGO working in the area in the field of sanitation as per policy of JMRC. Requirement of drinking water supply at an elevated station is about 6 KL/day. The water consumption for an elevated station to meet the requirements of its activities is 17 KLD. This shall be provided from JMC/ Jaipur authority sources.

Solid waste will be generated at station is about 0.4 – 0.62 m^3/Day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authority. The storage containers for this purpose need to be designed. However, it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality. During operation, as mitigation measures rainwater harvesting will be carried out at stations and along the viaduct.

14.26.16 Rain water harvesting

To conserve and augment the storage of groundwater, it is suggested to construct rainwater harvesting structures of suitable capacity along the alignment and at stations. The stations shall be provided with the facility of rainwater harvesting and artifical recharge. The total length of the proposed alignment is 23.63 km and there would be 21 stations. The estimated cost of rain water harvesting for elevated corridor is about 15 lakhs per km and 10 lakhs per station. The total cost of rainwater harvesting would be Rs. 354.45 Lakh for viaduct and Rs. 210 Lakh for Stations totaling Rs. 564.45 Lakh.

14.26.17 Tree Protection

There is requirement of felling 485 trees during construction of Metro corridors in Jaipur. An attempt shall be made to minimize the tree felling. As remediation of tree felling it is suggested to plant 3 trees for each tree felled as per the statute. Thus 1455 trees would be planted. Moreover, JMRC would chalk out the plantation program in close coordination with Tree Authority or will get plantation done through JMC by making the payment for plantation work including after care for three years. An attempt would be made to minimize the felling of trees to the bare minimum while working and undertaking construction work. The left-out trees shall be protected by providing metal or brick tree guard around the tree at a distance of one metre surrounding the tree. Scope of transplantation of trees would also be explored with discussion with the Tree Authority/ JMC. A provision of 10.00 Lakh has been made for tree protection.

14.26.18 Management Plans for Depot

The management plans for depot site includes:

- Water Supply,
- Oil Pollution Control,
- Sewage/Effluent Pollution Control,
- Surface Drainage,
- Green belt development,
- Rain water harvesting, and
- Recycling of treated waste water.

Water supply: About 300KLD of water will be required for operation and functioning of depot. This could be either taken from water supply Authority or through boring tube well into the ground after taking permission from Central Ground Water

Authority. The ground water will need treatment depending upon its use. Domestic and some of the industrial application, a reverse Osmosis (RO) plant of 8 liter/ minute capacity will be appropriate. The cost of water supply plant shall be included in Project Cost.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes.

Sewage/Effluent Pollution Control: About 80 KLD of sewage is likely to be generated at depot. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream**.** The cost of water supply plant shall be included in Project Cost.

Expectedly about 63 KLD effluent would be generated at Depot. The effluent will have oil, grease and, detergent as main pollutants. This has to be treated as per requirement of regulatory pollution control agency of the state (MSPCB). The cost of water supply plant shall be included in Project Cost.

Surface Drainage: The depot area should have proper drainage. The Storm water of the depot will be collected through the drain. Rain water harvesting structures at different locations in the drains and for surplus storm water, the drainage system is to be connected to nearby disposal site. The drainage costs have been included in project cost.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical structures of proposed buildings with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a provision of Rs 50.00 Lakh in the cost estimate for the green belt development.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the constructed depot site. A provision of Rs 35.00 Lakh for depot has been kept in the cost estimate.

Recycling of treated waste water: The Waste Water to be generated at the depot shall be treated by ETP & STP in each Depot. The treated waste water shall be recycled for horticulture work of the depot. About 64 KLD of treated waste water will be used for horticulture. The estimated cost of recycling of treated waste water is about Rs 41 Lakh in the depot. The costs of environment management measures have been included in the project cost as construction and civil costs of Depot.

14.27 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of Metro overhead rail. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should identify sources of repair equipments, materials, labour and expertise for use during emergency.

Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel/overhead rail, and
- Nearest medical facility

Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and fool proof communication system.

Emergency Action Committee

To ensure coordinates action, an Emergency Action Committee should be constituted. The civic administrator may be the Chairman of this Committee. The committee may comprise of:

- Station Manager concerned,
- Police Officer of the area,
- Jaipur Transport Corporation Representative,
- Home Guard representative,
- Fire Brigade representative,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations. It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

14.28 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, viaduct for a period of 2 hours.

Fire Protection

The building materials should be of appropriate fire resistance standard. The fire resistance period should be at least 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures,
- Fire control measures,

- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provided,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.

ii. Safety

Following provisions will be required from fire safety point of view:

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon Dioxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m.
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Jaipur Fire Services shall be provided through out each station and ancillary buildings including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area.

Beam detector or heat detector shall be installed at roof level, ceiling and floor cavity, whilst linear detecting cables shall be installed in under platform cable ducts and cable shafts. Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided an installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems. While designing the fire fighting system, Jaipur Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. With the exception of station public areas, a fire compartment will not exceed 1500 m^2. Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman should the need arise. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 25 cm.

E. Emergency Door

The rolling stock is provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

14.29 ENVIRONMENTAL MONITORING PLAN

14.29.1 Pre-Construction Phase

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of development project for review of indicators and for taking immediate preventive action. This helps in signalling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. The environmental monitoring will be required during both construction and operational phases. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality,
- Noise and Vibration,
- Environmental Sanitation and Waste Disposal

- Ecological Monitoring and Afforestation,
- Workers Health and Safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, water, soil quality and ecology.

14.29.2 Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels and water quality. Keeping a broad view of the sensitive receptors and also the past experience of Phase I and II and Delhi Metro, an estimate of locations has been made and are summarized in **Table 14.20.**

Table 14.20: Construction Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM_{2.5}$	24 hours Once a month During entire civil construction stage, if directed by JMRC- 3 years	21 locations
Water	Groundwater quality (IS 10500:1991)	Once in 6 months During entire civil construction stage or even later, if directed by JMRC – 3 years	4 locations
Noise	Noise Level (Leq and Lmax)	24hours Once a Month During entire civil construction stage or even later, if directed by JMRC – 3 years	21 locations
Ecology	Felled and planted trees	Once a year till all trees that were to be planted by Rajasthan Government on behalf of project authority, are planted- 3 years	All the trees felled and newly planted

The cost of Monitoring will be as follows:
Air : 21x 36=756 x Rs.2500 = Rs.1890000/-
Water : 4x 6 = 24 x Rs. 7500 = Rs.180000/-
Noise : 21 x 36 =756 x Rs. 1500 = Rs.1134000/-
Ecology: 3 x Rs. 25000 = Rs.75000/-
Total cost of Monitoring = Rs. 32.79 Lakh.

14.29.3 Operation Phase

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, water, waste water, solid waste and ecology during operation phase of the project. The parameters monitored during operation will be PM_{10} for air, heavy metals for solid waste, pH, TSS, BOD, COD, oil and grease for waste water. However, water quality parameters that will be monitored will be as per BIS 10500. The monitoring schedule is presented in **Table 14.21**.

Table 14.21: Operation Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM2_{.5}$	2×24hours Once in 2 month For 3years	21 location
Water	Surface, Waste water quality (IS 10500:1991)	Once a year For 3years	1+1 location
Noise	Noise Level (Leq)	24hours Once a year For 3years	21 locations (Sensitive Receptors)
Solid Waste		Once a year	Depot

The cost of Monitoring will be as follows:
Air : 21x 18=378 x Rs.2500 = Rs.945000/-
Water : 4x 3 = 12 x Rs. 7500 = Rs.90000/-
Noise : 21 x 3 = 63 x Rs. 1500 = Rs.94500/-
Solid Waste: 3 x Rs. 7500 = Rs.22500/-
Total cost of Monitoring = Rs. 11.52 Lakh.

The results of Air quality, water quality, waste water will be submitted to management quarterly during construction phase and half yearly during operation phase.

Establishment of an Environmental Division
JMRC already has the setup for environmental Management and the proposed corridor is an extension of already existing operative line, additional set-up for environmental management is not recommended. Existing set up for environmental management can also handle this extension.

14.30 COST ESTIMATES

14.30.1 Summary of Costs

All costs involved in Environmental mitigation and management and monitoring to be put on the account of Jaipur Metro Project corridor between India Gate (SIA) - Ambabari**.** A summary of these is presented in **Table 14.22**

Table 14.22: Environmental Costs

S. No.	ITEM	COST Rs. lakh
1.	Rain Water Harvesting at stations and along alignment	564.45
2.	Air, Noise, Waterand Ecology during construction	32.79
3.	Air, Noise, Water, Waste Water, Solid waste during operation	11.52
4.	Ecological monitoring	10.00
5.	Tree Plantation 1455 trees @ Rs.2000/- per tree	49.47
6.	Tree Protection	10.00
7.	Water Treatment Plant *	-

S. No.	ITEM	COST Rs. lakh
8.	Sewage Treatment Plant *	-
9.	Effluent Treatment Plant *	-
10.	Green Belt at Depot	50.00
11.	Rain water harvesting at Depot	35.00
12.	Recycling of treated waste water	41.00
	Total	**794.23**

- Denotes the cost has been taken under project cost

The environment management cost is worked out to be Rs. 794.23 Lakhs. The compensation for loss of land, fire control, information systems and contractor's obligations has been incorporated in project costs. The cost of compensation for acquisition of pucca buildings will be worked out by PWD after valuation of structures. Additionally, the resettlement and rehabilitation cost will be worked out on the basis of the Right to Fair Compansation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The Environmental management plan should be implemented in phases so that optimum benefit could be achieved and should be synchronized with the construction schedules.

14.31 CONCLUSION

The proposed Metro line is proved to have significant positive effects to the development of Jaipur City. Benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, and air quality improvement are the obvious positive effects from this Metro line. Besides, the potential adverse environmental impacts on air quality (during construction phase), water environment, noise, solid waste, ecology, population resettlement are also taken into consideration. Based on these detailed potential adverse environmental impacts, appropriate mitigation measures have been developed for consideration. The EIA concluded that project impacts from both construction and operation will be manageable, and can be mitigated through the use of prevailing current practices and appropriate technologies. With the implementation of the EMP and the monitoring plan, the Project is not expected to have significant negative environmental impacts rather there would be many long term posiive environmental impacts benefitting the society.

CHAPTER 15 – DISASTER MANAGEMENT MEASURES

CHAPTER -15

DISASTER MANAGEMENT MEASURE

15.1 INTRODUCTION

"Disaster is a crisis that results in massive damage to life and property, uproots the physical and psychological fabric of the affected communities and outstrips the capacity of the local community to cope with the situation." Disasters are those situations which cause acute distress to passengers, employees and outsiders and may even be caused by external factors. As per the disaster management act, 2005 "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area". As per World Health Organization (WHO):

"Any occurrence that causes damage, economic disruption, loss of human life and deterioration of health and services on a scale sufficient to warrant an extra ordinary response from outside the affected community or area."

A disaster is a tragic event, be it natural or manmade, which brings sudden and immense agony to humanity and disrupts normal life. It causes large scale human suffering due to loss of life, loss of livelihood, damages to property and persons and also brings untold hardships. It may also cause destruction to infrastructure, buildings, communication channels essential services, etc.

15.2 NEED FOR DISASTER MANAGEMENT MEASURES

The effect of any disaster spread over in operational area of Metro Rail System is likely to be substantial as Jaipur Metro will be dealing with thousands of passengers daily. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of Metro Rail System. Therefore there is an urgent need to provide for an efficient disaster management plan.

15.3 OBJECTIVES

The main objectives of this Disaster Management Measures are as follows:

- Save life and alleviate suffering.

- Provide help to stranded passengers and arrange their prompt evacuation.
- Instill a sense of security amongst all concerned by providing accurate information.
- Protect Metro Rail property.
- Expedite restoration of train operation.
- Lay down the actions required to be taken by staff in the event of a disaster in VMRT in order to ensure handling of crisis situation in coordinated manner.
- To ensure that all officials who are responsible to deal with the situation are thoroughly conversant with their duties and responsibilities in advance. It is important that these officials and workers are adequately trained in anticipation to avoid any kind of confusion and chaos at the time of the actual situation and to enable them to discharge their responsibilities with alertness and promptness.

15.4 LIST OF SERIOUS INCIDENTS REQUIRING USE OF PROVISIONS OF THE DISASTER MANAGEMENT MEASURES

Medium Metro specific disasters can be classified into two broad categories e.g.: Man-made and Natural.

- **Man Made Disaster**
    1. Terrorist attack
    2. Bomb threat/ Bomb blast
    3. Hostage
    4. Release of Chemical or biological gas in trains, stations or tunnels
    5. Fire in Metro buildings, underground/ elevated infrastructures, power stations, train depots etc.
    6. Train accident and train collision/derailment of a passenger carrying train.
    7. Sabotage
    8. Stampede

- **Natural Disaster**
    1. Earthquakes
    2. Floods

15.5 PROVISIONS UNDER DISASTER MANAGEMENT ACT, 2005

A. The National Disaster Management Authority (NDMA)
Establishment of National Disaster Management Authority:-

(1) With effect from such date as the Central Government may, by notification in the Official Gazette appoint in this behalf, there shall be established for the purposes of this Act (The Disaster Management Act, 2005), an authority to be known as the National Disaster Management Authority.

(2) The National Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the Central

Government and, unless the rules otherwise provide, the National Authority shall consist of the following:-

(a) The Prime Minister of India, who shall be the Chairperson of the National Authority, ex officio;
(b) Other members, not exceeding nine, to be nominated by the Chairperson of the National Authority.

(3) The Chairperson of the National Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the National Authority.

(4) The term of office and conditions of service of members of the National Authority shall be such as may be prescribed.

B. State Disaster Management Authority

Establishment of State Disaster Management Authority:-

(1) Every State Government shall, as soon as may be after the issue of the notification under sub-section (1) of section 3, by notification in the Official Gazette, establish a State Disaster Management Authority for the State with such name as may be specified in the notification of the State Government.

(2) A State Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the State Government and, unless the rules otherwise provide, the State Authority shall consist of the following members, namely:-

(a) The Chief Minister of the State, who shall be Chairperson, ex officio;
(b) Other members, not exceeding eight, to be nominated by the Chairperson of the State Authority;
(c) The Chairperson of the State Executive Committee, ex officio.

(3) The Chairperson of the State Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the State Authority.

(4) The Chairperson of the State Executive Committee shall be the Chief Executive Officer of the State Authority, ex officio: Provided that in the case of a Union territory having Legislative Assembly, except the Union territory of Delhi, the Chief Minister shall be the Chairperson of the Authority established under this section and in case of other Union territories, the Lieutenant Governor or the Administrator shall be the Chairperson of that Authority: Provided further that the Lieutenant Governor of the Union territory of Delhi shall be the Chairperson and the Chief Minister thereof shall be the Vice-Chairperson of the State Authority.

(5) The term of office and conditions of service of members of the State Authority shall be such as may be prescribed.

C. Command & Control at the National, State & District Level

The mechanism to deal with natural as well as manmade crisis already exists and that it has a four tier structure as stated below:-

(1) National Crisis Management Committee (NCMC) under the chairmanship of Cabinet Secretary
(2) Crisis Management Group (CMG) under the chairmanship of Union Home Secretary.
(3) State Level Committee under the chairmanship of Chief Secretary.
(4) District Level Committee under the Chairmanship of District Magistrate.

All agencies of the Government at the National, State and district levels will function in accordance with the guidelines and directions given by these committees.

D. Plans by Different Authorities at District Level and their Implementation

Every office of the Government of India and of the State Government at the district level and the local authorities shall, subject to the supervision of the District Authority:-

(a) Prepare a disaster management plan setting out the following, namely:-

(i) Provisions for prevention and mitigation measures as provided for in the District Plan and as is assigned to the department or agency concerned;
(ii) Provisions for taking measures relating to capacity-building and preparedness as laid down in the District Plan;
(iii) The response plans and procedures, in the event of, any threatening disaster situation or disaster;

(b) Coordinate the preparation and the implementation of its plan with those of the other organizations at the district level including local authority, communities and other stakeholders;

(c) Regularly review and update the plan; and

(d) Submit a copy of its disaster management plan and of any amendment thereto, to the District Authority.

15.6 PROVISIONS AT METRO STATIONS/OTHER INSTALLATIONS

To prevent emergency situations and to handle effectively in case 'one arises' there needs to be following provisions for an effective system which can timely detect the threats and help suppress the same.

(A) FIRE DETECTION AND SUPPRESSION SYSTEM
(B) SMOKE MANAGEMENT
(C) ENVIRONMENTAL CONTROL SYSTEM (ECS)
(D) TRACK-WAY EXHAUST SYSTEM (TES)
(E) STATION POWER SUPPLY SYSTEM
(F) DG SETS& UPS
(G) LIGHTING SYSTEM
(H) STATION AREA LIGHTS
(I) SEEPAGE SYSTEM
(J) WATER SUPPLY AND DRAINAGE SYSTEM
(K) SEWAGE SYSTEM
(L) ANY OTHER SYSTEM DEEMED NECESSARY

The above list is suggestive not exhaustive actual provisioning has to be done based on site conditions and other external and internal factors.

15.7 PREPAREDNESS FOR DISASTER MANAGEMENT

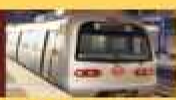
Being a technological complex system worked by new set of staff, with a learning curve to improve and stabilize with time, intensive mock drills for the staff concerned is very essential to train them to become fully conversant with the action required to be taken while handling emergencies.

They also need to be trained in appropriate communication skills while addressing passengers during incident management to assure them about their wellbeing seeking their cooperation.
Since learning can only be perfected by 'doing' the following Mock Drills is considered essential:

a. Fire Drill
b. Rescue of a disabled train
c. Detrainment of passengers between stations
d. Passenger evacuation from station
e. Drill for use of rescue & relief train
f. Hot line telephone communication with state disaster management authority.

15.8 COMMUNICATION WITH STATE DISASTER MANAGEMENT CELL

Operation Control Centre will have a hotline connection with the State Disaster Management cell so as to avoid any time loss in communication of the information.



CHAPTER 16 – MULTI MODAL TRAFFIC INTEGRATION AT METRO STATIONS

CHAPTER – 16

MULTI MODAL TRAFFIC INTEGRATION AT METRO STATIONS

16.1 INTRODUCTION

Ridership of a Mass Rapid Transit System is directly or indirectly dependent on the accessibility of the trip generating and trip attracting areas within catchment zone. Importance of Last mile connectivity becomes crucial. A well connected, integrated network of footpath, cycle and bus feeder system acts as complimentary modes to generate ridership of Metro. The steps that need to be considered for preparing an efficient multimodal integration plan for metro stations are:

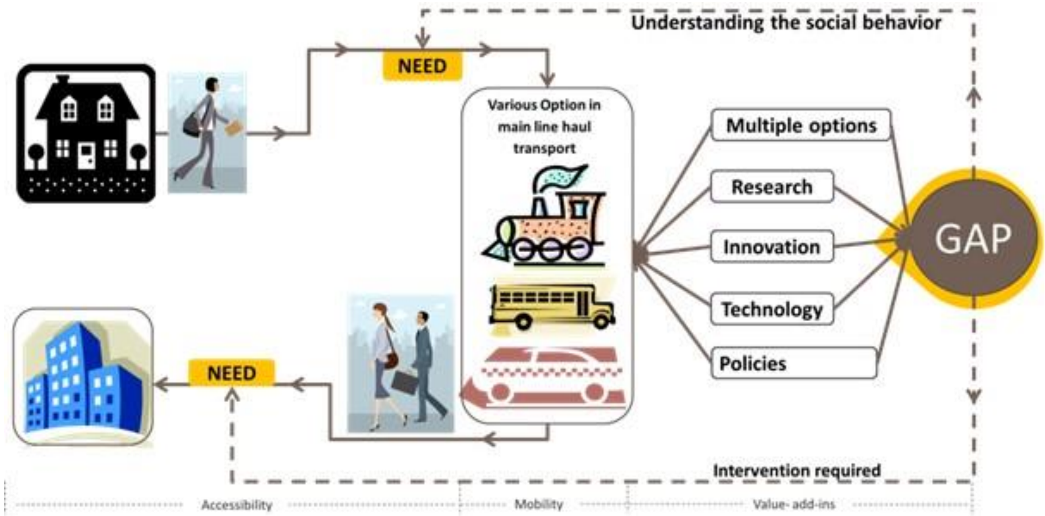
i. Defining requirement of last mile connectivity for multimodal integration at metro stations
ii. Assessment of existing and proposed land use to identify major trip demand points and trip attraction points
iii. Assess correlation of placement of station location and possibility of multimodal integration within station area
iv. Understand the road network and possibility of area level integration
v. Assess presence of pedestrian network, NMT lanes, IPT connectivity and Bus stops within catchment area.

16.2 NEED FOR MULTI MODAL INTEGRATION

Multimodal Integration ensures the smooth movement of commuters by various transportation modes like buses, IPT, private vehicles, NMT in such a way that efficiency is achieved in terms of time, cost, comfort, safety & accessibility. A successful multimodal integration can result in increased demand for public transportation by optimizing travel cost & time and allow seamless interchange between the various modes.

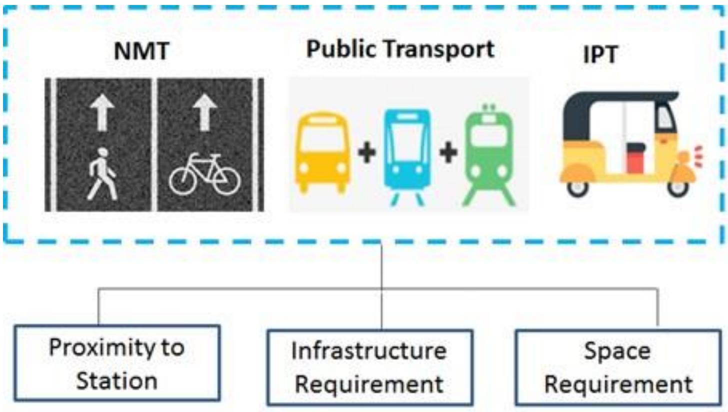
Multimodal Integration consists of combining and coordinating the operation of varied transport modes in order to offer continuous and door-to-door services. Intermodal facilities are infrastructures where people who use public transit can shift between different modes of transport. These infrastructure are especially planned to allow for the operation of at least two transport modes at the same time.

The approach to be adopted while planning for multi modal integration is to focus on last mile connectivity and ensure seamless travel from door to door.



16.2.1 Last Mile Connectivity

Last mile connectivity services enables commuters to easily plug in or transfer to main metro line at the start or at the end of their trips. They complement rapid transit services by offering commuters the complete trip they require. The quality of the last mile to a great extent influences transit ridership and the choice opted by users. The three key parameters to be considered while planning for multi modal integration is presented below:



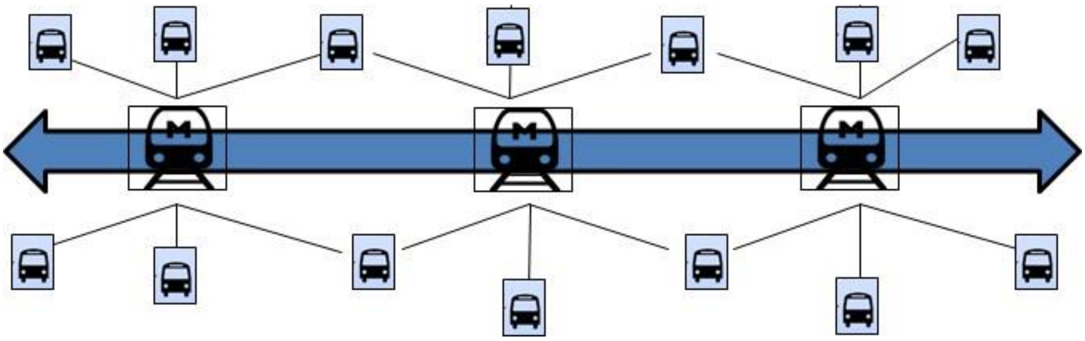
Last mile connectivity ensures ease of availability of mode and options reduce time and cost incurred in the last mile, ease of changing the mode and ease of walking/cycling to and from stops or stations.

16.3 MULTI MODAL INTEGRATION AT CORRIDOR LEVEL

At a corridor level analysis, the important criterion is to understand the present transport and transit scenario along the proposed study corridor. The availability of various transit options/modes and their characteristic is pivotal to carryout multi modal integration plans.

16.3.1 Feeder Services

Feeder becomes essential and majorly targets users beyond 1 km from metro catchment zone. Within 1 km, users would tend to take a NMT or walk to station, but absence of a feeder option beyond 1 km will propagate use of private modes. Feeder system ideally consists of buses/ mini buses/ shared autos operating within certain frequency in small loop routes, providing connectivity between trip generating/attracting areas and the linear network of metro.



The parameters to be considered for feeder service is as explained below:

- **Frequency:** The frequency of feeder buses should be in sync with metro timings and be at Ideally 5—10 min
- **Connectivity:** The feeder routes should connect nearest residential, commercial and activity centres to metro station based on Hub and Spokes model
- **Influence Areas/Catchment for Metro:** Assess the catchment area around the metro station around a radius of 3-4kilometres and identify major trip generation points in the vicinity
- Assessment of areas that are poorly connected by existing bus routes to the metro station
- **Bus Type:** Shuttle buses, mini vans, battery operated vehicles etc.

The existing public transport in Jaipur city comprises of both JCTSL buses and unorganized private mini buses operated by various private operators. An attempt has been made to rationalize the existing routes in order to improve the efficiency of public transport system and reduce the overlap with the proposed metro corridor. The existing PT routes should act as a feeder to the metro system and thereby improve the last mile connectivity.

The methodology followed to rationalize the existing PT/IPT routes is explained below:

- To map and analyse public transport route structure plying along the proposed and proposed metro corridor
- Assess which sectors within the catchment area are poorly connected by existing bus routes to the metro station

16.3.2 Existing Public Transport Routes

There are about 400 buses plying in the city under JCTSL. Other than the JCTSL bus services, there are about 2,300 mini buses plying through the city roads by private operators. JCTSL is presently operating 408 buses on 39 urban and sub-urban routes in Jaipur city. The details of the routes are presented in Table below.

Table 16.1: Details of City Bus Routes

Sl. No.	Route No.	From	To	Via	Distance (km)	Frequency (Minutes)
1	1	Todi	Transport Nagar	Harmada, Chomu puliya, Pittal Factory, Chandpole, GPO, M.I road, Sanganeri Gate	22	20
2	3	Sanganer	Kukas	Sanganer Police Station, Tonk Fatak, Rambhag, Ajmeri Gate, Sanganeri Gate, Badi Chaupar, Ramdhar Mod, Jal Mahal, Amber Fort	22	06
3	3A	Sanganer	Choti Chaupar	Sanganer Police Station, Jawahar Circle, Durgapura, Tonk Fatak, Rambhag, Narayan Singh Circle, Ajmeri Gate	14	06
4	3B	Pannadhay Circle	Kunda	Shoupur, Goshala, Sanganer Thana, Durgapura, Tonk Fatak, Ajmeri Gate, Sanganeri Gate, Badi Chopad, Joravar Singh Gate, Ramghar Mod, Amber, Kunda	28	30
5	3C	Mahatma Gandhi	Ajmeri Gate	Genpect, India Gate, Sanganer Police Station, Durgapura, Tonk Fatak, Rambhag, Ajmeri Gate	20	10
6	6A	Airport	Kirni Fatak	Malviya Nagar Sector 5 & 1+B 405, Underpass Bridge, Malviya Nagar Sector 1 - 3, Saras Dairy, JLN Marg, Dainik Bhaskar, Gandhi Nagar Station, Tonk Fatak, Rambhag, SMS, Ajmeri Gate, MI Road, Collectory Circle, Chinkar Canteen, Panipej, Chomu Pulia, Jhotwara	26	11
7	7	Khirni Fatak Pulia	Transport Nagar	Heerapura (New T.P. Nagar), Gaj Singh Pura, Kisan Dharm Kanta, Gurjar Ki Thadi, Triveni Nagar, Gopalpura, Rambhag, Narayan Singh	21	07

Sl. No.	Route No.	From	To	Via	Distance (km)	Frequency (Minutes)
				Circle, Moti Dungri, Govind Marg, Mental Hospital		
8	8A	Jagatpura	Chomu Puliya	Apex Circle, Jhalan, Gandhi Nagar Mod, Rambhag, Ajmeri Gate, MI Road, GPO, Sindhi Camp, Railway Station, Chinkara, Panipech	18	10
9	9	Agrawal Farm	Govindpura	Mansrower Madhyam Marg, Gurjar ki Thadi, Gopalpura, Tonk Phatak, Ajmeri Gate, MI Road, Collectrat, Chinkara, Chomu Puliya, Jhotwara, Joshi Marg	31	12
10	9A	Agarwal Farm	Dadi Ka Fatak	Vijay Path, Sipra Path, Maharani Form, Durgapura, Tonk Fatak, Rambhag, Ajmeri Gate, Sanganeri Gate, Badi Chaupar, Chandpole, Pittal Factory, Shastri Nagar, Vidyadhar Nagar, Alka Cinema, Road No. 1, Murlipura	28	07
11	9B	Mahatma Gandhi Hospital	Heerapura	Sitapura, India Gate, Sanganer Thana, Sanganer RICCO Chouraha, New Sanganer Road, Kisan Dharm Kanta, Heerapura	27	30
12	10B	Galta Gate	Niwaru	T.P. Nagar, Jawahar Nagar Shanti Path, Tilak Nagar, JDA Circle, Rambag Circle, Shakar Bhawan, Sodala, ESI No. 4, Hasanpura, Rialway Station, Chandpole, Pital Factory, Chomu Puliya, Jhotwara Kanta, Shalimar	25	15
13	11	Siwad Nagar	Goner	Meenawala, Khatipura, Railway Station, Chandpole, Ajmeri Gate, Durgapura, Sanganer Thana, Pratap Nagar, India Gate, 12 Meel, Vidhani	47	60
14	14	Jhotwara	Bassi	Khatipura, Vaishali Nagar, Sodala, Rambagh, Ajmeri	47	15

Sl. No.	Route No.	From	To	Via	Distance (km)	Frequency (Minutes)
				Gate, Transport Nagar, Kanota		
15	15	Chandpole	Chomu	Rampura, Jetpura	32	20
16	16	Ajmeri Gate	Chaksu	Tonk Phatak, Durgapura, Sanganer Thana, Pratap Nagar, 12 Mile, Bilwa, Shivdaspura, Shitla	42	15
17	18	Chomu Puliya	Kalwada	Jhotwada, Khatipura, Vaishali Nagar, Chitrakut Nagar, Heerapura, Bhankrota, Mahapura, Mahendra Sez	32	150
18	23	Ajmeri Gate	Ptarkar Colony	Rambagh, Gopalpura, Gurjar ki Tadi, Ganga Jamuna, Mansarower Madhyam Marg, Arawali Path, Patrakar Colony.	17	120
19	26	Chandpole	Bagru	Sodala, Purani Chungi, DCM, Heerapura, Bhankrota, Bad Ke Balaji, Dahmi Kala/ Sanjhariya	34	20
20	27	Mohanpura Watika	Goner	12mile, India Gate, Sanganer Thana, Tonk Phatak, Ajmeri Gate, TP Nagar, Khaniya, Luniyawas, Dantli, Siroli	48	30
21	28	Ajmeri Gate	Renwal	Tonk Phatak, Durgapura, Sanganer Thana, Malpura Gate, Balawala, Banyawali	31	20
22	30	Badi Chopad	Ramgarh	Jorawer Singh Gate, Ramgarh Mod, Sadawa	25	20
23	32	Narayan Vihar	Nayla	Bhakhar Paradise, Vardhman Nagar, Badarwas, Metro, Gopalpura, Rambhag, Ajmeri Gate, Ghatgate, Transport Nagar, Kanota, Nayla	42	20
24	AC 1	Sanganer	Kukas	Sanganer Police Station, Tonk Fatak, Rambhag, Ajmeri Gate, Sanganeri Gate, Badi Chaupar, Ramdhar Mod, Jal Mahal, Amber Fort	33	16

Sl. No.	Route No.	From	To	Via	Distance (km)	Frequency (Minutes)
25	AC 2	Joshi Marg	Mahatma Gandhi Hospital	Jhotwara, Choumu Pulia, Panipej, Railway Station, Chandpole, Badi Chaupar, Ajmeri Gate, Rambhag, Tonk Fatak, Durgapura, Sanganer Police Station, Pratap Nagar, Sitapura	33	10
26	AC 3	Todi	NRI	Todi, Chomu Pulia, Railway station, Ajmeri gate, Gopalpura, Sanganer thana, NRI	34	22
27	AC 5	Agrawal Farm	Amber	Mansrower, Madhayam Marg, Gurjar Ki Tadi, Gopal Pura, Ram Bagh, Ajmeri Gate, Sanganeri Gate, Badi Chopad, Ramghad Mod, Jal Mahal	29	16
28	34 (Mini Bus)	RIICO	Jaisinghpura Khor	Maharani Farm, Durgapura Railway Station, Triveni Nagar, Gopalpura, Rambagh, Ajmeri Gate, Badi Chopad, Subhash Chowk, Ramghar Mod.	24	16
29	37 (Mini Bus)	200 Feet	Muhana Village	200 feet, Metro,Vijay path,Muhana mandi, Muhana village	19	22
30	38 (Mini Bus)	Khirni Phatak Puliya	Jawahar Nagar	Panchawala Puliya, Karni Palace, Nursery Circle, Aamrapali Circle, Gandhi Path, Purani Chungi, Sodala, Rambagh, Ajmeri Gate, Gurudwara Mod, Barf Khana	19	22
31	39 (Mini Bus)	Agrawal Farm	Amber	Mansrower, Madhayam Marg, Gurjar Ki Tadi, Gopal Pura, Ram Bagh, Ajmeri Gate, Sanganeri Gate, Badi Chopad, Ramghad Mod, Jal Mahal	35	36

Source: http://transport.rajasthan.gov.in/

Other than JCTSL, private mini buses play a major contribution towards public transport as they ply on 136 routes with around 3950 vehicles. The routes overlap with the same routes as JCTSL.

16.3.3 Route Rationalisation of Existing Public Transport Routes

Route rationalisation is a crucial part of PT system and shall guide the routing of buses onto and off the proposed metro corridor to carry more passengers with fewer transfers between the stations and avoid overlapping with the existing/proposed metro corridors. The existing Bus/IPT routes shall acts as a complimentary/feeder routes to the metro system and improve the last mile connectivity.

The process of route rationalization is carried out with an analytic approach. First the existing public bus transportation routes are delineated; the overlapped routes are marked and analyzed. The following criteria are considered while categorizing the routes in rationalization process.

- **Overlap of route length with existing/proposed Metro corridor –** percentage of existing route length overlapping with the Metro corridor
- **Start and End point of route –** Origin or Destination within 2 to 3kms of catchment area of proposed metro corridor

The development frame work of the system is described in the graphical flow below.

Route Rationalization Approach

Route Retained (To ply in along the metro corridor)	**Routes to be curtailed**
✓ Overlapping route length – The routes that overlap 2 to 3 stations along the metro corridor and exits the corridor are retained ✓ Suburban routes with O/D outside the catchment area of metro corridor to continue to ply along the metro	✓ Overlapping route length ✓ Origin/Destination of the bus route lie within the 2 to 3km catchment area of the proposed metro alignment

Figure 16.1: Development Framework Diagram for Route Rationalization

Existing Public Transport routes overlapping with existing/proposed BRTS corridor are presented in Figure below:

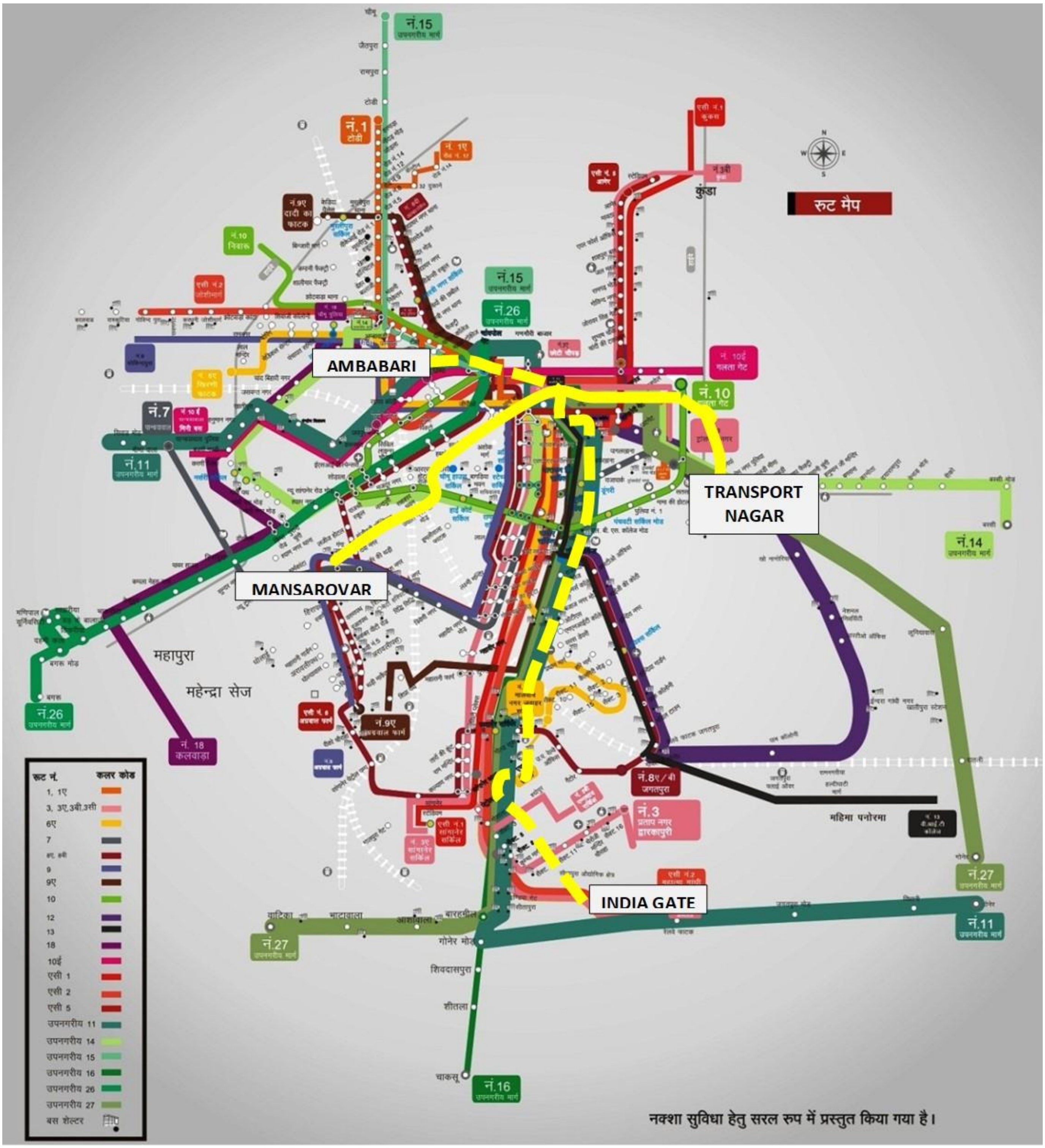


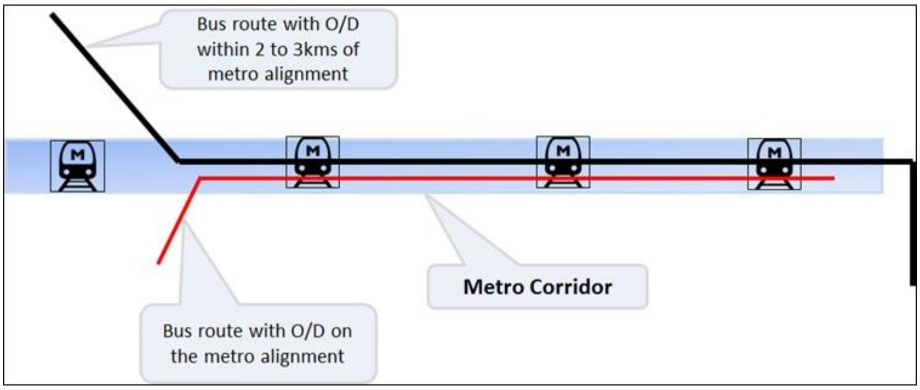
Figure 16.2: Details of City Bus Routes

16.3.4 Routes to be curtailed and run as feeder routes

The following routes were selected based on the overlapping length of the bus routes with the proposed metro alignment, origin and destination of the bus route. The criteria selected for the curtailment of the bus routes is discussed below:

- Either origin or destination of the bus route lies on the proposed metro alignment
- Origin/Destination of the bus route lie within the 2 to 3km catchment area of the proposed metro alignment

The schematic diagram is presented below:



It is observed that Public transit (Govt.bus services as well as private bus services) operate on the study corridor from India Gate to Ambabari. The routes that enter the study corridor were identified and studied in terms of overlapping length with the proposed metro corridor, number of bus stops within the proposed catchment area of metro corridor.

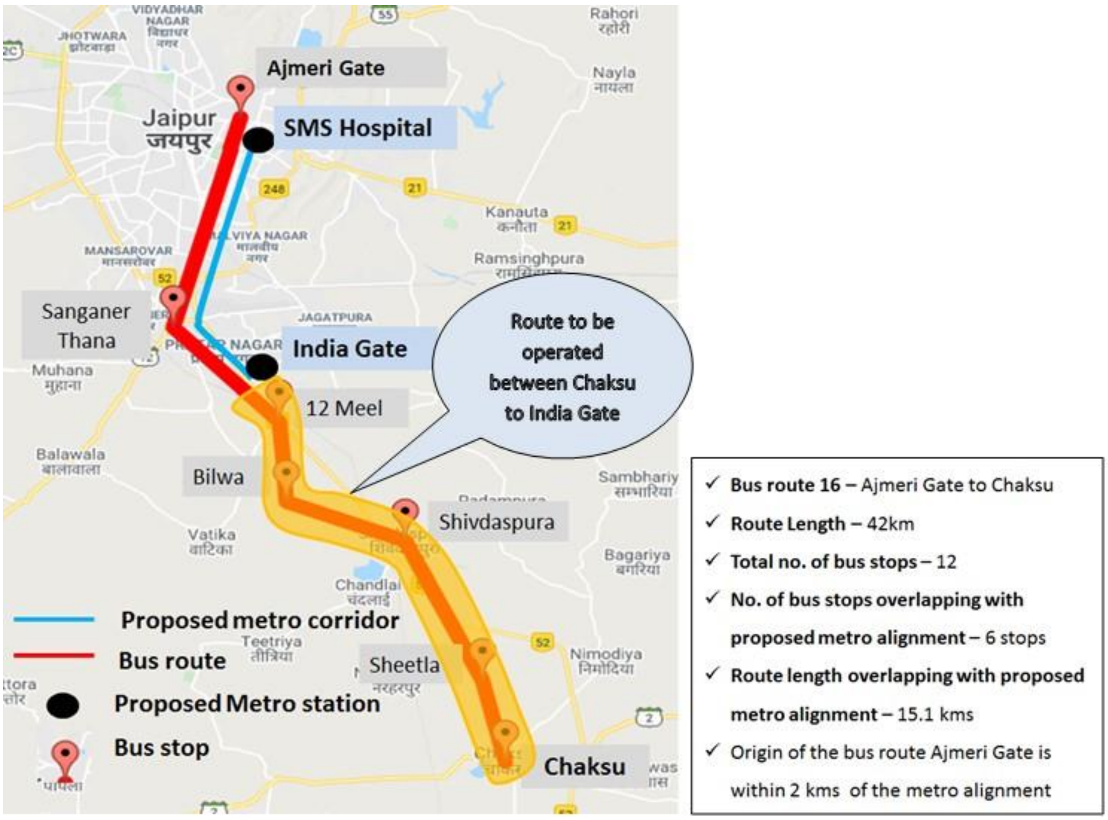


Figure 16.3: Rationalisation of Existing Route-16

An illustration of route 16 is presented below. Route 16 operates between Ajmeri Gate to Chaksu and the route length is 42 km. Around 35% of route length and 6 bus stops overlap with the proposed metro corridor. Hence it is proposed that the route to be curtailed and operate between Chaksu to India Gate stop. Ajmeri gate bus stop is within 2 km of the proposed metro alignment and can be catered by the other feeder routes.

Based on the analytical approach illustrated above, following existing bus routes have been identified and proposed to be curtailed and act as feeder routes to the metro system based on the parameters of route length, frequency and origin & destination of the bus routes.

Table 16.2: Details of routes proposed to be curtailed

Sl. No.	Route No.	From	To	Distance (km)	Frequency (Min)	Route Length Overlapping with Proposed Metro Corridor	O/D of the Bus Route within 2-3 km of the Metro Corridor	Proposed Curtailed Route	Percentage of Overlapping with Metro Corridor
1	1	Todi	Transport Nagar	22	20	12.65	Destination bus stop Transport Nagar on the metro corridor	Todi to Ambabari	58%
2	3A	Sanganer	Choti Chaupar	14	6	9.4	Sanganer stop on the metro corridor	Choti Chaupar to SMS Hospital	67%
3	3C	Mahatma Gandhi	Ajmeri Gate	20	10	10	Ajmeri Gate one stop outside the metro corridor	Mahatma Gandhi Hospital to Sanganer	50%
4	16	Ajmeri Gate	Chaksu	42	15	18	Ajmeri Gate one stop outside the metro corridor	From Chaksu to India Gate	43%
5	28	Ajmeri Gate	Renwal	31	20	9.1	Ajmeri Gate one stop outside the metro corridor	Gopalpura Mod to Renwal	29%
6	AC 1	Sanganer	Kukas	33	16	11	Sanganer stop on the metro corridor	Kukas to Rambagh	33%
7	AC 2	Joshi Marg	Mahatma Gandhi Hospital	33	10	13.7	Route 9B starts from Mahatma Gandhi Hospital and touches Tonk Road via Sitapur area. Hence it is proposed to curtail the route	Joshi Marg to Rambagh	42%

The routes that enter the proposed metro corridor for shorter distance were also identified and are presented in the Table below. The routes have been identified with respect to the Metro stations that they feed. Thus, it presents an idea of the routes that feed individual metro stations. They complement the proposed metro system by feeding onto the corridor and therein enabling a potential for integration between the two modes. Thus, station area level planning takes into consideration the presence of these complementing public transit routes and has accordingly provided for their infrastructure facilities.

Table 16.3: Details of City Bus Routes crossing the proposed Metro Stations

Station Name	Bus Routes
India Gate	9B, 11, 27
Kumbha Marg	9B, 11, 27
Haldi Ghat Gate	9B, 11, 27
Sanganer	3B, 9B, 11, 27
Bypass	3B, 11, 27
Durgapura	3B, 9, 9A, 11, 27
Mahaveer Nagar	3B,7, 9, 9A, 11, 27
Dev Nagar	3B,7, 9, 9A, 11, 27
Gandhi Nagar Railway Station	3B, 6A, 9, 9A, 12, 11, 27
Tonk Phatak	3B, 6A, 7, 9A, 12, 11, 27
Rambagh Circle	3B, 6A, 7, 8, 9A, 12, 11, 27
Narayan Singh Circle	3B, 6A, 7, 8, 9A, 12, 11, 27
SMS Hospital	3B, 6A, 8, 9A, 12, 11, 27
Collectorate	6A
Subhash Nagar	6A
Pani Petch	6A
Ambabari	6A

16.3.5 Private Bus Routes and IPT

Other than JCTSL, private mini buses play a major contribution towards public transport. Some of the routes run parallel on the same route as JCTSL. It is proposed that the routes overlapping with the proposed metro corridor be curtailed and act as a feeder to the proposed system. The list of routes proposed to be curtailed is presented in Table below:

Table 16.4: Details of private bus routes proposed to be curtailed

S. No.	Route Details	Proposed Curtailed Route
1	Chauki Dhani to Sirsi Road	Route to be curtailed and run from: 1. Chauki Dhani to India Gate Bus stop 2. SMS hospital to Sirsi
2	Kanakpura Railway Station to Pratap Nagar Kumbha Marg	Kanakpura Railway Station to SMS Hospital
3	Jaipur Railway Station to Malviya Nagar Sector 3	SMS Hospital to Railway Station
4	Bhatta Basti to Pratap Nagar	Bhatta Basti to SMS Hospital
5	Pratap Nagar to Khole Ke Hanuman Ji	Pratap Nagar to Khole Ke Hanuman Ji

There are certain routes that overlap with the proposed metro corridor for few bus stops and then exit the corridor. These routes are proposed to be feeder routes to the metro stations. The detail of the routes that shall act as a feeder to the proposed metro system is presented below:

Table 16.5: Details of Private Bus Routes crossing the proposed Metro Stations

Sl. No.	Private Bus Route	Metro Stations
1	Goner to Sanganer Police Station	Sanganer
2	Khirni Phatak to Jawahar Nagar	Rambagh Circle
3	Khole ke Hanuman Ji More Bus Stand to Patrakar Colony	Tonk road metro stations
4	Malviya Nagar (Sector 5,6,7) to Bhankrota	Tonk road metro stations Mahaveer Nagar, Dev Nagar, Gandhi Nagar, Tonk Phatak
5	Mansarovar to Jaisinghpura Khor	Tonk road metro stations Gandhi Nagar Railway Station, Tonk Phatak, Rambag Circle, Narayan Singh Circle, SMS Hospital
6	Nadi Ka Phatak – Railway Crossing to Goner Mod – 12 Mile	Tonk road metro stations Bypass, Sanganer, Haldi Ghat Gate, Kumbha Marg

Apart from Public transit, the other major focus for multi modal integration is IPT and NMT. Presence of IPT like autorickshaws and shared services was observed on the corridor. The IPT in Jaipur consists of modes like autorickshwas, shared autos/temp and e-rickshaws with about 15000 nos. on 31 dedicated routes. The frequency during peak hour is 3-5 minutes and during off-peak hour is 10 to 15 minutes. The list of the route that shall act as a feeder to the proposed metro system is presented below:

Table 16.6: Details of IPT Routes selected for Feeder Services

S. No.	IPT Route	Proposal
1	Sanganer to Goner, Tonk Road	Curtail from Goner Mod to India Gate
2	Malviya Nagar Sector no.3 Temp to Muhana Mandi	Feeder to Bypass Circle metro station
3	Jaipur Hotel, Tonk Road 200 Feet to Lalanpur	Feeder to Tonk road metro stations
4	Jagannathpura Fagi Road to SMS Medical College, Durgapura Railway Station	Feeder to SMS hospital metro station
5	Ramgarh Mod to Pannadhyay Circle	Feeder to Pratap Nagar metro station
6	Jagatpura Stand No.7 to Vatika Road Hanuman Mandir	Feeder to India Gate metro station
7	Sanganer Stadium to Nehru Sehkar Bhavan	Feeder to Tonk road metro stations
8	Jawahar Circle to Gandhi Nagar Railway Station (Platform no.1)	Route overlaps on Tonk road and shall be curtailed and act as a feeder route

16.3.6 Pedestrian Network

The provision of a pedestrian-friendly infrastructure at station access, on roads leading to transit stops is of utmost importance to enhance efficiency of rapid transportation system. As proposed in Jaipur CMP report, there is a need to improve the pedestrian network in the city as majority of roads lack pedestrian facilities. For construction of a new pedestrian network within the catchment area of proposed metro, following parameters should be considered:

- Land use distribution
- Important landmarks
- and missing pedestrian infrastructure links within the catchment area

This is followed by identification of major residential areas and major destinations within the surrounding of the proposed metro network. The network is planned with an assumption that construction of pedestrian network around the areas will improve local environment, encourage walking as well provide connectivity to metro stations.

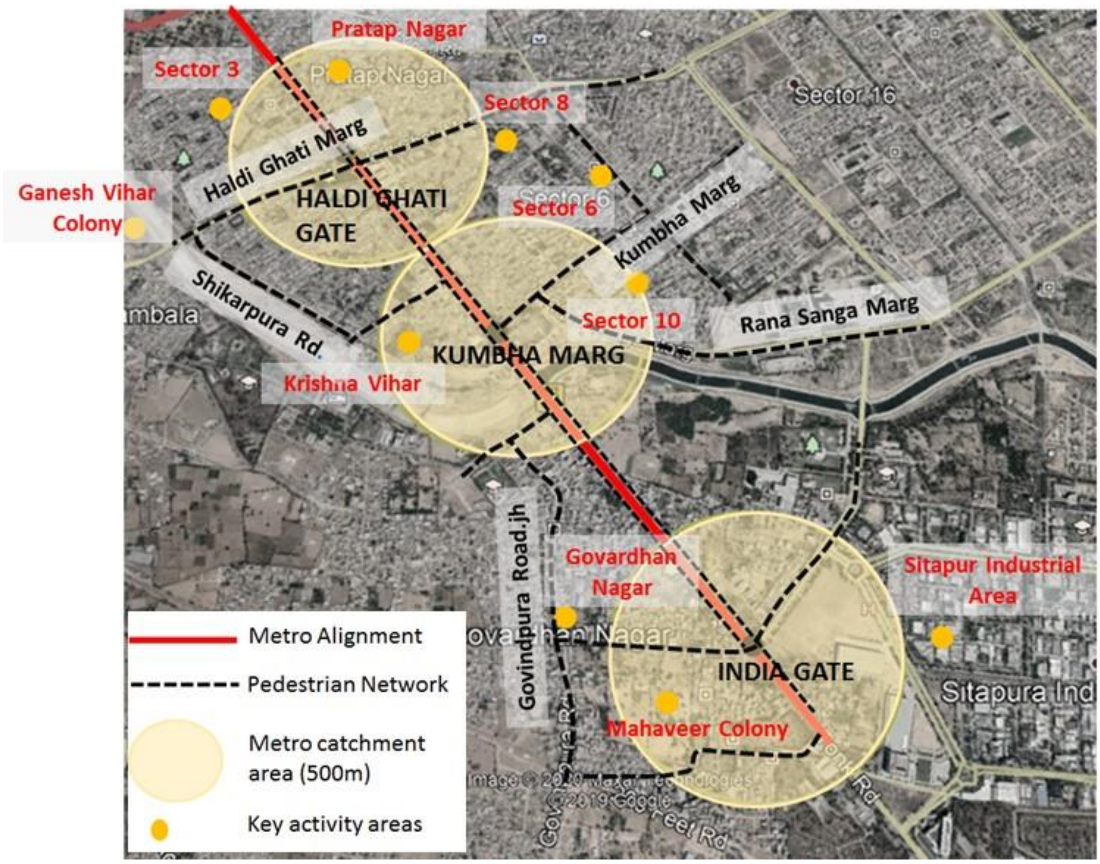


Figure 16.4: Pedestrian Network Improvement Proposal for Three Metro Stations

Corridor level intervention is proposed for proposed metro stretch that includes 21 stations from India Gate to Ambabari and typical representation of pedestrian network for metro stations (India Gate, Kumbha Marg, Haldi Ghati Gate) along the proposed corridor is presented above.

It is proposed to have pedestrian network along the existing roads within the catchment areas of 500m from the proposed metro alignment. The footpath width on the main corridor to be kept between 1.5 to 3m and on the side streets to be minimum 1.5m and maximum height of 150mm from the finished road surface. Pedestrian pathways should be upgraded through adequate infrastructure like width, paved surface, ease of crossing, universal accessibility, continuity and aesthetic improvements. This will create pedestrian friendly environment and encourage people to use the footpaths.

16.3.7 NMT and Public Bicycle Sharing

Public Bicycle Sharing (PBS) systems are a flexible public transport service that is created by a dense network of cycles to provide last mile connectivity. Along with having vehicular and pedestrian network along all vertical and horizontal networks, provision of cycle lane or non-motorized lane is necessary to boost use of sustainable and non-motorized modes. To facilitate use of cycles as last mile connectivity to metro station, provision of cycle docking station should be made at metro station, and also in major residential, commercial, institutional areas. A cycling network is incomplete without facilitating docking stations at places beyond metro stations.

PBS has to be segregated from main carriageway and to accommodate the same along the metro corridor land needs to be acquired. Also docking stations has to be proposed at stations which cannot be accommodated in the existing scenario due to non availability of extra land parcels. Hence it is suggested that the proposal of cycle track to be incorporated in future proposals of road widening along the metro corridor and its catchment area so as to improve the last mile connectivity.

16.4 MULTI MODAL INTEGRATION AT STATION AREA LEVEL

Multimodal integration at station areas is crucial as it aims at seamless integration of modes at metro station. It is generally an integration of spaces and its relation between accessible modes to and from metro station. It should also be sustainable and provide affordable mobility solution to metro users. Thus, station area planning and design should ensure integration with Public Transport (PT), Intermediate Public Transport (IPT) and NMT provisions.

Station area should include provision of safe, accessible and comfortable infrastructure provision. Station area infrastructure includes bus stops, IPT stops, continuous and connected pedestrian network, information board with feeder timings, adequate lighting and interactive public space outside metro with seating area with self-explanatory signage’s and symbols. Purpose of a station area plan is to make last mile more accessible.

The basic design principles to be followed for station design are presented below:

Figure 16.5: Design Principles for Intermodal Integration at Metro Station Area

16.4.1 Standard Practices and Guidelines

In order to carry out station area level design for multi modal integration, the standard practices and guidelines were referred to guide the design process. As a part of which, IRC and UTTIPEC guidelines and reference documents including: Street Design Guidelines, Street Design Checklist and MRTS Connectivity and Multimodal Integration – Checklist, were referred.

The elements that constitute an integrated station area level design including sidewalks, transit stops, cycle docks, travel lanes etc. all vie for space within the limited available space. Hence, the judicious allocation of space as per their characteristic requirements is of utmost importance.

Footpath or sidewalk, provided on both edges of the street, should be walkable, clean and safe for pedestrians. It should be free from encroachments, parking and utility obstructions. In furtherance, it should be continuous and should ensure universal accessibility. As a standard practice, universal accessibility features (like barrier free designs) is required for all elements like sidewalks, crossings, public spaces and amenities.

Modal interchange facilities have also been specified to ensure seamless connectivity to the metro users while also ensuring accessibility to the mobility impaired. The bus stop locations should be within 50m level walk from the station exits. Pick-Up & Drop-Off should be located without interfering with barrier-free movement of exiting pedestrians and movement of Non-motorized vehicles. These should be located away from main pedestrian exist, so as to ensure to interference in pedestrian movement.

Further, the location and quality of facilities outside the station premises including NMT and IPT facilities should be within the Multi-Functional Zones. Adequate Information maps and boards including Way finding Maps, Bus information & timetable, IPT stands/

Pick-Up & Drop-Off zones etc. should be present in the station premises to aid metro users.

A conceptual design of intermodal integration at elevated metro station based on requirements is shown in figure below:

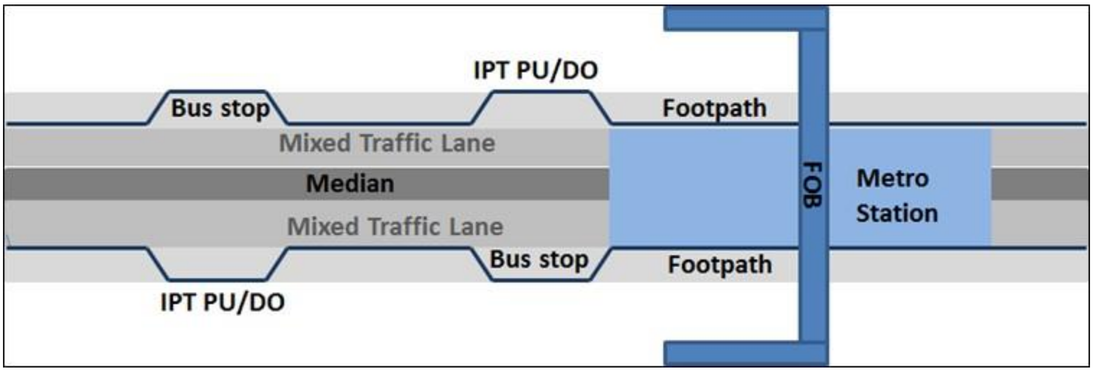


Figure 16.6: Conceptual Design for Intermodal Integration at Metro Station Area

As per the design, provision of passenger access and egress are located at the entry and exit of metro station for easy accessibility. Two lane divided road with footpath on each side is proposed for most of the stretch along the metro alignment. Bus stops and IPT pick up/drop off are proposed near the station.

16.4.2 Station Area Design

The purpose of developing station area plans is to make last mile more accessible and integrated. This would ensure integration between the various modes present in the city. Moreover, adequate facilities for Non-Motorized modes including Pedestrian is also required to ensure a smooth transit experience.

Station area planning and design was carried out in lieu of the standard design practices. Every station area unit was designed as per contextual constraints and demands. A typical station area planning took into consideration three integral components besides the mandatory station provisions, which are:

- Bus Stops
- IPT Pick-Up and Drop-Off provisions and
- Footpath provisions

A complete station area planning is envisaged as an integrated design consisting of the above-mentioned components. While designing the vehicular movement around the station area, the location of the trees has also been considered to avoid tree cutting. A typical multi-modal integration plan incorporating the various elements is shown in the figure below.

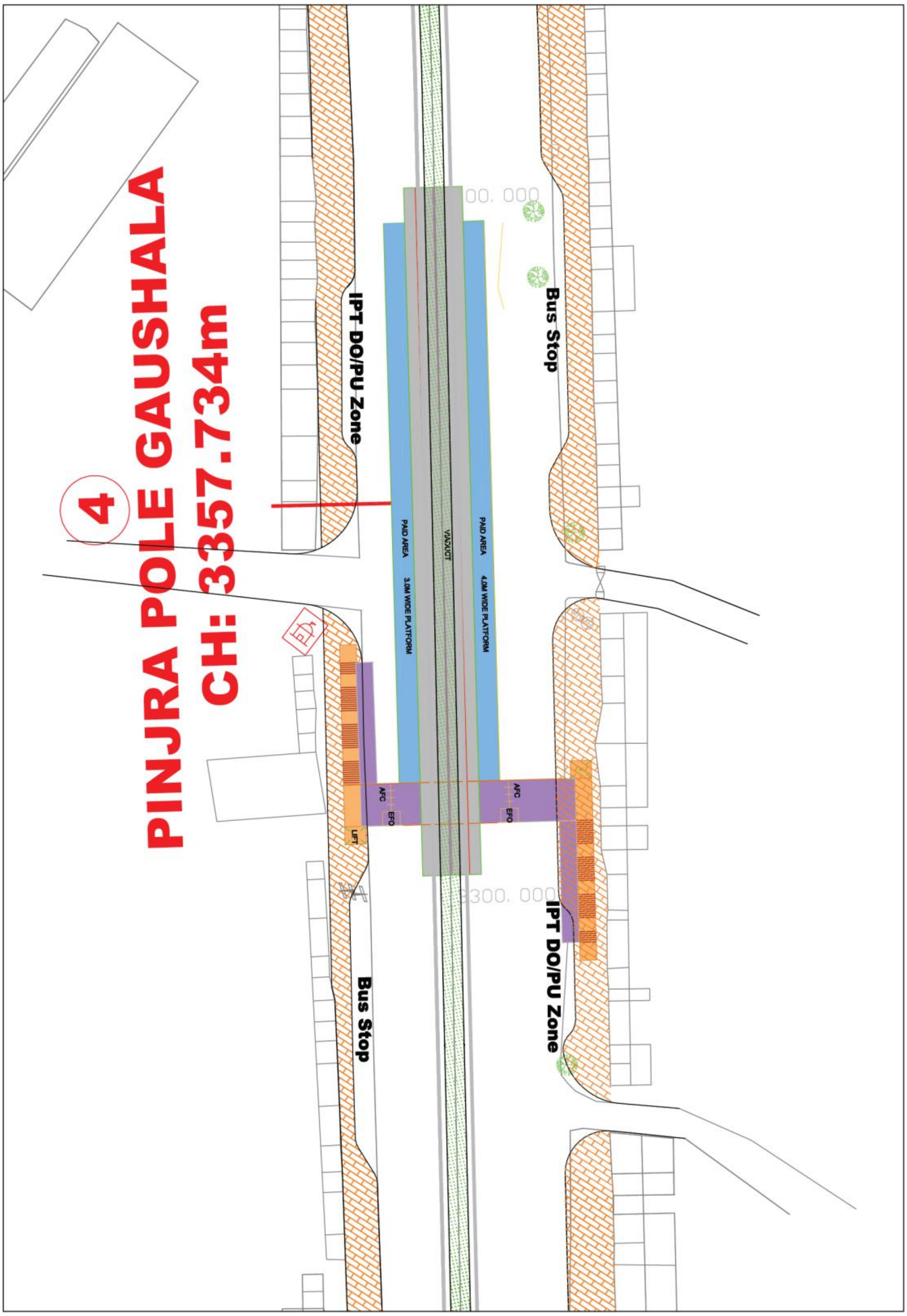
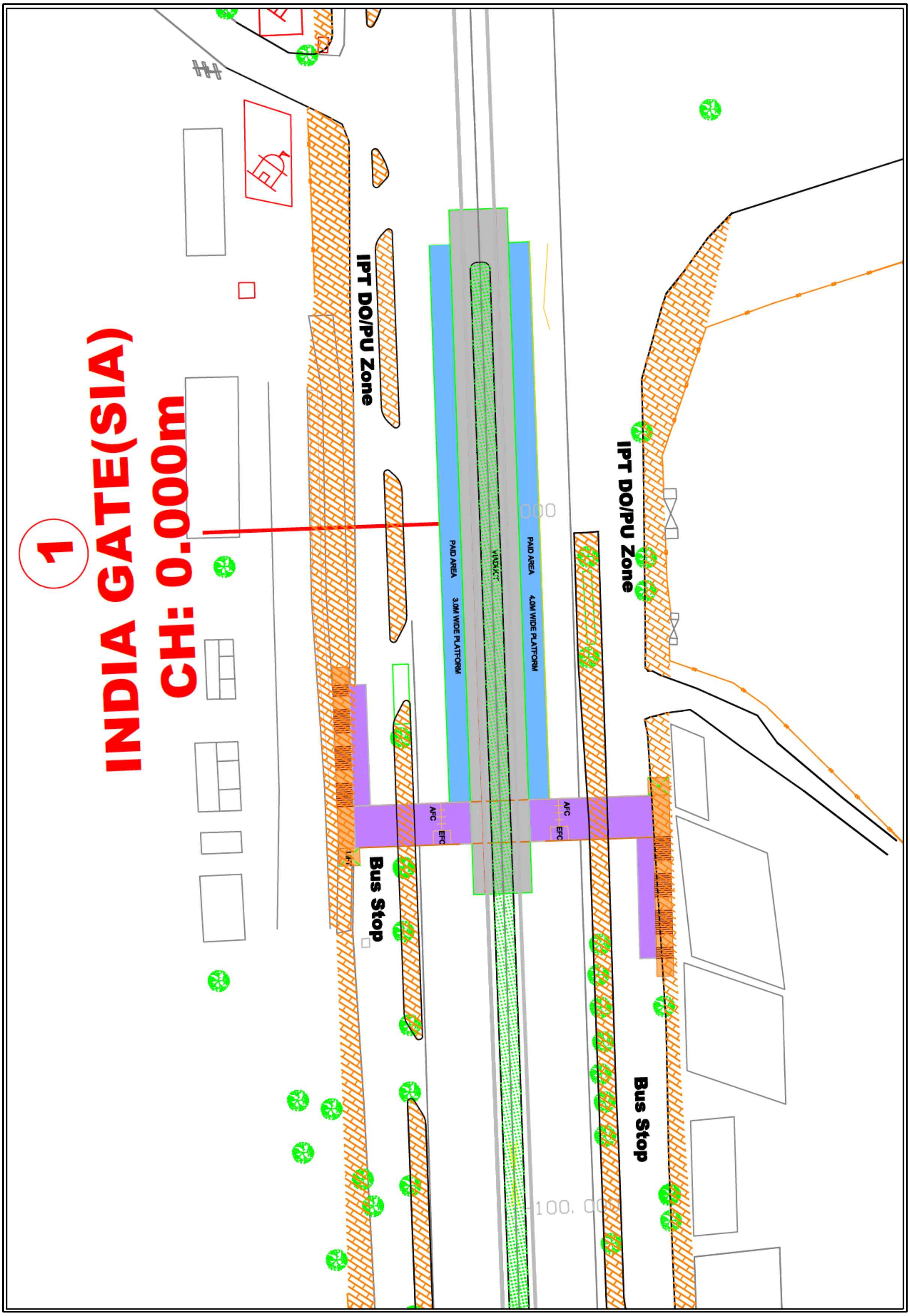


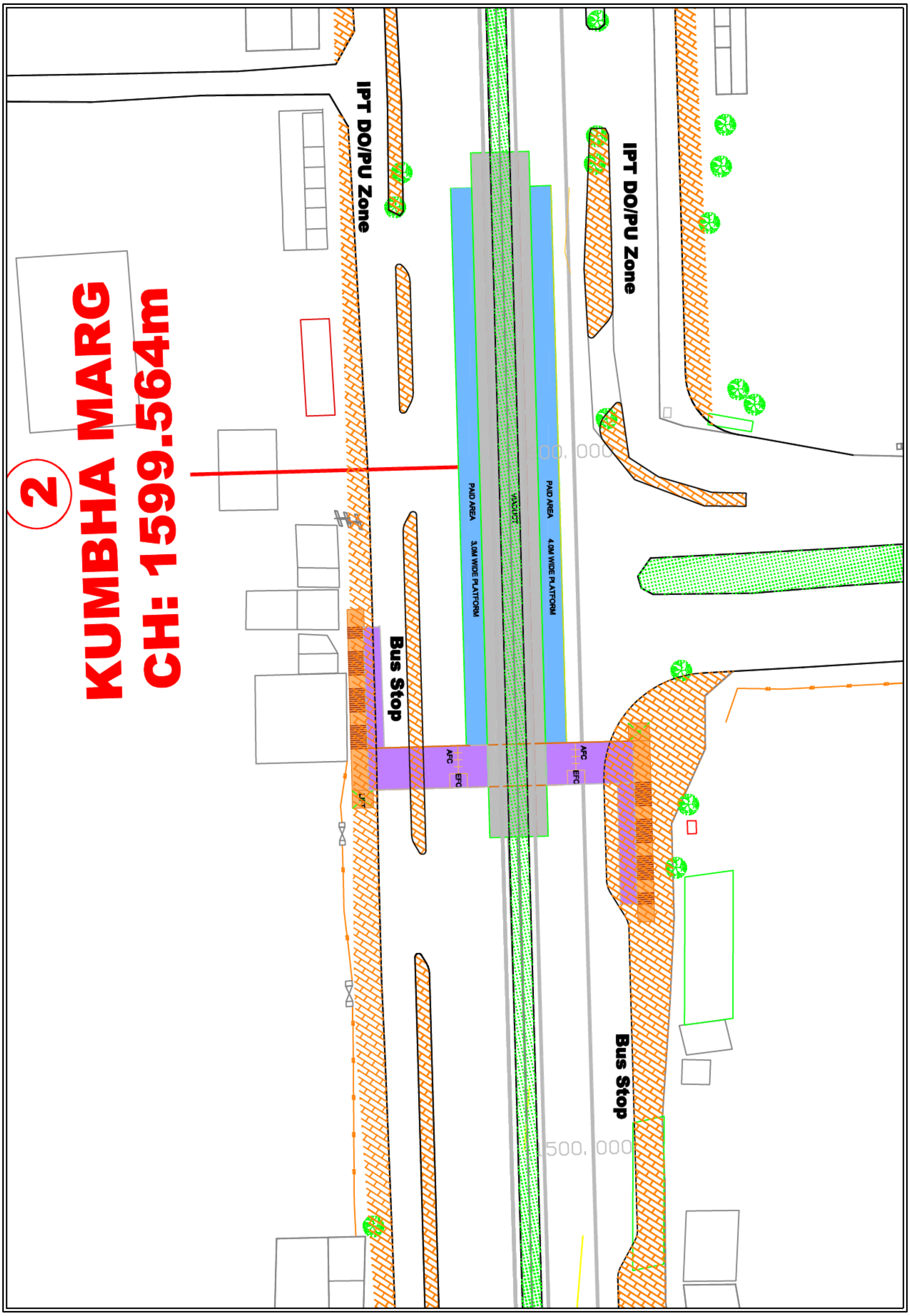
Figure 16.7: Typical Multi-modal Integration Plan at Metro Station Area for Jaipur Metro Phase-2

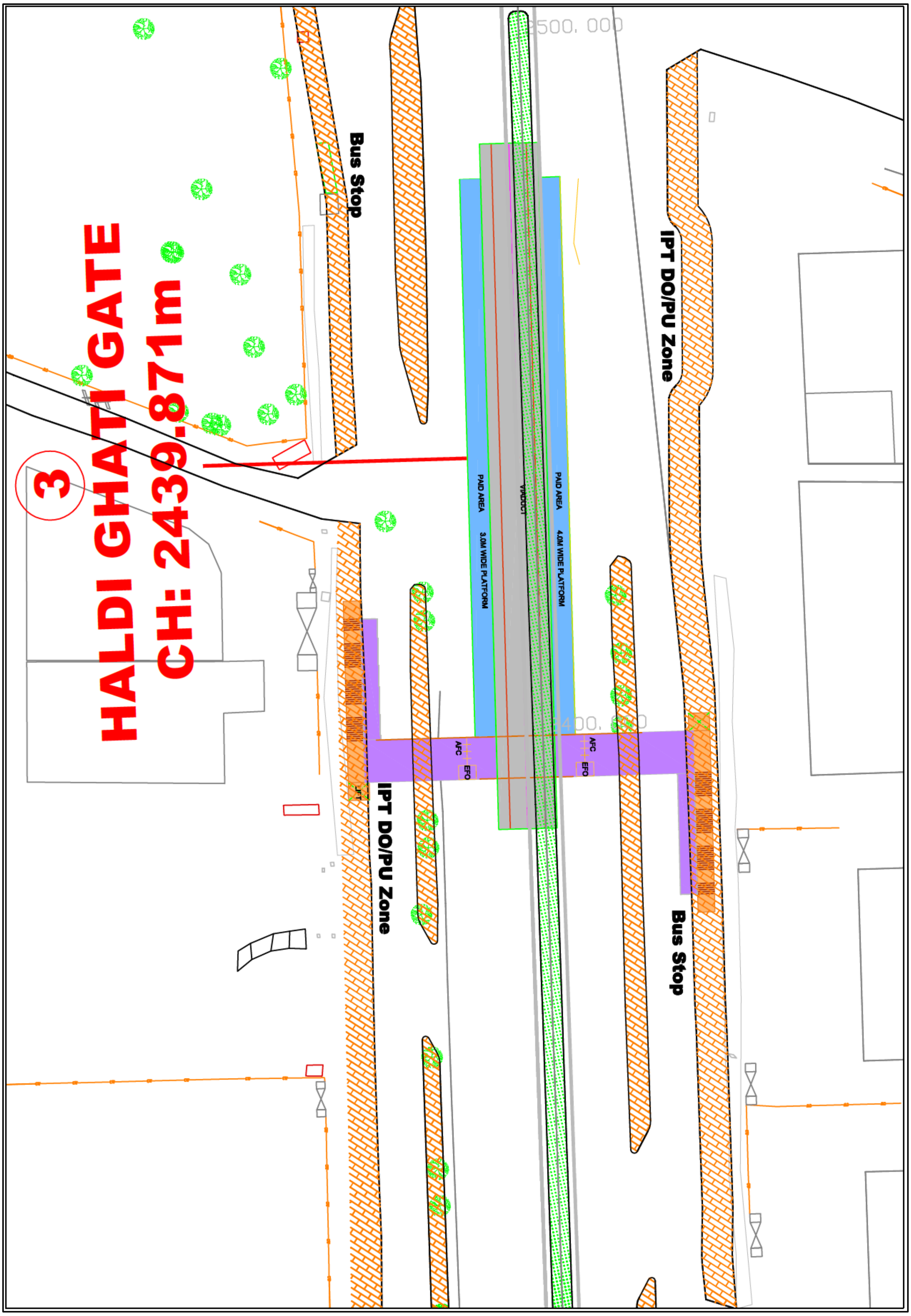
As can be seen from the above figures, a typical station area plan incorporates the infrastructure provisions for PT, IPT and Footpath, so as to provide a seamless connectivity for metro users. Adequate footpath provision of width ranging from 1.5m to 3.0 m depending on the availability of the land has been ensured at all station area. The bus stops have been designed to accommodate two buses and with a width of 3 m and length of 45 m. In addition to the provision for bus stops, Pick-Up and Drop-Off points have also been designed within the station areas. For all Pick-Up and Drop-Off spaces designed within the station modules, a minimum width of 2 to 3 m has been maintained. The distance between the bus station and pick up/drop off points is kept at 25 m for the vehicles to maneuver.

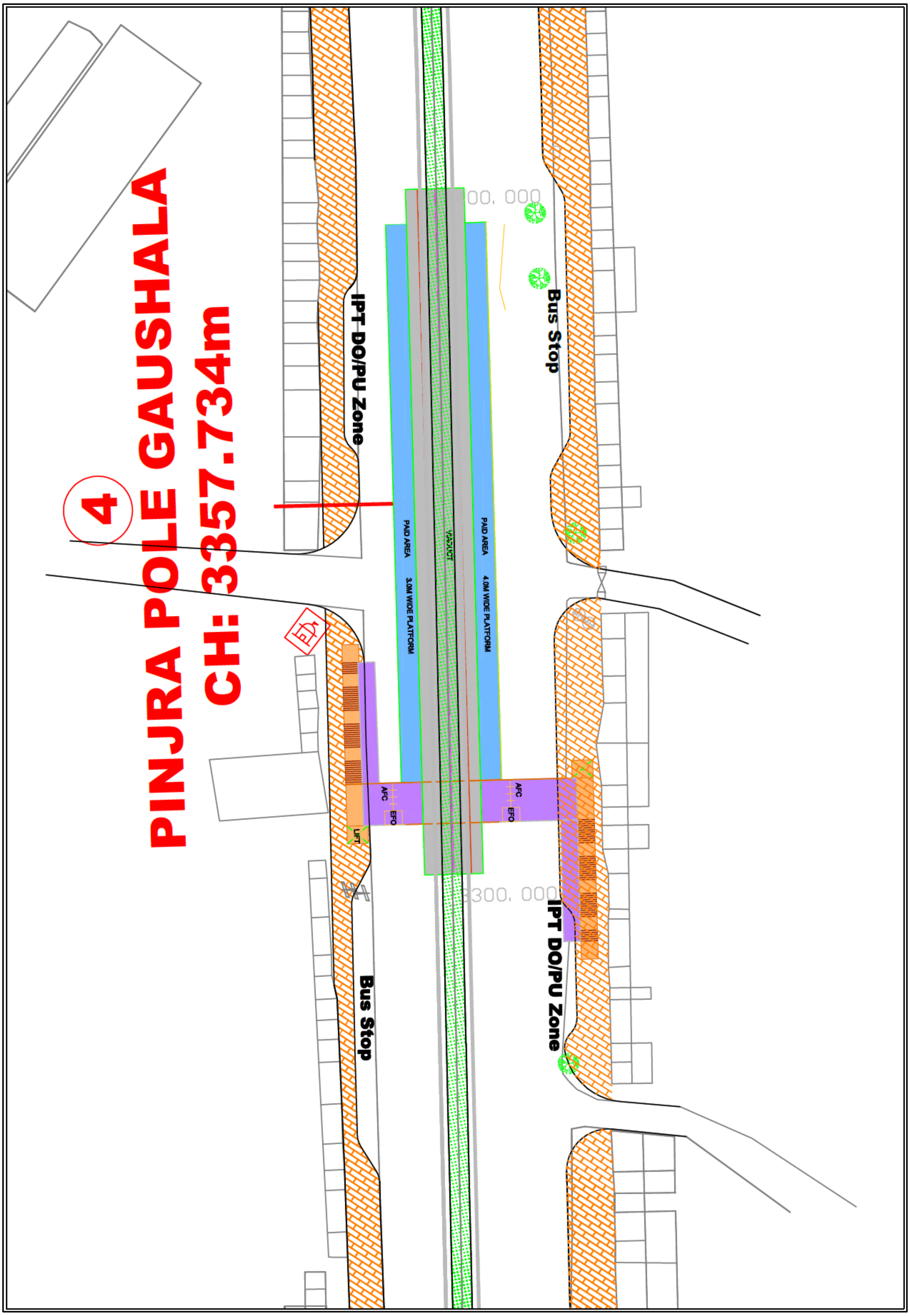
However, in case of land constraints at station areas, priority is given to provision of PT infrastructure than the IPT pick-up and drop-off points, wherein the latter is accommodated slightly further away from the station area locations. These would be having a length of 25 m and a width of 2.0 m.

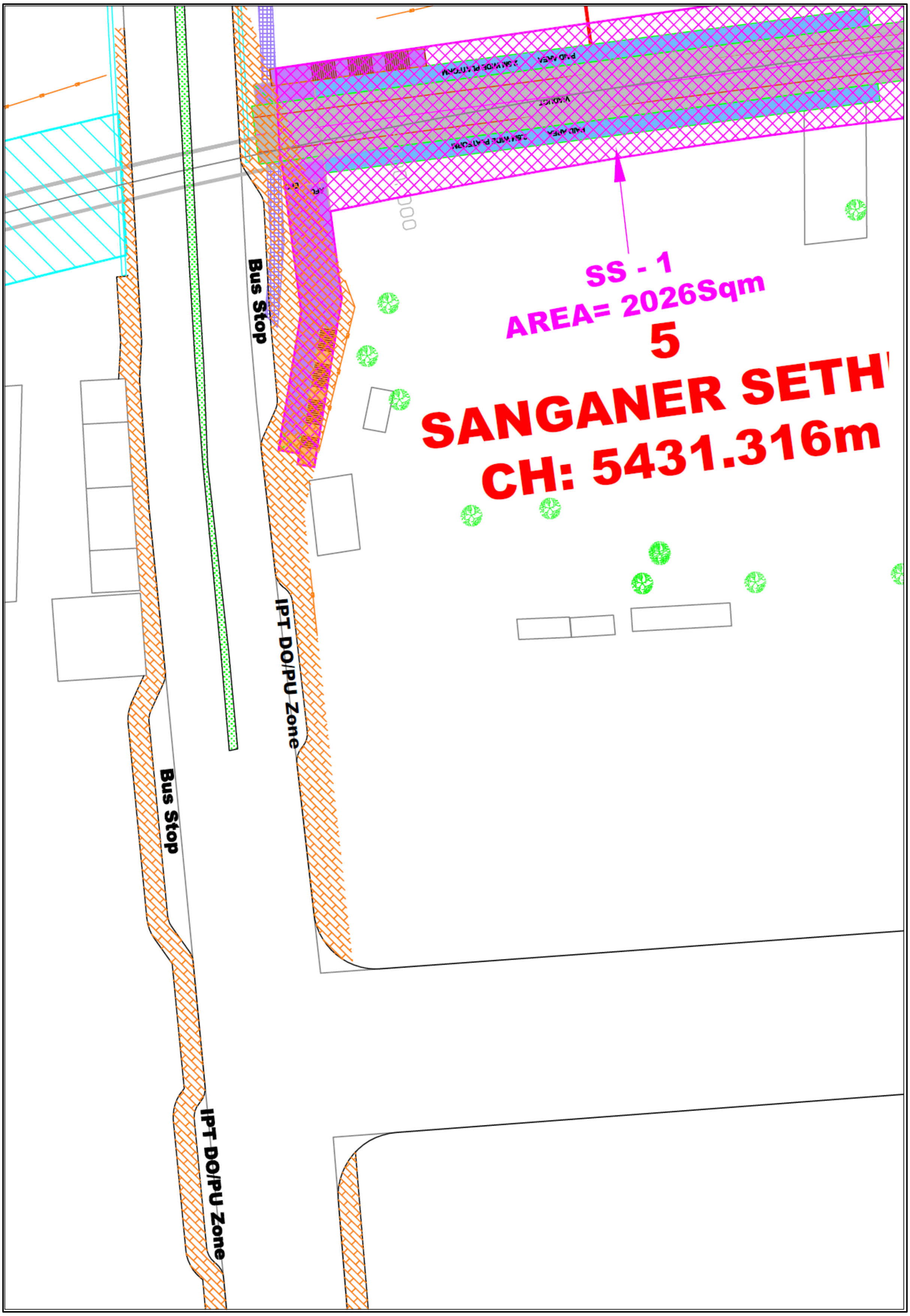
Provision of passenger access and egress area should ideally be located at the entry and exit of metro station for easy accessibility. The design caters to the above-mentioned aspects pertaining to PT, IPT and NMT facilities to ensure integration between the modes and metro. The above-mentioned facilities and infrastructure provisions have been designed for all entry/exit points of the metro stations. The designs have been developed such that, the integration with all mentioned facets have been achieved. Individual station location wise designs are presented below.

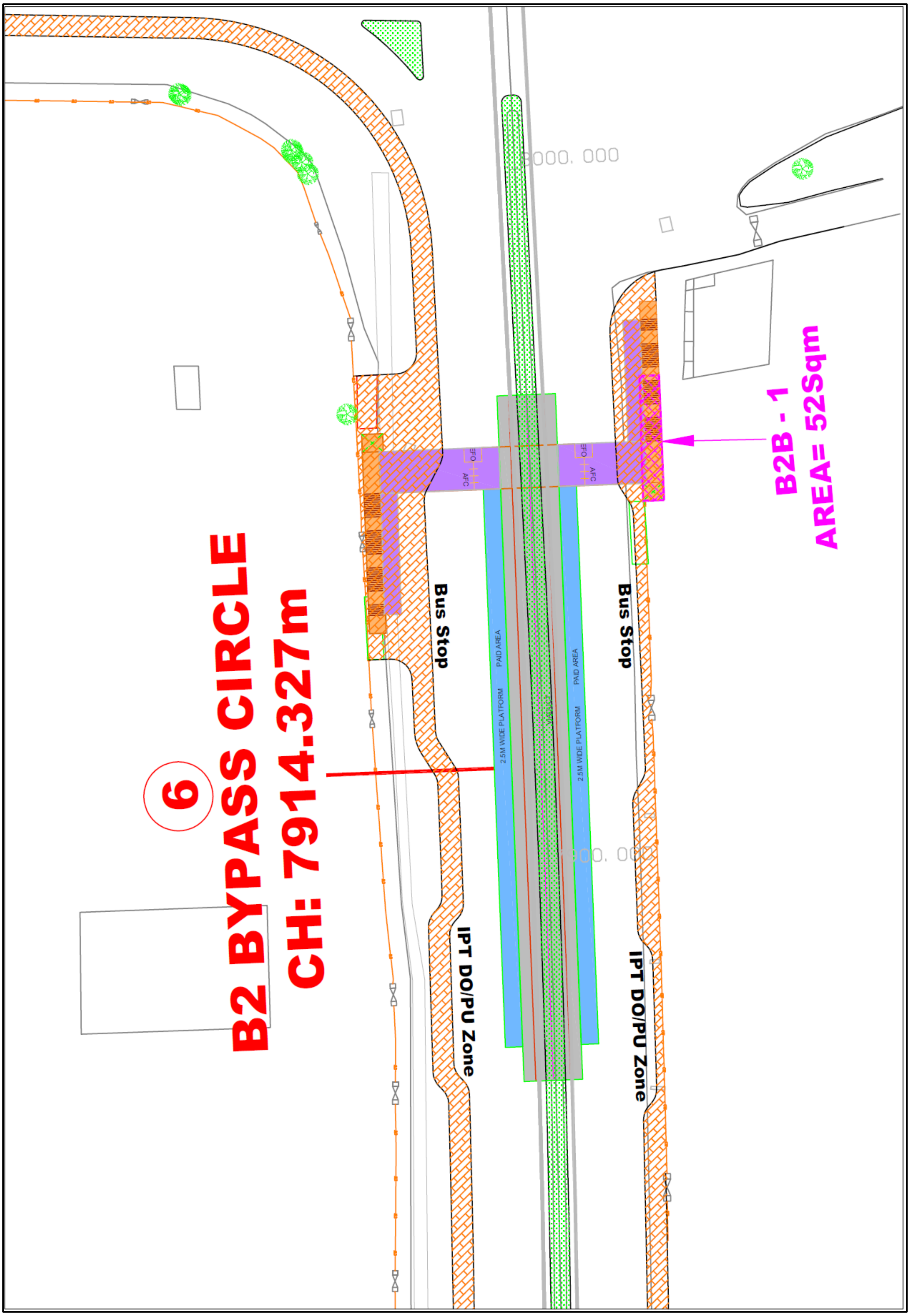

1
INDIA GATE(SIA)
CH: 0.000m
IPT DO/PU Zone
IPT DO/PU Zone
PAID AREA
3.0M WIDE PLATFORM
PAID AREA
4.0M WIDE PLATFORM
AFC
EFC
AFC
EFC
Bus Stop
Bus Stop

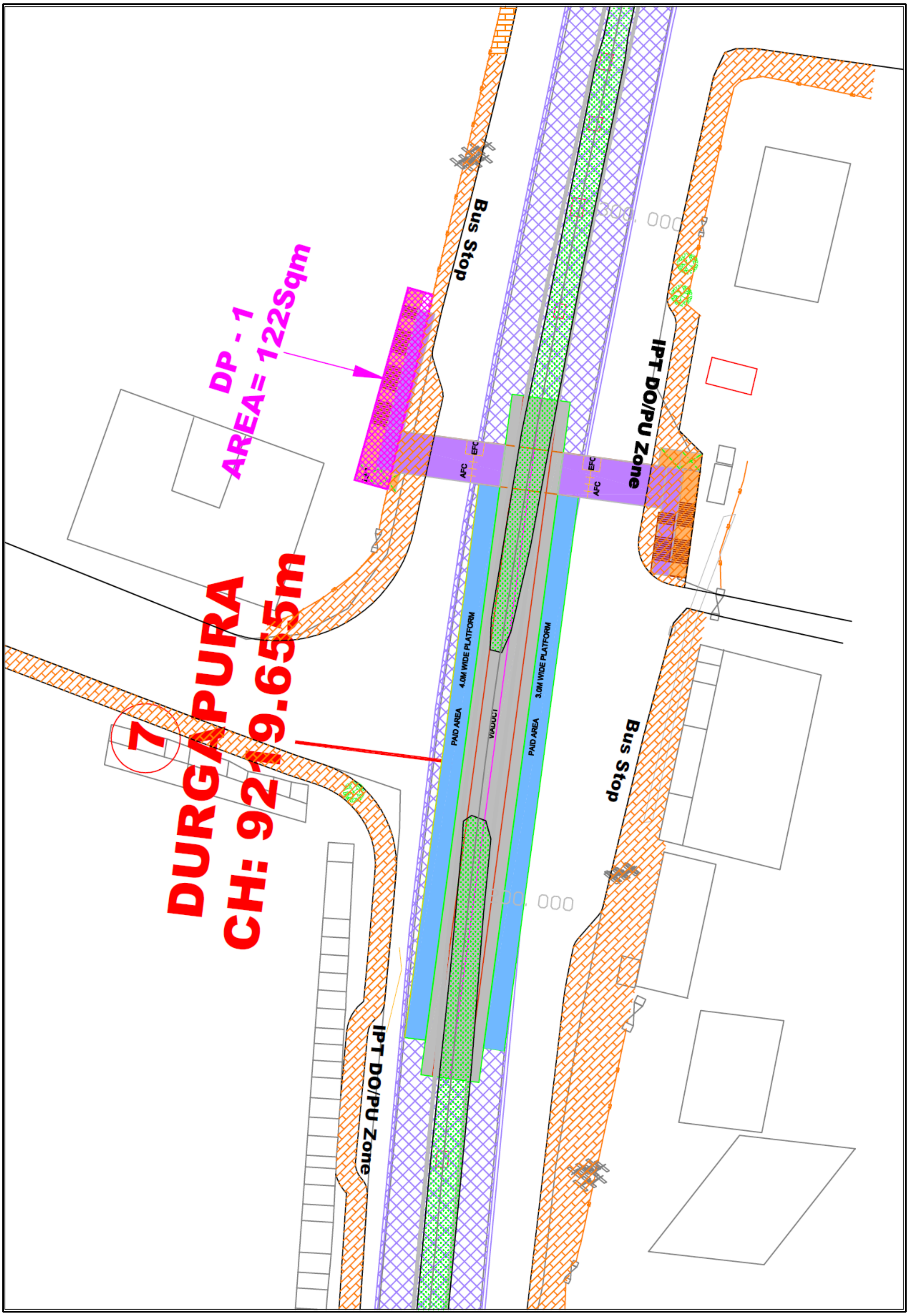

IPT DO/PU Zone
IPT DO/PU Zone
2
KUMBHA MARG
CH: 1599.564m
Bus Stop
Bus Stop
PAID AREA
3.0M WIDE PLATFORM
VIADUCT
PAID AREA
4.0M WIDE PLATFORM
AFC
EFC
AFC
EFC

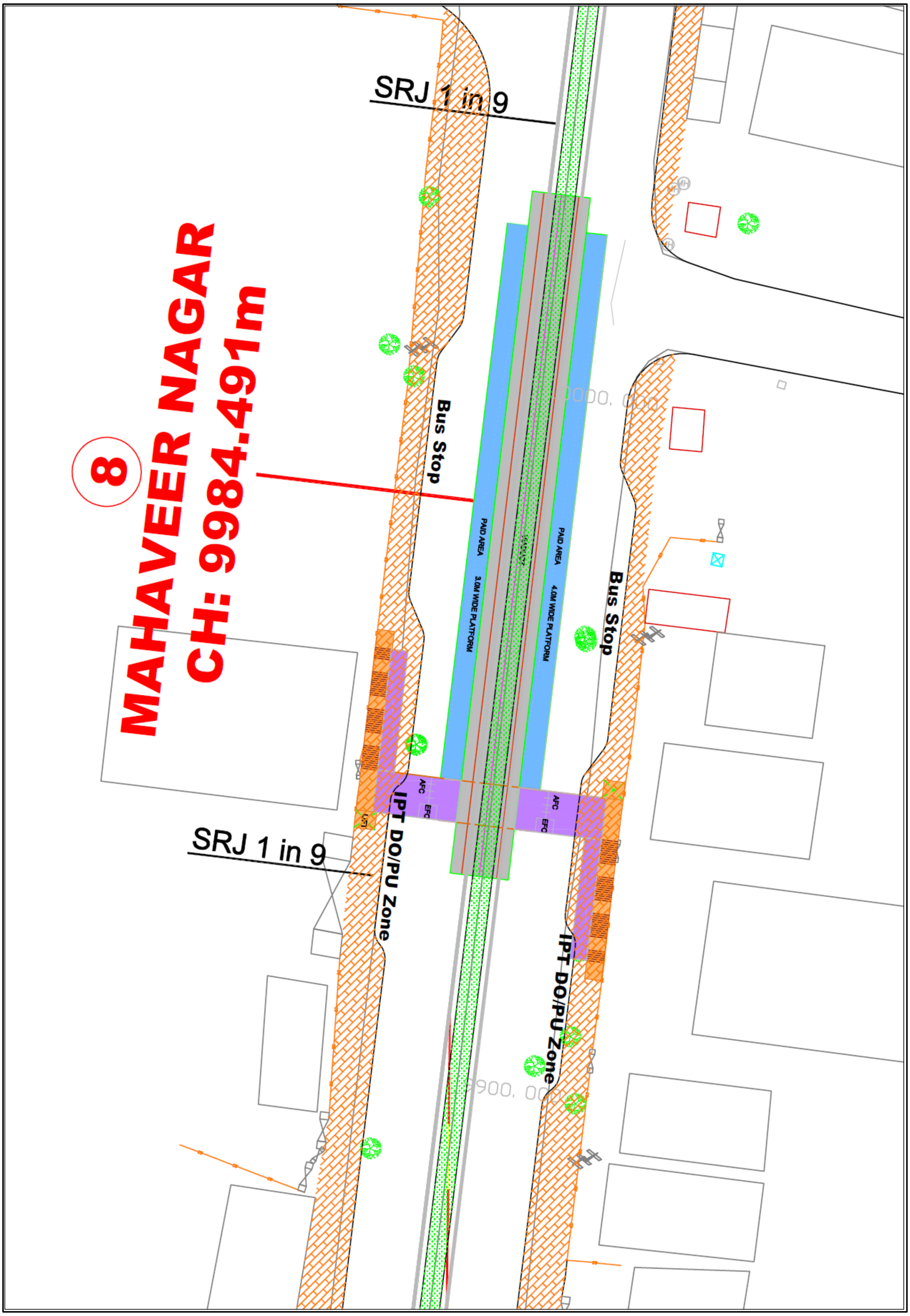

3
HALDI GHATI GATE
CH: 2439.871m
Bus Stop
IPT DO/PU Zone
PAID AREA
3.0M WIDE PLATFORM
4.0M WIDE PLATFORM
VIADUCT
AFC
EFO
IPT DO/PU Zone
Bus Stop

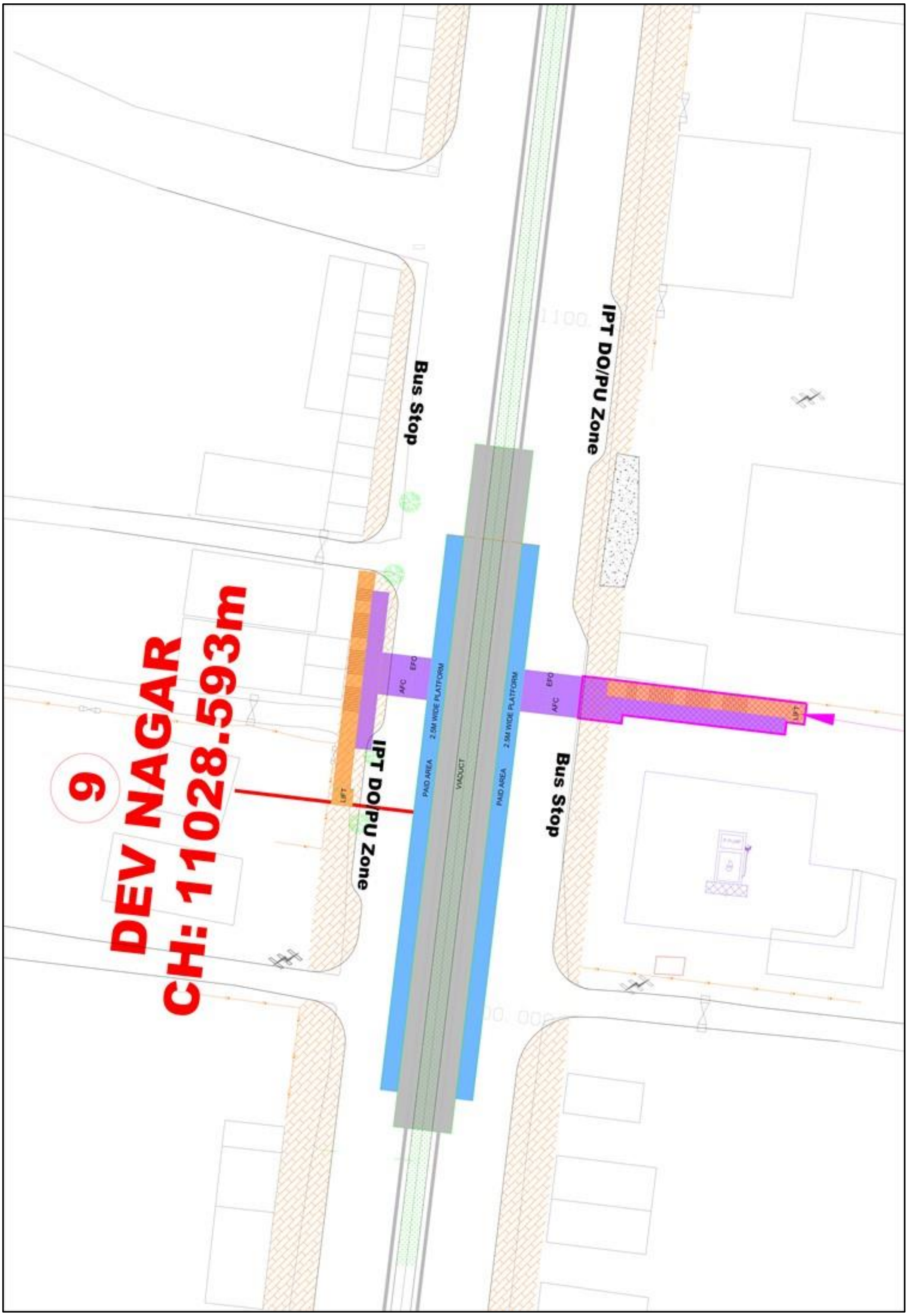

4
PINJRA POLE GAUSHALA
CH: 3357.734m
IPT DO/PU Zone
Bus Stop
PAID AREA
3.0M WIDE PLATFORM
VIADUCT
PAID AREA
4.0M WIDE PLATFORM
AFC
EFO
AFC
EFO
LIFT
Bus Stop
IPT DO/PU Zone

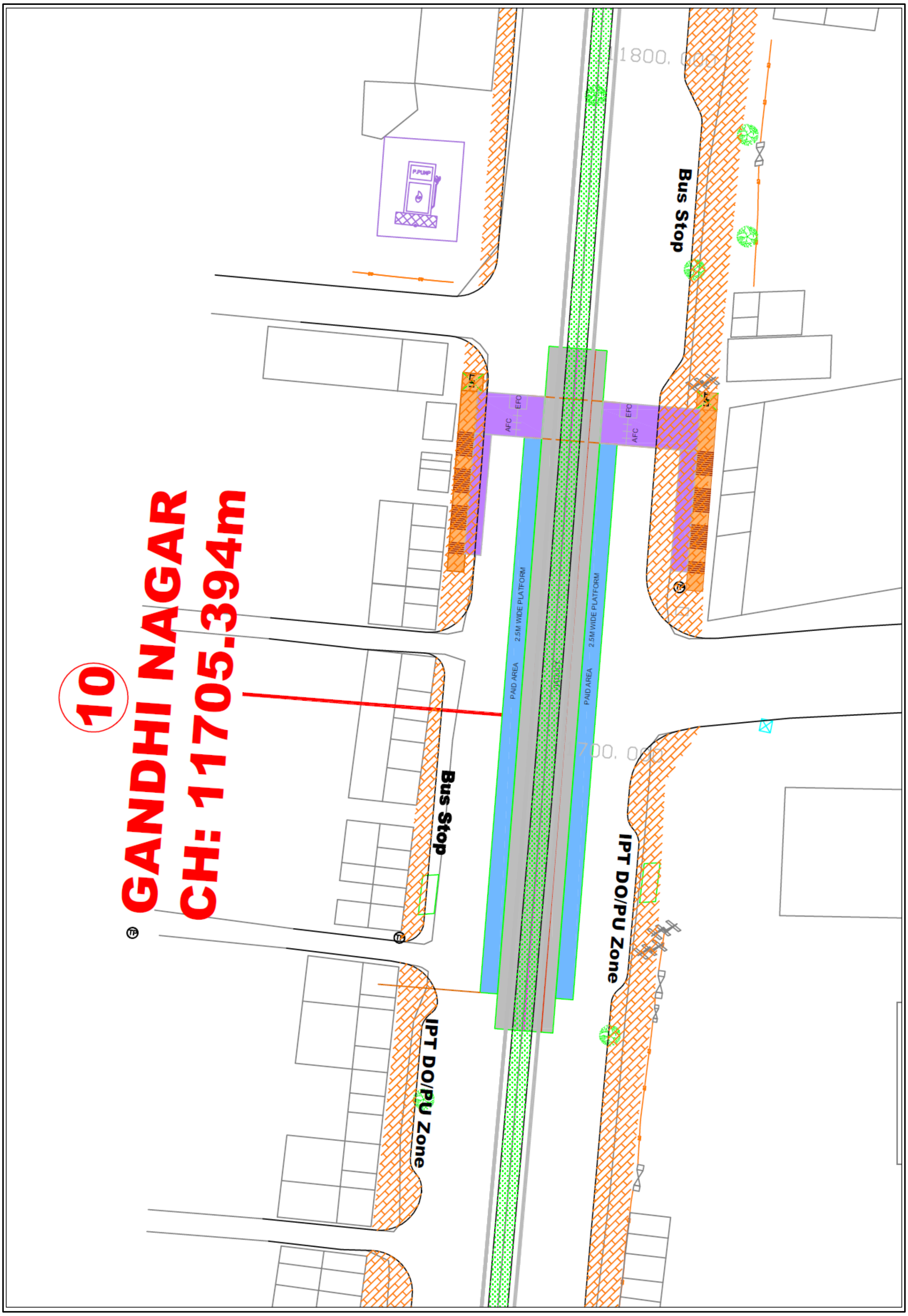

SS - 1
AREA= 2026Sqm
5
SANGANER SETH
CH: 5431.316m
Bus Stop
IPT DO/PU Zone
Bus Stop
IPT DO/PU Zone

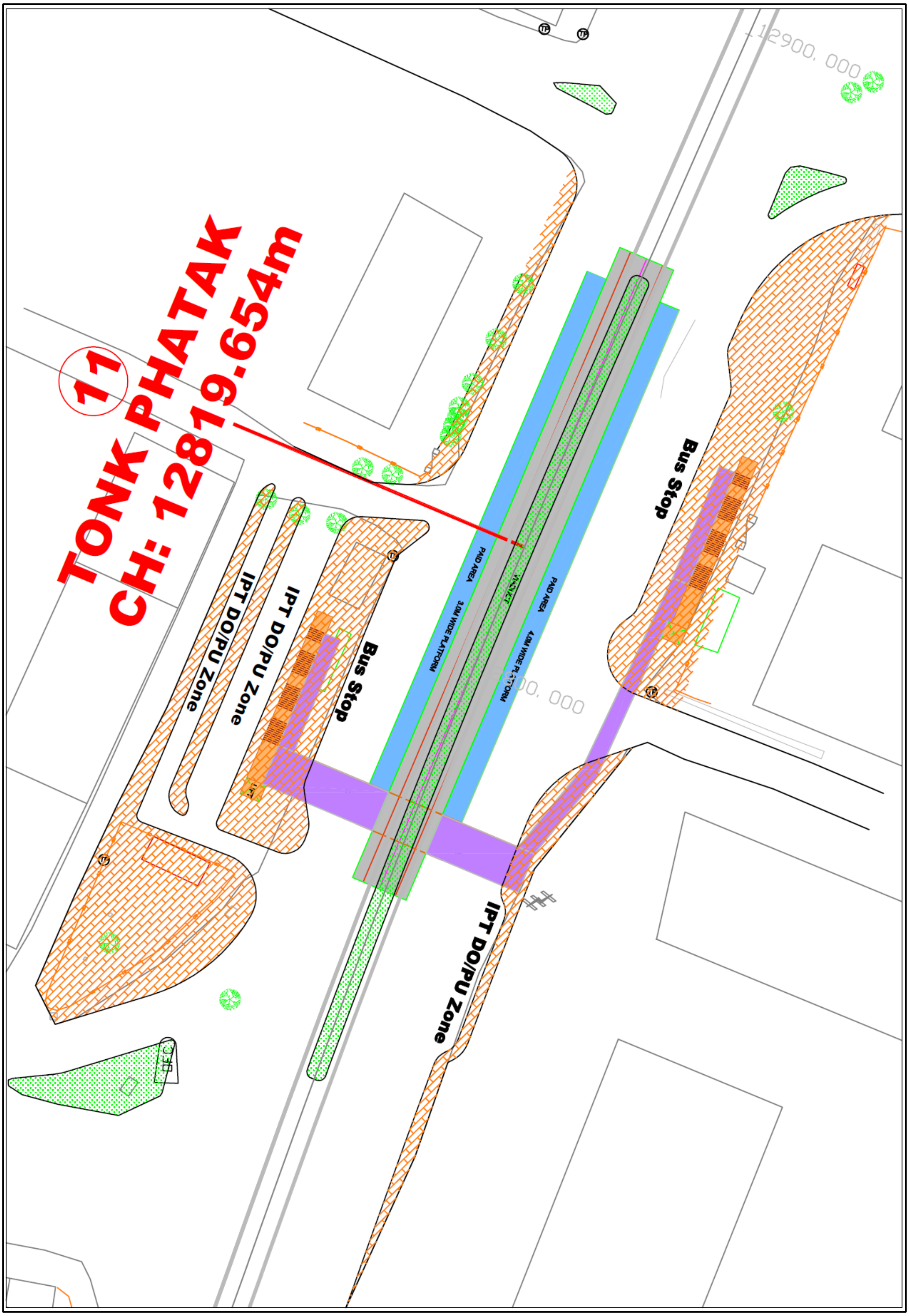

6
B2 BYPASS CIRCLE
CH: 7914.327m
B2B - 1
AREA= 52Sqm
Bus Stop
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone
PAID AREA
PAID AREA
2.5M WIDE PLATFORM
2.5M WIDE PLATFORM
AFC
AFC

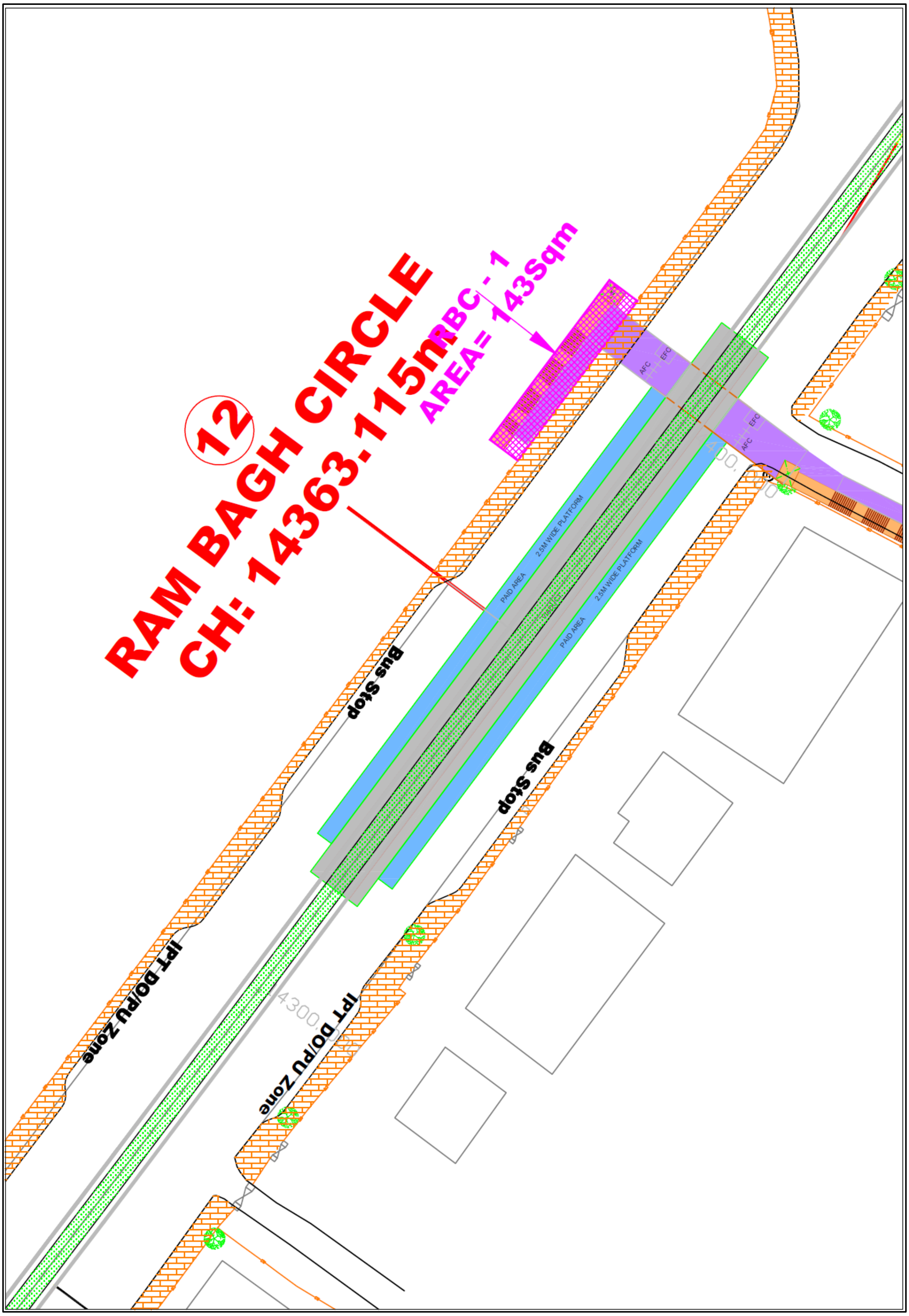

DP - 1
AREA= 122Sqm
Bus Stop
IPT DO/PU Zone
DURGAPURA
7
4.0M WIDE PLATFORM
3.0M WIDE PLATFORM
PAID AREA
PAID AREA
AFC
EFC
AFC
EFC
Bus Stop
IPT DO/PU Zone

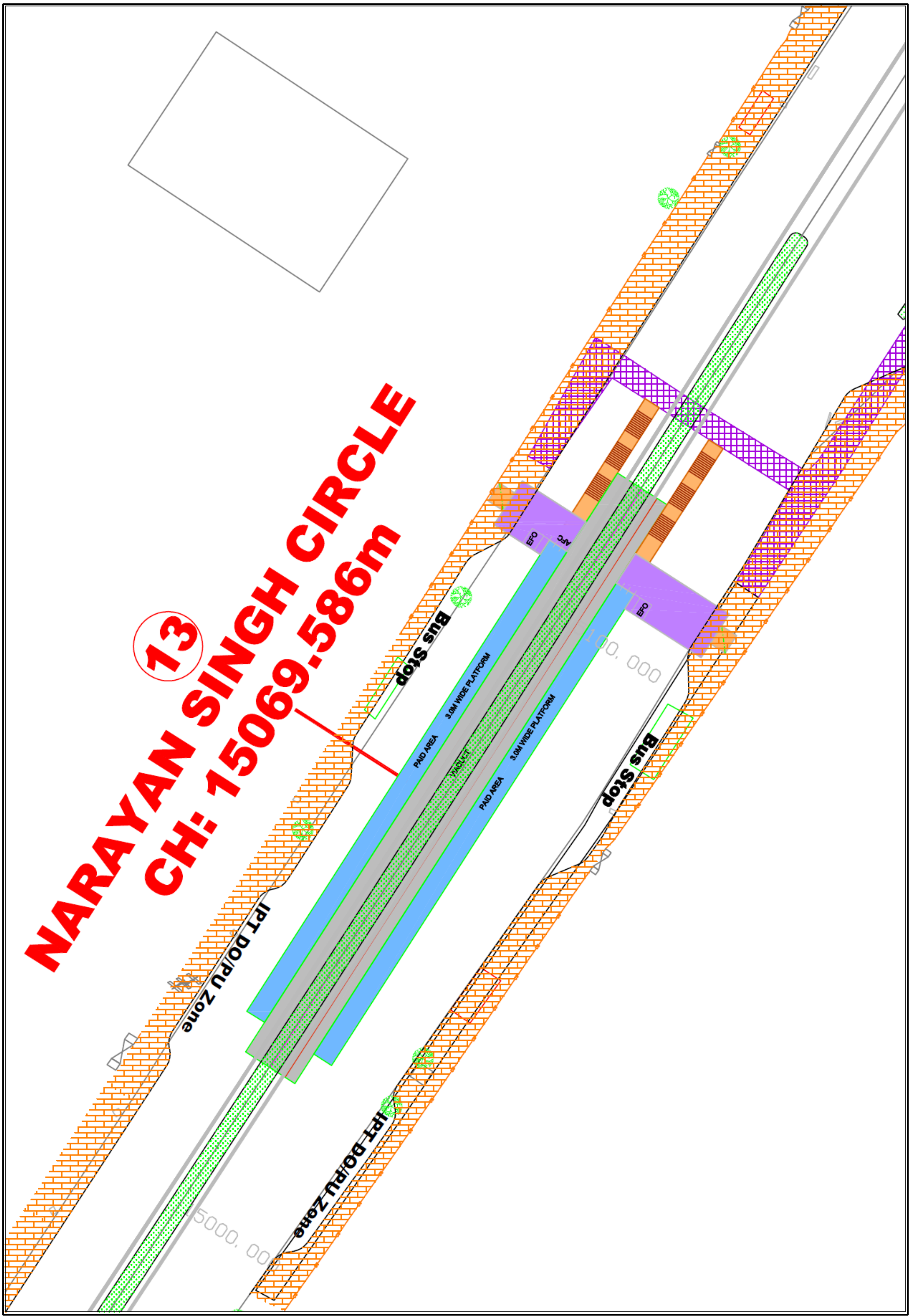

SRJ 1 in 9
8
MAHAVEER NAGAR
CH: 9984.491m
Bus Stop
PAID AREA
3.0M WIDE PLATFORM
PAID AREA
4.0M WIDE PLATFORM
Bus Stop
AFC
EFC
AFC
EFC
SRJ 1 in 9
IPT DO/PU Zone
IPT DO/PU Zone

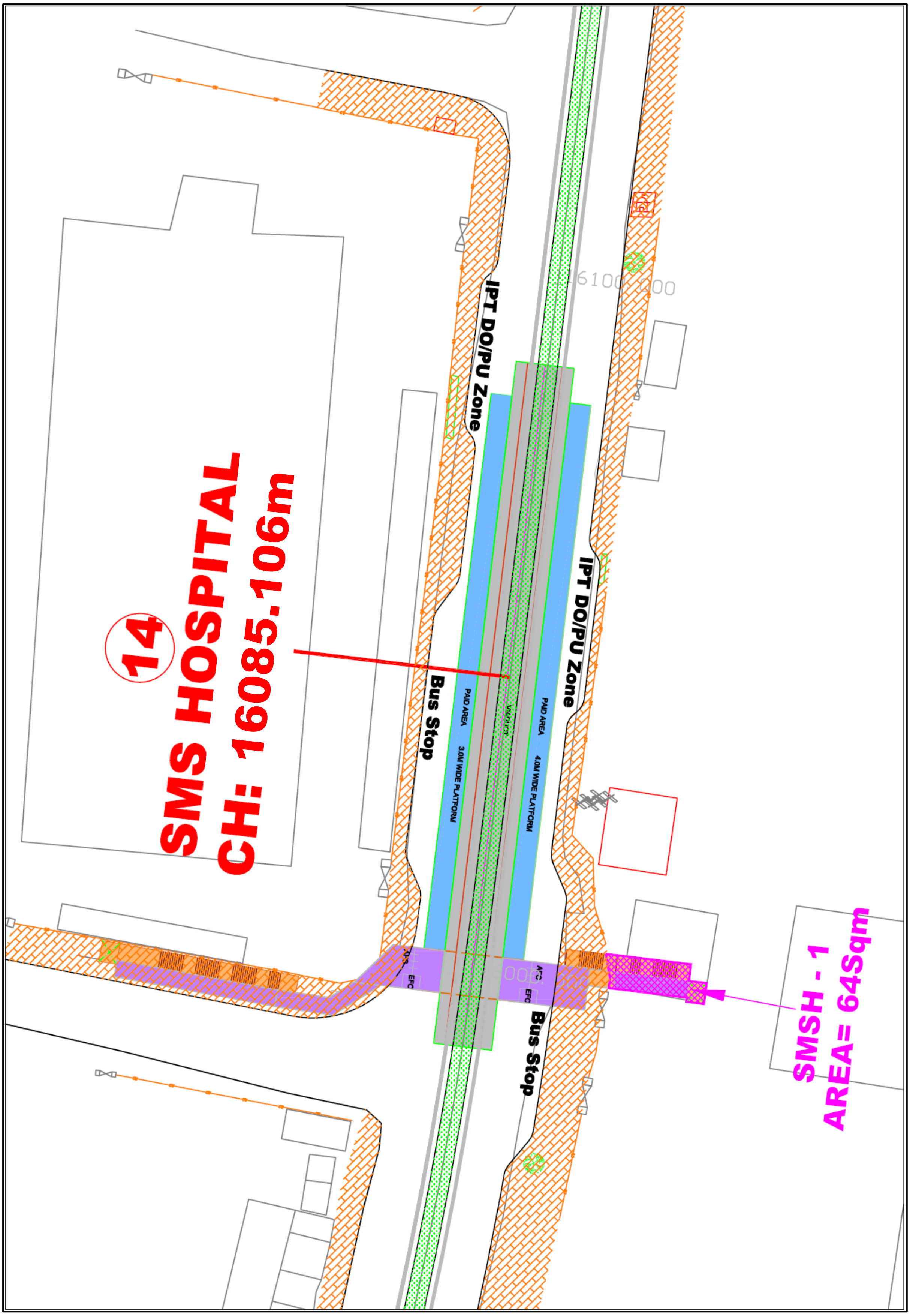

9
DEV NAGAR
CH: 11028.593m
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone
Bus Stop
PAID AREA
VIADUCT
PAID AREA
2.5M WIDE PLATFORM
2.5M WIDE PLATFORM
AFC
EFO
AFC
EFO
LIFT
LIFT

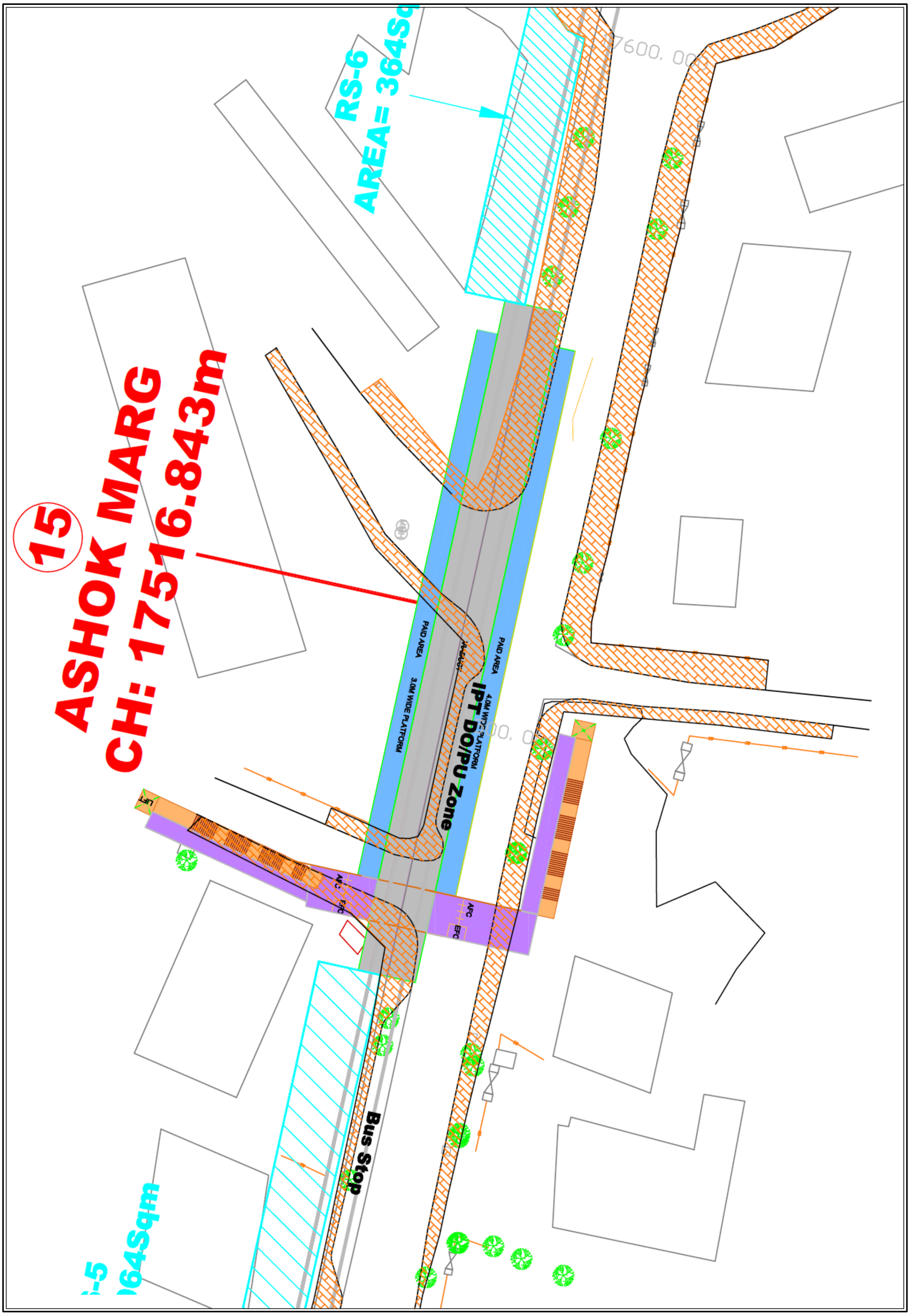

10
GANDHI NAGAR
CH: 11705.394m
Bus Stop
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone
2.5M WIDE PLATFORM
2.5M WIDE PLATFORM
PAID AREA
PAID AREA

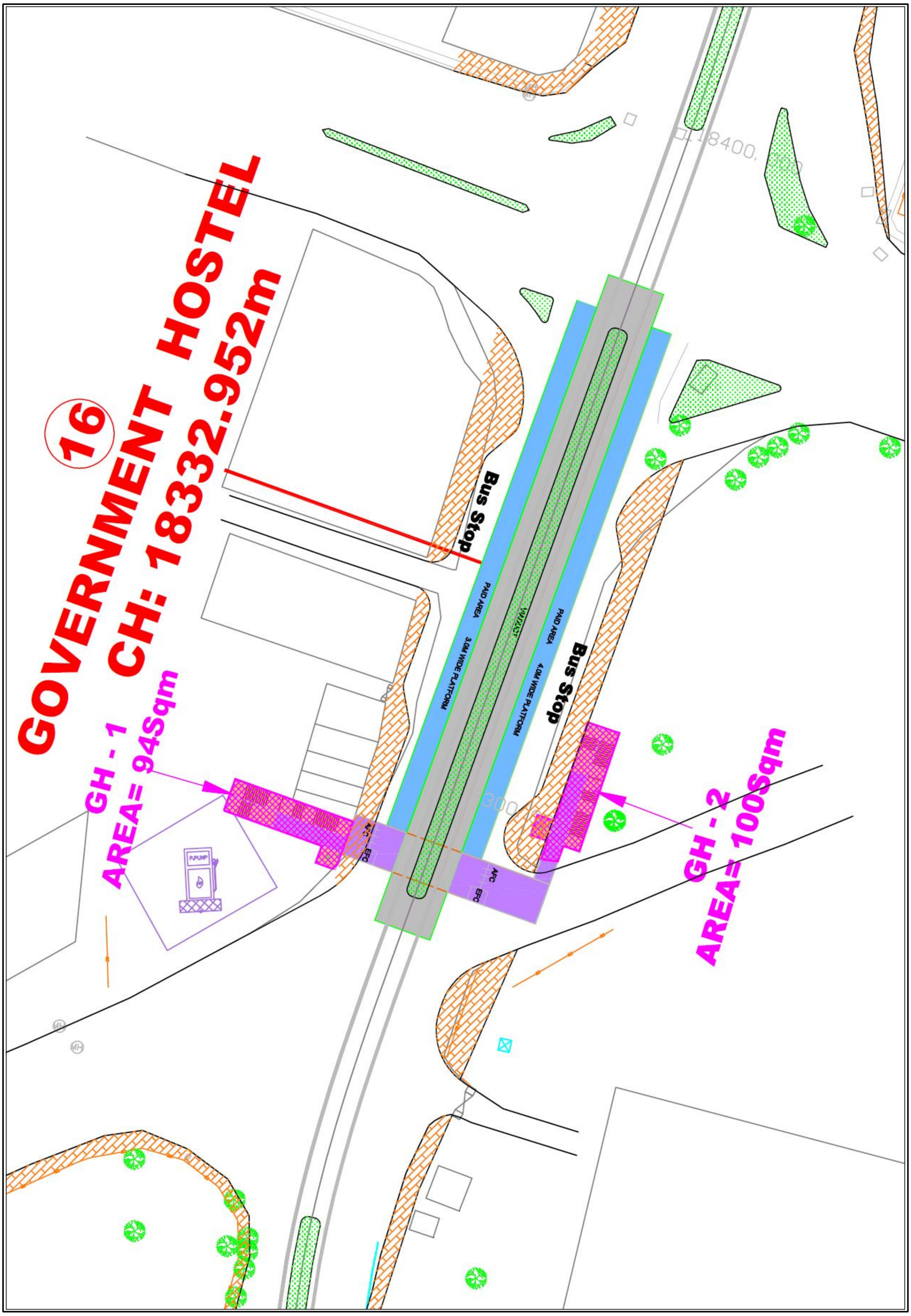

11
TONK PHATAK
CH: 12819.654m
IPT DO/PU Zone
IPT DO/PU Zone
Bus Stop
Bus Stop
IPT DO/PU Zone
PAID AREA
PAID AREA
3.0M WIDE PLATFORM
4.0M WIDE PLATFORM
12900. 000

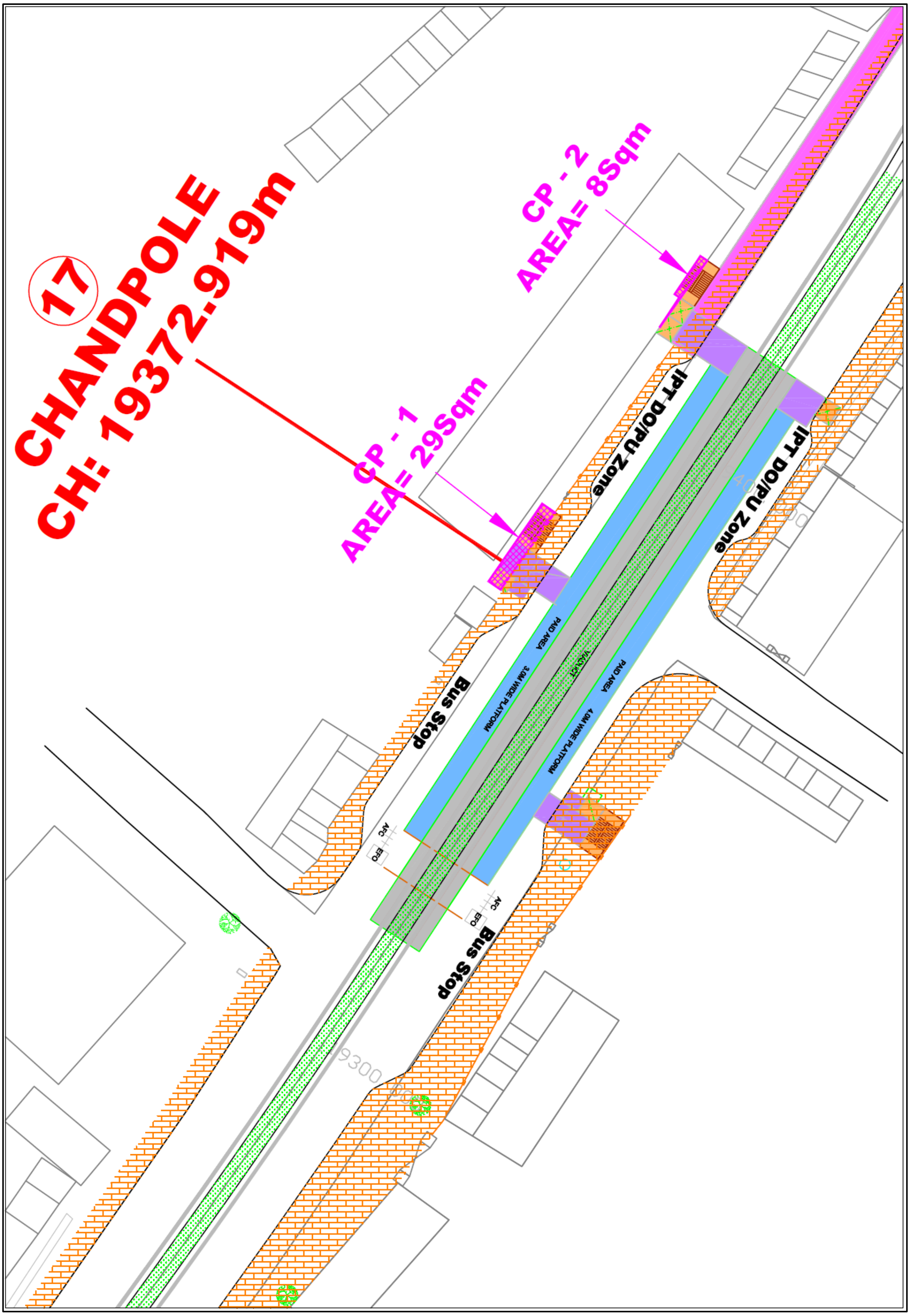

12
RAM BAGH CIRCLE
CH: 14363.115m
RBC - 1
AREA= 143Sqm
Bus Stop
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone
PAID AREA
2.5M WIDE PLATFORM
AFC
EFC

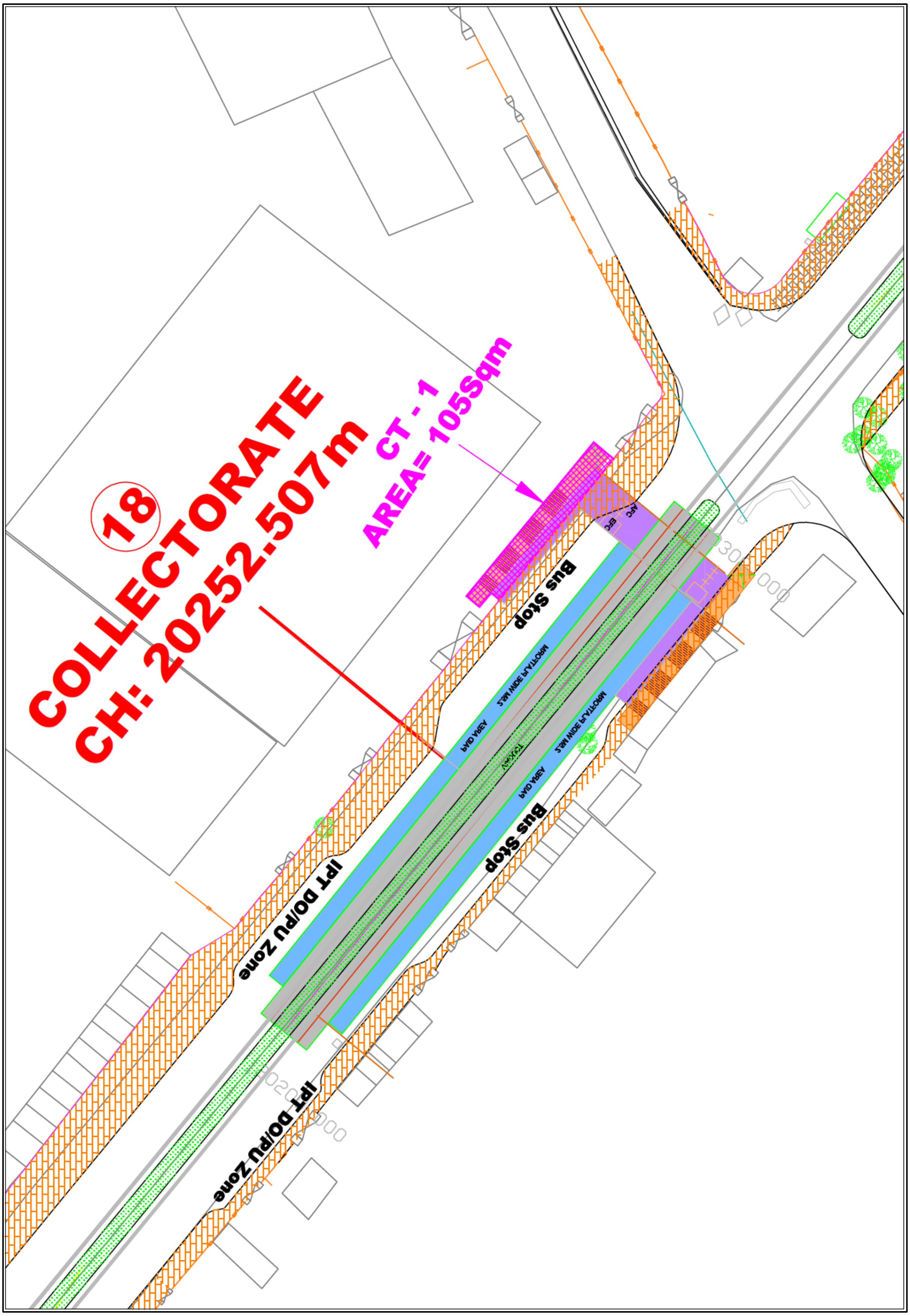

13
NARAYAN SINGH CIRCLE
CH: 15069.586m
Bus Stop
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone
3.0M WIDE PLATFORM
3.0M WIDE PLATFORM
PAID AREA
PAID AREA
EFO
EFO

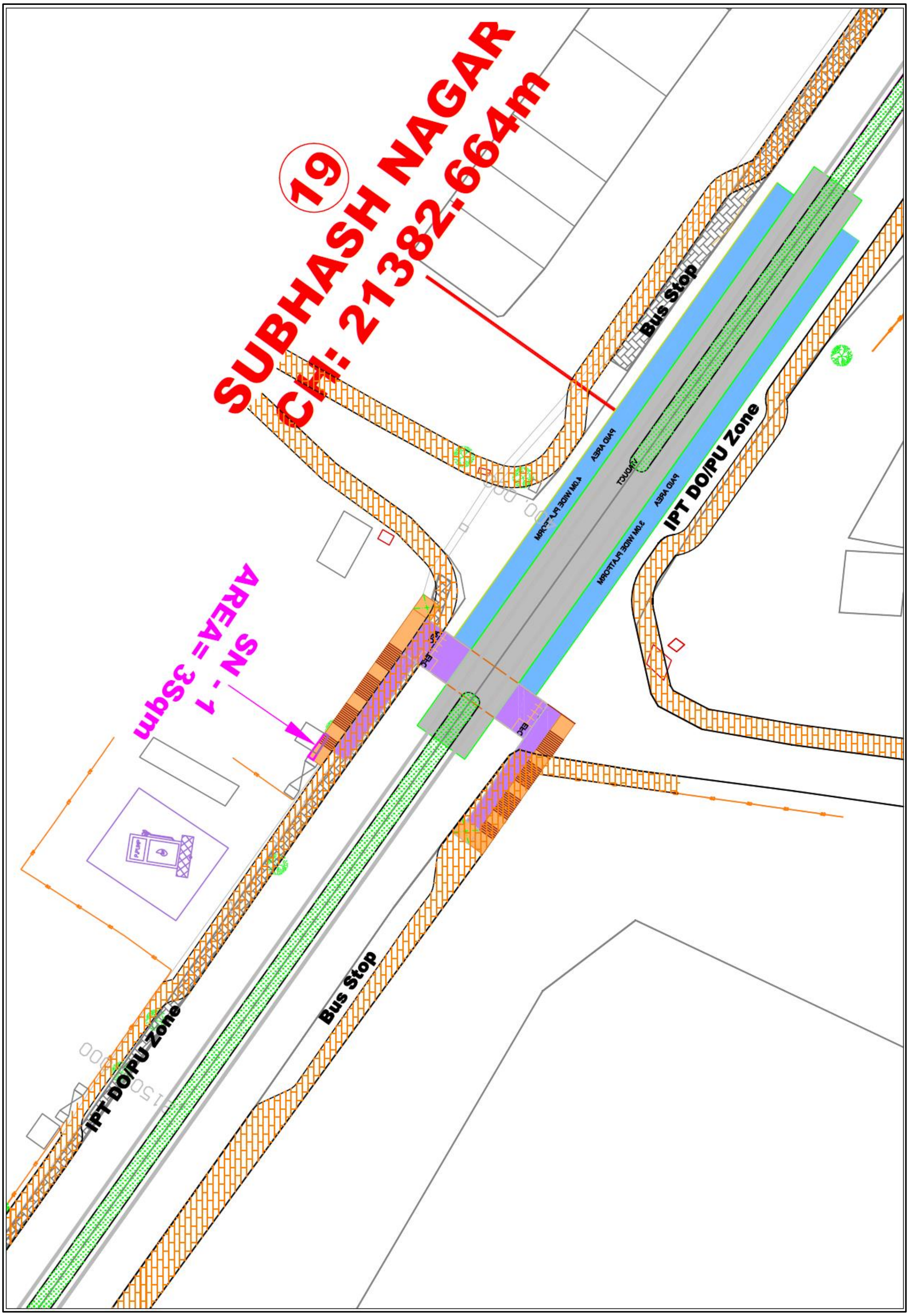

14
SMS HOSPITAL
CH: 16085.106m
IPT DO/PU Zone
IPT DO/PU Zone
Bus Stop
Bus Stop
PAID AREA
3.0M WIDE PLATFORM
PAID AREA
4.0M WIDE PLATFORM
SMSH - 1
AREA= 64Sqm

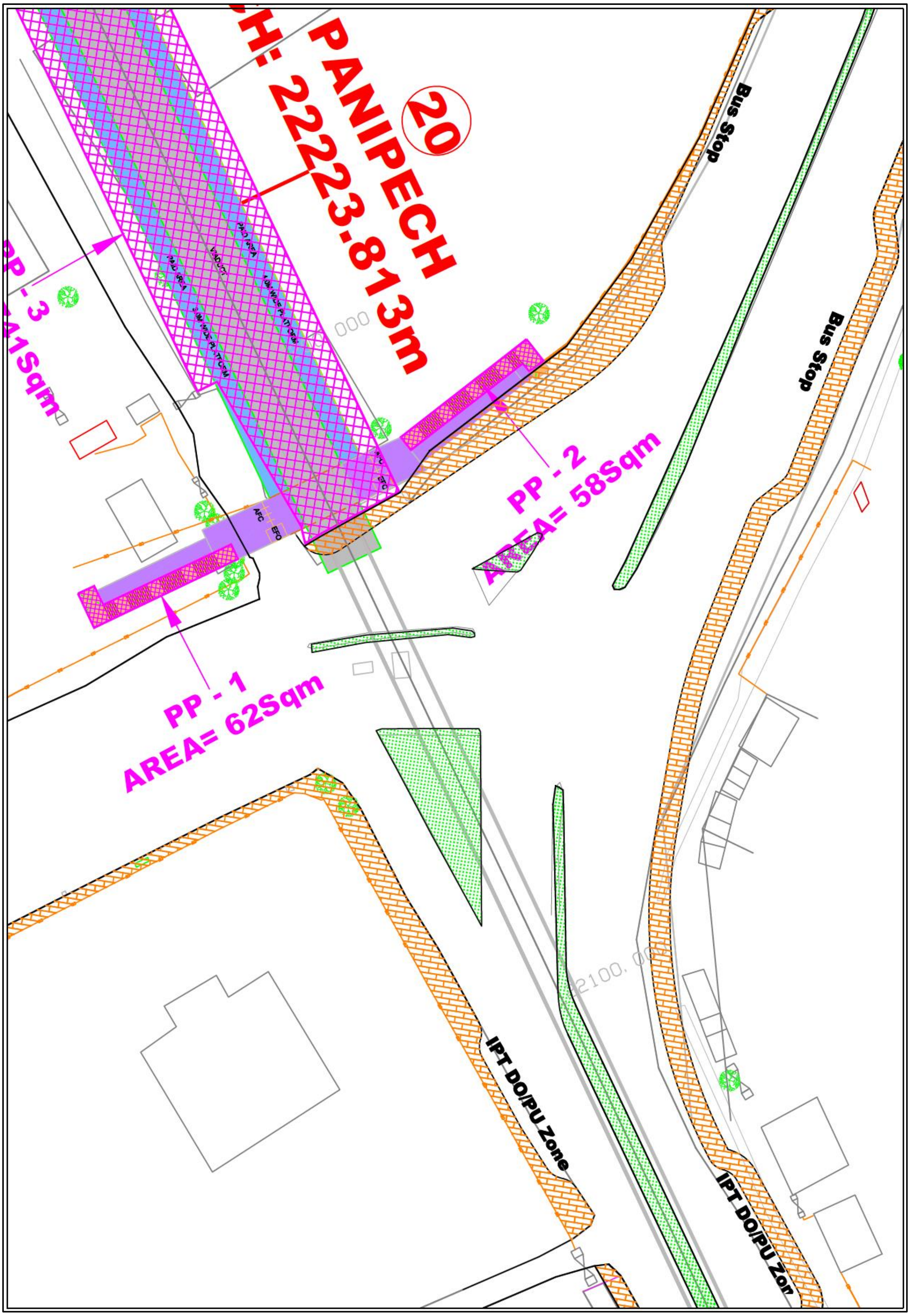

15
ASHOK MARG
CH: 17516.843m
RS-6
IPT DO/PU Zone
PAID AREA
3.0M WIDE PLATFORM
PAID AREA
AFC
EFC
Bus Stop

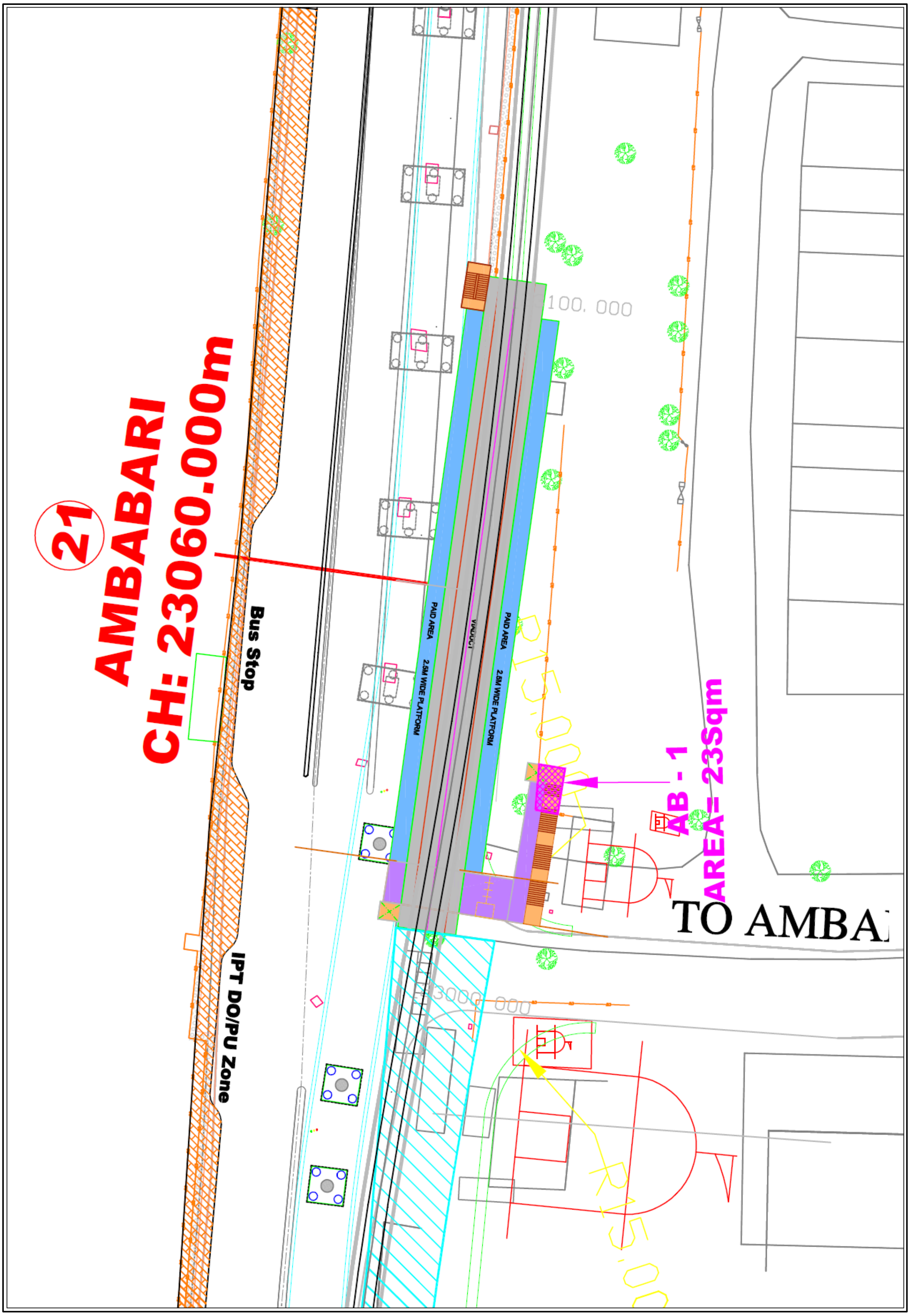

16
GOVERNMENT HOSTEL
CH: 18332.952m
Bus Stop
Bus Stop
PAID AREA
3.0M WIDE PLATFORM
PAID AREA
4.0M WIDE PLATFORM
GH - 1
AREA= 94Sqm
GH - 2
AREA= 100Sqm
AFC
EFC


17
CHANDPOLE
CH: 19372.919m
CP - 2
AREA= 8Sqm
CP - 1
AREA= 29Sqm
IPT DO/PU Zone
IPT DO/PU Zone
Bus Stop
Bus Stop
PAID AREA
PAID AREA
AFC
EFO
AFC
EFO


18
COLLECTORATE
CH: 20252.507m
CT - 1
AREA= 105Sqm
Bus Stop
Bus Stop
IPT DO/PU Zone
IPT DO/PU Zone


19
SUBHASH NAGAR
CH: 21382.664m
Bus Stop
IPT DO/PU Zone
SN - 1
AREA= 3Sqm
Bus Stop
IPT DO/PU Zone


20
PANIPECH
22223.813m
Bus Stop
Bus Stop
PP - 3
PP - 2
AREA= 58Sqm
PP - 1
AREA= 62Sqm
IPT DO/PU Zone


21
AMBABARI
CH: 23060.000m
Bus Stop
IPT DO/PU Zone
PAID AREA
2.5M WIDE PLATFORM
PAID AREA
2.5M WIDE PLATFORM
AB - 1
AREA= 23Sqm
100. 000

CHAPTER 17 - COST ESTIMATES

CHAPTER –17

COST ESTIMATES

17.1 INTRODUCTION

Project Cost estimates for India Gate (SIA) to Ambabari Corridor of Jaipur Metro has been prepared covering civil, electrical, signaling and telecommunication works, rolling stock, environmental protection, rehabilitation, considering 25 kV AC traction etc. at January 2020 price level.

While preparing the cost estimates, various items have generally been grouped under three major heads on the basis of:-

(i) Route km. Length of alignment
(ii) No. of units of that item and
(iii) Item being an independent entity.

All items related with alignment, permanent way, OHE, signaling and telecommunication, have been estimated on rate per route km basis. The cost of elevated stations includes civil work for station structures, architectural finishes, platform, roofing, etc. Provisions for electrical and mechanical works, air conditioning, lifts, escalators, etc, have been worked out separately. These rates do not include cost of permanent way, O.H.E., power supply, signaling and telecommunication, automatic fare collection (AFC) installations, for which separate provisions have been made in the cost estimates. Similarly, for other items like Rolling stock, Traction & Power, etc, costs have been summed up separately. In remaining items, viz. land, utility diversions, rehabilitation, etc. the costs have been assessed on the basis of each item taken as an independent entity.

In order to arrive at realistic cost of various items, costs have been assessed on the basis of rates published in “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019. The rates are considered at January 2020 level without escalating the rates published in the referred report except few items, since Light Capacity Metro with 3-car train configuration is proposed for this corridor, which is expected to have reduced cost compared to Medium Capacity Metro. Moreover, since it is proposed to construct Stations with 3 coach platform without full-fledged concourse and rates provided in Benchmarking Report are for 6 Coach Platform, thus rates of Station Building Civil Works, Traction & Power Supply, RSS and Telecommunication System were reduced accordingly. Taxes & Duties such as Customs Duty, CGST, SGST and IGST wherever applicable, have been worked out on the basis of prevailing rates and included in the cost estimate separately.

The overall Capital Cost for this Corridor of Jaipur Metro at January 2020 price level works out to **Rs.3669 Crores** excluding applicable Taxes & Duties of **Rs. 464 crores** as tabulated hereunder.

Table 17.1: Details of Capital Cost

Sr. No.	Name of the corridor	Capital Cost (Rs. Crore)	Taxes & Duties (Rs. Crore)	Total (Rs. Crore)
1.	India Gate (SIA) – Ambabari	3669	464	4133

Details and methodology of arriving at these costs are discussed in paras hereinafter.

17.2 CIVIL ENGINEERING WORKS

17.2.1 Land

Land requirements have been kept to the barest minimum and worked out on area basis. Acquisition of private land has been minimized as far as possible. Elevated alignment is proposed within the Right of way as far as possible. The land acquisition is required to be done mainly for exit and entries and also for running section at few locations where alignment runs outside the ROW.

Private land for MRTS project shall be acquired by JMRC/ Rajasthan State Government and compensation shall be paid as per Land Acquisition Act 2013. The rates of private land parcels along with estimated compensation amount for each plot have been provided by JMRC and are placed as Annexure-17.1. Cost of govt. land is considered as NIL as suggested by JMRC vide Annexure-17.1.

Provision for Rehabilitation and Resettlement is made separately.

In addition to the lands required permanently, some areas of land (mainly Govt.) are proposed to be taken over temporarily for construction depots. Ground rent charges for this temporary govt. land is also considered as NIL as suggested by JMRC vide Annexure-17.1.

Details of the land with costs have been shown in cost estimate.

17.2.2 Formation and Alignment

Elevated section: Entire alignment is proposed with elevated viaduct and the rates adopted are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, taken at January 2020 price level without any escalation. Cost of viaduct length for station has been included in elevated section.

17.2.3 Stations

Elevated Stations: Rates adopted for elevated stations cover works of station structures, platforms, architectural finishes, covering, lifts, escalators, etc. Provisions for Electrical and Mechanical works have been made separately. Also provisions for Viaduct, P-way, O.H.E., Signalling & Telecommunication works, Automatic fare collection installations, etc. have been made separately.

Rates for stations have been arrived on the basis of “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, taken at January 2020 price level without any escalation. Moreover, rates of 6 coach platform length station were suitably reduced for 3 coach platform length station without full-fledged concourse.

17.2.4 Permanent way

For elevated alignment ballastless track and for depot, ballasted track is proposed except for washing lines, repair lines etc. Rates adopted are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, taken at January 2020 price level without any escalation.

17.3 DEPOT

Depot for this corridor has been planned at Sitapura Industrial Area on the bank of Dravyavati River, near Kumbha Marg Station, having an area of 27 ha. Cost is considered based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, incorporating some reduction in civil works cost due to Light Capacity Metro.

17.4 UTILITY DIVERSIONS, ENVIRONMENTAL PROTECTION, MISCELLANEOUS OTHER WORKS

Provisions have been made to cover the cost of utility diversions, miscellaneous road works involved, road diversions, road signages etc. and environmental protection works on route km basis, based on DMRC’s past experience and corridor specific conditions.

17.5 REHABILITATION AND RESETTLEMENT

Provisions have been made on fair assessment basis, to cover cost of relocation of Jhuggies, shops, residential Houses on private land etc.

Provision for Staff Quarters for O&M Wing has been made in the cost estimates on the basis of average cost involved per km length in the recent past.

17.6 TRACTION AND POWER SUPPLY

Provisions have been made to cover the cost of O.H.E., Auxiliary sub stations, receiving substations, service connection charges, SCADA and miscellaneous items, on route km basis separately for elevated and at-grade section (Depot Connection).

Rates provided are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, with project specific modifications and suitable escalation.

17.7 SIGNALLING AND TELECOMMUNICATION WORKS

Rates adopted are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, with project specific modifications and without any escalation.

17.8 AUTOMATIC FARE COLLECTION

Adopted rates are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, without any escalation.

17.9 ROLLING STOCK

Adopted rates are based on “Report on Benchmarking for Cost Estimation of Metro Rail Projects” by M/o Housing & Urban Affairs, February 2019, with suitable escalation till January 2020.

In view of JMRC, *“Train Operation Plan projects requirement of 12 trains for the year 2023 and 15 trains for 2031. With bare rake requirement of 13 and 1 no. as traffic reserve, keeping one no. rake as R&M is considered inadequate and it is suggested to be enhanced to 2 nos., thus enhancing total rake requirement in 2031 to 16 nos. This will amount to procuring additional 4 train sets within a span of 8 years, which appears to be impracticable and costly proposition due to small number of coach requirement. Also, it is felt that the traffic projections are on conservative side and in case the traffic projections are exceeded during the initial years of operation, shortage of rakes may put pressure on operation. Hence, it is suggested that 16 rakes may be procured out-rightly meeting the requirement of 2031. This will avoid procuring small number of rakes at later date”*. Therefore, procurement of 16 trains is considered in the cost estimate.

17.10 MULTIMODAL TRAFFIC INTEGRATION

A lump sum provision of Rs. 3.0 Crore per station has been made to have seamless integration of metro stations with other modes of transport. It is envisaged that in case this money is not sufficient for this purpose the deficient part of money will borne by the Urban Local Body (ULB) in whose area station is located.

17.11 GENERAL CHARGES AND CONTINGENCES

Provision @ 5% has been made towards general charges on all items, except cost of land, which also includes the charges towards Detailed Design Charges (DDC), etc. Provision for contingencies @ 3 % has been made on all items including general charges, except cost of land.

17.12 CAPITAL COST ESTIMATES

17.12.1 India Gate (SIA) – Ambabari Corridor

The overall Capital Cost for this Metro Corridor at January 2020 price level works out to **Rs. 3669 Crores** excluding applicable Taxes & Duties of **Rs. 464 crores** as tabulated hereunder.

Table 17.2 - Capital Cost Estimate

Total length = 23.51 km (Entirely Elevated); Total Stations (All Elevated) =21

January 2020 level

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.0	**Land and R & R incl. Hutments etc.**				
1.1	Permanent				
a	Government (As per Annex-17.1)	ha	0	1.794	0
b	Private (As per Annex-17.1)	ha	---	33.02	462
1.2	Temporary Land (@5% pa for 4 years)				
a	Government (As per Annex-17.1)	ha	0	8.8	0
1.3	**R & R incl. Hutments etc.**	R. Km.	5.00	23.510	117.55
	Subtotal (1)				**579.55**
2.0	**Alignment and Formation**				
2.1	Elevated section (viaduct) including in station portion (Including Cost of Rain Water Harvesting)	R. Km.	37.00	23.510	869.87
2.2	Depot Entry connection	R. Km.	37.00	0.70	25.90
2.3	Cost for Dismantling of Tonk Phatak and reconstruction of integrated structure, Additional Cost due to height of Durgapura Station over Durgapura Flyover, Provision for additional height of Piers at Gopalpura Bypass Crossing, Construction of portals at certain locations of the corridor	LS			30.00
	Subtotal (2)				**925.77**
3.0	**Station Buildings**				
3.1	Elevated stations (including finishes)	Each			
a	Civil works excluding viaduct in station portion	Each	16.00	21	336.00
b	EM works including lifts and escalators	Each	8.00	21	168.00
	Subtotal (3)				**504.00**
4.0	**Depot and Admin Building**				
a	Civil works	LS			70.00
b	E&M and M&P works	LS			68.25
	Subtotal (4)				**138.25**
5.0	**P-Way**				
5.1	Ballast less track	R. Km.	6.60	24.210	159.79
5.2	Ballasted track for Depot, At Grade Section	T. Km.	3.90	9.00	35.10
	Subtotal (5)				**194.89**
6.0	**Traction & Power Supply** **25 kV Overhead Catenary System (OCS)**				

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
6.1	Elevated Section	R.Km.	4.20	24.210	101.68
6.2	Depot	T.Km.	2.10	9.00	18.90
6.3	Catenary Maintenance Vehicle	LS			6.63
6.4	RSS without AMS (AIS Type)	Each	32.25	1	32.25
6.5	Bay Cost by DISCOMs	Each	5.00	1	5.00
6.6	Augmentation on RSS (Sindhi Camp)	LS			5.00
6.7	132 kV double run double circuit cable from GSS to RSS (Approx. Length of 5 km is taken, will be finalized after Survey)	R.Km.	6.00	5	30.00
	Subtotal (6)				**199.46**
7.0	**Signalling and Telecom.**				
7.1	**Signalling**				
	Main line	R.Km.	3.40	24.21	82.31
	Depot including DCC	T.Km.	3.20	9	28.80
	On Board Equipment	Per Train	1.70	16	27.20
7.2	**Telecom**				
	Station	Per Station	3.50	21	73.50
	Depot	Per Depot	3.50	1	3.50
7.3	**Automatic Fare Collection (AFC) system**	Per Station	3.50	21	73.50
	Subtotal (7)				**288.81**
8.0	**Shifting of Miscellaneous Utilities**				
a	Civil and EM works	R. Km.	4.00	24.210	96.84
	Subtotal (8)				**96.84**
9.0	**Rolling Stock (2.9 m wide Coaches)**	Each	8.40	48	403.20
	Subtotal (9)				**403.20**
10.0	**Staff quarter for O & M**				
a	3 BHK Flats	Each	0.35	25.000	8.75
b	2 BHK Flats	Each	0.25	100.000	25.00
	Sub Total (10)				**33.75**
11.0	**Multimodal Integration and Last mile connectivity**				
a	Multimodal Integration and Last mile connectivity	Per Station	3.00	21	63.00
	Sub Total (11)				**63.00**
12.0	**Total of all items except Land**				**2965.52**
13.0	**General Charges incl. Design charges @ 5 % on all items except land**				**148.28**
14.0	**Total of all items including G. Charges except land**				**3113.80**
15.0	**Contingencies @ 3 %**				**93.41**
16.0	**Gross Total**				**3207.21**
	Cost without land			**=**	**3207**
	Cost including land			**=**	**3669**

Table 17.3 - Details of Taxes and Duties

Basic Customs duty =	5.500
CGST Customs Duty=	9.495
SGST Customs Duty=	9.495
Total Customs Duty=	**24.490**
General IGST=	12
General CGST =	6
General SGST =	6

S. No.	Description	Total cost without Taxes & duties (Cr.)	Taxes and duties		Total Taxes & Duties (Cr.)
			Total Customs Duty (Cr.)	Total GST (CGST & SGST) (Cr.)	
1	**Alignment & Formation**				
	Elevated & At-Grade	925.77		111.09	**111.09**
2	**Station Buildings**				
	a) Elevated station - civil works	336.00		40.32	**40.32**
	b) Elevated station-EM works	168.00	8.23	16.13	**24.36**
3	**Depot**				
	Civil works	70.00	5.14	5.88	**11.02**
	E&M and M&P works	68.25	3.34	6.55	**9.89**
4	**P-Way**	194.89	38.18	4.68	**42.86**
5	**Traction & power supply**				
	Traction and power supply	199.46	19.54	14.36	**33.90**
6	**S and T Works**				
	S & T	215.31	42.18	5.17	**47.35**
	AFC	73.50	13.50	2.21	**15.71**
7	**R & R hutments**	117.55		14.11	**14.11**
8	**Misc. (Shifting of Utilities, Staff Quarters and MMTI)**				
	Civil works	128.63	0.00	15.44	**15.44**
	EM works	64.96	0.00	7.80	**7.80**
9	**Rolling stock**	403.20	59.52	3.98	**63.50**
10	**Rent on Temporary Land**	0.00		0.00	**0.00**
11	**General Consultancy charges**	148.28		26.69	**26.69**
	Total	**3113.80**	**189.64**	**274.39**	**464.03**
	Total Taxes & Duties				**464**
Rate of Taxes & Duties on Total cost without taxes & duties					**14.90%**
Total Central GST & Basic Customs duty					253.31
Total State GST					210.72
Total Taxes & Duties					464.03

Annexure-17.1

Total Requirement of Land and Cost (Revised)

S.No.	Land Parcel Identification No.	Area (Sq.m)			DLC Rate	Cost/Market Value as per DLC Rate Dated 09.09.2019 of Reg. & Stamp Deptt.	Estimated compensation as per L.A. Act 2013 of Private Land (Land cost as per DLC+100% of cost solatium+12% Add. Amount)
		Govt.	Pvt.	Total			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Station Land Area	4,650	659	5,309	N/A	50,37,44,040	21,48,81,969
2	Running Section	13,811	70,189	84,000	N/A	1,38,78,89,495	1,92,83,49,509
3	Depot Land Area	-	2,70,000	2,70,000	N/A	1,16,63,00,000	2,47,25,56,000
	Total	**18,461**	**3,40,848**	**3,59,309**		**3,05,79,33,535**	**4,61,57,87,478**

Aprox. 462 Crores.

1. Govt. Land 18,461 Sqm. Compensation Amount-Nil

2. Pvt. Land 3,40,848 Sqm. Compensation Amount Aprox 462 Crore

Temporary Govt. Land (Casting Yard) at Village Keshopura Area = 40,000 Sqm.

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(Revised)

Station Land Area

S.No.	Land Parcel Identification No.	Area (Sq.m)	DLC Rate (Sq.m)	Cost/Market Value as per DLC Rate Dated 09.09.2019 of Reg.& Stamp Deptt.	Prima facie Ownership (Govt./Pvt.)	Type of the Land (Open/Residential/ Commercial)	Estimated compensation as per L.A. Act 2013 of Pvt. Land (Land cost as per DLC+100% of cost solatium+12% Add. Amount)	Remarks
1	SS-1	2026	22,000	4,45,72,000	Govt.	Res.	-	
2	B2S-1	52	1,32,070	68,67,640	Govt.	Com.	-	
3	DP-1	122	1,34,330	1,63,88,260	Pvt.	Com.	3,47,43,111	
4	GP-1	158	1,49,240	2,35,79,920	Pvt.	Com.	4,99,89,430	
5	RBC-1	143	1,79,090	2,56,09,870	Pvt.	Com.	5,42,92,925	
6	SMSH-1	64	2,40,600	1,53,98,400	Govt.	Com.	-	
7	GH-1	94	1,71,860	1,61,54,840	Pvt.	Com.	3,42,48,260	
8	GH-2	100	1,71,860	1,71,86,000	Govt.	Com.	-	
9	CP-1	29	1,49,240	43,27,960	Pvt.	Com.	91,75,275	
10	CP-2	8	1,49,240	11,93,920	Pvt.	Com.	25,31,110	Structure Area Not Provided
11	CT-1	105	1,34,330	1,41,04,650	Pvt.	Com.	2,99,01,858	
12	SN-1	3	1,34,330	4,02,990	Govt.	Com.	-	
13	PP-1	62	1,34,330	83,28,460	Govt.	Com.	-	
14	PP-2	58	1,34,330	77,91,140	Govt.	Com.	-	
15	PP-3	1741	1,34,330	23,38,68,530	Govt.	Com.	-	
16	AB-1	23	1,37,490	31,62,270	Govt.	Com.	-	
17	RGC-1	104	1,24,390	1,29,36,560	Govt.	Com.	-	
18	RGC-2	156	1,24,390	1,94,04,840	Govt.	Com.	-	
19	RGC-3	157	1,24,390	1,95,29,230	Govt.	Com.	-	
20	RGC-4	104	1,24,390	1,29,36,560	Govt.	Com.	-	
	Total	**5309**		**50,37,44,040**			**21,48,81,969**	

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Running Section (Revised)

S.No.	Land Parcel Identification No.	Area (Sq.m)			DLC Rate (Sq.m)	Cost/Market Value as per DLC Rate Dated 09.09.2019 of Reg. & Stamp Deptt.		Prima facie Ownership (Govt./Pvt)	Type of the Land (Open/Residential/ Commercial)	Estimated compensation as per L.A. Act 2013 of Pvt. Land (Land cost as per DLC+100% of cost solatium+12% Add. Amount)	Remarks
		Area to be Notified as no construction Zone	Area to be proposed for acquisition	Total Area		Cost of coloum-3	Cost of coloum-4				
1	2	3	4	5	6	7	8	9	10	11	12
1	RS-1	-	20900	20900	97,00,000 *(Per Bigha)*	-	8,01,52,825	Pvt.	Agriculture	16,99,23,989	
		-	16146	16146	6,000	-	9,68,76,000	Pvt.	Res.	20,53,77,120	
2	RS-2	-	15700	15700	8,240	-	12,93,68,000	Pvt.	Res.	27,42,60,160	
		-	4400	4400	8,240	-	3,62,56,000	Govt.	Res.	-	
			11962	11962	16,435	-	19,65,95,470	Pvt.	Res.	41,67,82,396	
3	RS-3	2425	2425	4850	60,080	14,56,94,000	14,56,94,000	Pvt.	Res.	30,88,71,280	
4	RS-4	2598	-	2598	-	15,60,87,840	-	Pvt.	Res.	-	Structure Area Not Provided
5	RS-5	964	-	964	-	14,60,65,280	-	Pvt.	Com.	-	
6	RS-6	364	870	1234	1,51,520	5,51,53,280	13,18,22,400	Pvt.	Com.	27,94,63,488	
7	RS-7	1643	-	1643	1,51,520	24,89,47,360	-	Pvt.	Com.	-	
8	RS-8	1358	-	1358	1,51,520	20,57,64,160	-	Pvt.	Com.	-	
9	RS-9	-	1571	1571	60,080	-	9,43,85,680	Pvt.	Res.	20,00,97,642	
10	RS-10	-	615	615	56,430	-	3,47,04,450	Pvt.	Res.	7,35,73,434	
11	RS-11	-	4797	4797	46,970	-	22,53,15,090	Govt.	Res.	-	
12	RS-12	-	1438	1438	46,970	-	6,75,42,860	Govt.	Res.	-	
13	RS-13	-	108	108	46,970	-	50,72,760	Govt.	Res.	-	
14	RS-14	-	3068	3068	46,970	-	14,41,03,960	Govt.	Res.	-	
	Total	**9,352**	**84,000**	**93352**		**95,77,11,920**	**1,38,78,89,495**			**1,92,83,49,509**	

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Depot Land at Village Sheopur Tehsil Sanganer (Revised)

S.No.	Area (Hect.)	Rate	Cost/Market Value as per DLC Rate Dated 09.09.2019 of Reg. & Stamp Deptt.	Ownership (Govt./Pvt.)	Type of the Land (Open/Residential/ Commercial)	Estimated compensation as per L.A. Act 2013 of Pvt. Land (Land cost as per DLC+100% of cost solatium+12% Add. Amount)	Remarks
1	27	2,70,000	1,16,63,00,000	Pvt.	Agriculture	2,47,25,56,000	Structure Area Not Provided

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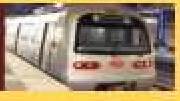


CHAPTER 18- FINANCING OPTIONS, FARE STRUCTURE AND FINANCIAL VIABILITY

CHAPTER –18

FINANCING OPTIONS, FARE STRUCTURE AND FINANCIAL VIABILITY

18.1 INTRODUCTION

The India Gate (SIA) to Ambabari metro project is part of Jaipur Phase-2 MRTS project being proposed to be constructed with an estimated cost of Rs 4133.03 Crore including taxes and land cost. The route length of the metro system and estimated cost at January-2020 price level is placed in table 18.1 as under:

Table 18.1 Cost Details

Name of Corridor	Route Length (km)	Estimated cost without Land and taxes (Rs/Crore)	Estimated cost with land cost (Rs/Crore)	Estimated cost with all taxes & land cost (Rs/Crore)
India Gate (SIA) to Ambabari	23.51	3207.21	3669.00	4133.03

18.2 COSTS

18.2.1 Investment Cost

For the purpose of calculating the Financial Internal Rate of Return (FIRR), the completion cost with central taxes have been calculated by taking escalation factor @5.00% PA on all items except land. The effective Customs Duty (CD) rate under project import scheme, post GST, works out to 24.49% {Basic CD @ 5.5%, IGST (CGST & SGST) @ 18% and cess} on the imported portions. The GST rate on supply of indigenously manufactured items and services has been considered @ 12% (CGST & SGST @ 6% each). The Interest Free Subordinate Debt is normally repayable in 5 equal instalments after repayment of Multilateral/Overseas Development Assistance Loan.

It is assumed that the construction work of the line will commence from October-2020 and is expected to be completed by 30.11.2023 with Revenue Opening Date (ROD) as 01.12.2023. The total completion costs duly escalated and shown in the table 18.2 below have been taken as the initial investment.

Table 18.2: Year –wise Investment (Completion Cost) Rs./ Cr.

Financial Year	Cost at January-2020 Price Level including all Taxes & Land cost	Completion Cost including all Taxes & land cost
2020-21	521.05	530.23
2021-22	1,255.30	1,337.90

Financial Year	Cost at January-2020 Price Level including all Taxes & Land cost	Completion Cost including all Taxes & land cost
2022-23	1,622.43	1,809.66
2023-24	734.25	868.34
Total	**4,133.03**	**4,546.14**

The cost of Land including Rehabilitation and Restoration of Rs. 461.79 crore on completion cost basis included in the above cost shall have to be provided free of cost by the JDA, Government of Rajasthan.

18.2.2 Additional Investment

Total investment provided in the FIRR calculation towards requirement of additional rolling stock duly escalated @5% PA is placed in table 18.2 as under: -

Table 18.2 Additional Investment towards Rolling Stock

(Rs/Crore)

With Taxes & Duties		
Year	**No. of Cars**	**Amount**
2041-42	33	670.41
Total	**33**	**670.41**

18.2.3 Operation & Maintenance (O&M) Costs

The Operation & Maintenance costs can be divided into four major parts: -

(i) Staff costs
(ii) Maintenance cost which include expenditure towards upkeep and maintenance of the system and consumables
(iii) Energy costs, and
(iv) Service cost of Public Private Partnership (PPP) component

The corridor is proposed for a Light Capacity Metro Rail System capable to cater the PPHPD demand upto 30,000, with conventional Rolling Stock but with cost cutting features of the Metrolite. There will be no concourse and arrangement for frisking of the passengers for security at the stations. Keeping this in view, the requirement of staff will be less compared to conventional metro and hence, has been assumed @ 18 persons per kilometre. The escalation factor used for staff costs is 9% per annum to provide for both escalation and growth in salaries.

Based on the actual O & M unit cost incurred for a conventional metro of Jaipur Metro Phase-I project, the O&M cost for the proposed Light Capacity Metro Rail corridor with cost efficient features is taken as Rs. 80 lakh/Km. The average rate of electricity being paid by Jaipur Metro for its operation in Jaipur at present is Rs. 8.00 per unit, the same has been considered for energy cost in the calculations. As per Metro Rail Policy 2017, it is mandatory now to involve Public Private Partnership (PPP) in some form for implementation, operation & maintenance, fare collection or any other unbundled activities of the proposed metro rail project. It has been proposed that activities involving AFC for all the stations may be given on PPP basis in this project.

The cost of above unbundled activities may be funded by engaging concessionaire in line with Kochi Metro, Nagpur Metro and Noida Metro for a period of 10 years. The expected return to the concessionaire will be in between 12% to 16% from all sources. For calculation of FIRR, the cost of servicing PPP activities over a period of 10 years has been considered taking into account principal repayment and Interest @ 12% per year on PPP cost of proposed activities of Rs. 198.36 Crore on completion cost basis. The O&M cost (excluding staff cost and PPP component) for the proposed corridor has been obtained by providing an escalation of 5% per annum. The O&M cost has been calculated on life cycle cost basis. The O&M costs have been tabulated in Table 18.3 as below:

Table 18.3 Operation and Maintenance Costs

Rs. In Crore

S. No.	YEAR			Staff	Maintenance Expenses	Energy	PPP Servicing	Total
1	2023	-	2024	13.19	8.68	6.82	4.67	33.36
2	2024	-	2025	43.12	27.35	21.50	25.67	117.64
3	2025	-	2026	47.00	28.71	22.57	24.27	122.56
4	2026	-	2027	51.23	30.15	23.70	22.87	127.95
5	2027	-	2028	55.85	31.66	24.89	21.47	133.86
6	2028	-	2029	60.87	33.24	26.13	20.07	140.31
7	2029	-	2030	66.35	34.90	27.44	18.67	147.36
8	2030	-	2031	72.32	36.65	28.81	17.27	155.05
9	2031	-	2032	78.83	38.48	38.84	15.87	172.01
10	2032	-	2033	85.93	40.40	40.78	14.47	181.57
11	2033	-	2034	93.66	42.42	42.82	13.07	191.97
12	2034	-	2035	102.09	44.54	44.96		191.59
13	2035	-	2036	111.28	46.77	47.20	-	205.25
14	2036	-	2037	121.29	49.11	49.57	-	219.97
15	2037	-	2038	132.21	51.56	52.04	-	235.82
16	2038	-	2039	144.11	54.14	54.65	-	252.89
17	2039	-	2040	157.08	56.85	57.38	-	271.30
18	2040	-	2041	171.21	59.69	60.25	-	291.15
19	2041	-	2042	186.62	62.68	87.36	-	336.66
20	2042	-	2043	203.42	65.81	91.73	-	360.96
21	2043	-	2044	221.72	69.10	96.31	-	387.14
22	2044	-	2045	241.68	72.56	101.13	-	415.37
23	2045	-	2046	263.43	76.18	106.19	-	445.80
24	2046	-	2047	287.14	79.99	111.50	-	478.63
25	2047	-	2048	312.98	83.99	117.07	-	514.05
26	2048	-	2049	341.15	88.19	122.92	-	552.27
27	2049	-	2050	371.85	92.60	129.07	-	593.53
	Total			**4037.61**	**1406.42**	**1633.61**	**198.36**	**7276.00**

18.2.4 Depreciation

Although depreciation does not enter in the FIRR calculation (not being a cash outflow) unless a specific depreciation reserve fund has been provided, yet in the present calculation, depreciation calculations are placed for purpose of record.

18.2.5 Replacement Cost

The replacement costs are provided for meeting the cost on account of replacement of equipment due to wear and tear. With the nature of equipments proposed to be used in the system, it is expected that only 50% of the Signalling and Telecom equipments and 25% of electrical equipments would require replacement after 20 years. Based on this assumption, cost of replacement of these equipments has been provided in the 20th and 21st year of operation in following Table 18.4 below:

Table 18.4

Year	Replacement Cost
2044-45	491.07
2045-46	515.62
Total	**1006.68**

18.3 REVENUES

The Revenue of India Gate (SIA) to Ambabari metro project mainly consists of fare box collection and other incomes from property business, advertisement, parking etc.

18.3.1 Fare box

The Fare box collection is the product of projected ridership per day and applicable fare structure based on trip distribution at different distance zones.

18.3.2 Traffic

18.3.2.1

a. ICRA Online Limited had conducted Traffic and Transportation Study for Jaipur Metro Phase-2 Corridors. The projected ridership figures and average passenger lead year-wise are indicated in table 18.5 as below: -

Table 18.5 Projected Ridership

Year	Trips per day (lakhs)	Average Passenger Lead (km)
2023-24	1.21	8.37
2030-31	2.09	8.90
2040-41	3.64	9.46
2050-51	5.95	9.64

b. The growth rate for traffic as interpolated are 7.10% Per Annum upto 2030-31, @ 5.71% per annum upto 2040-41 and thereafter @ 5.04% per annum

18.3.2.2 Trip Distribution

The trip distribution has been worked out by considering average lead of 8.37 km and, which is placed in Table 18.6 below: -

Table 18.6: Trip Distribution

Stations	Percent distribution (2023-24)
0-2	10%
3-5	20%
6-8	20%
9-11	30%
12-14	10%
15-17	5%
18-20	3%
> 20	2%
Total	**100.00%**

18.3.3 Fare Structure

The fare structure of Jaipur Metro prevailing in 2019 has been considered during traffic survey and ridership projections; hence, the same has been used as base fare for calculation of FIRR of the project. The FIRR has been calculated by using an escalation factor @14.00% once in every two years on the existing fare structure considering the average trend in the Consumer Price Index (CPI) and for the last ten years and input costs of operation. While estimating revenue, it is presumed that 70% of the commuters will be using smart card and therefore the existing arrangement of providing 10% additional discount on smart card travellers for tickets costing more that Rs. 10 and 15% discount on tickets costing more than Rs. 20 have been considered as per existing practice in Jaipur Phase-I. The fare structure assumed for the Year 2023 with an escalation @ 14% once in two years on the existing fare structure as per the proposed fare slabs is shown in the Table 18.7 below**:**

Table 18.7: Fare Structure in 2023-24

	2019	2023
Stations	**Fare in week days**	**Fare in week days**
0-2	6	8.00
3-5	12	16.00
6-8	18	23.00
9-11	24	31.00
12-14	30	39.00
15-17	36	47.00
18-20	42	55.00
More Than 20 Station	48	62.00

18.3.4 Other sources of revenues

Other revenues from Property Business and advertisement have been estimated at 15 % of the fare box revenues during operations. Apart from development of property on metro stations and depot it is possible to raise resources through leasing of parking rights at stations, advertisement on trains and tickets, advertisements within stations and parking lots, advertisements on viaducts, columns and other metro structures, co-branding and naming rights to corporate, film shootings and special events on metro premises.

18.4 FINANCIAL INTERNAL RATE OF RETURN (FIRR)

The Financial Internal Rate of Return (FIRR) based on SPV model for 30 years business model is placed in Table 18.8:

Table 18.8 –FIRR

Figures in cr. (Rs.)

S. No.	YEAR			Completion Cost	PPP Receipts	Additional Cost	Replacement Cost	Depreciation	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow
1	2020	-	2021	530	9								-521
2	2021	-	2022	1338	29								-1309
3	2022	-	2023	1810	40								-1769
4	2023	-	2024	868	21			46	33	5	38	33	-842
5	2024	-	2025					138	107	16	123	118	6
6	2025	-	2026					138	130	19	149	123	27
7	2026	-	2027					138	139	21	160	128	32
8	2027	-	2028					138	170	25	195	134	61
9	2028	-	2029					138	182	27	209	140	69
10	2022	-	2030					138	223	33	256	147	109
11	2030	-	2031					138	239	36	275	155	119
12	2031	-	2032					138	306	46	352	172	180
13	2032	-	2033					138	323	49	372	182	190
14	2033	-	2034					138	389	58	448	192	256
15	2034	-	2035					138	411	62	473	192	281
16	2035	-	2036					138	496	74	571	205	365
17	2036	-	2037					138	525	79	603	220	383
18	2037	-	2038					138	634	95	729	236	494
19	2038	-	2039					138	670	101	771	253	518
20	2039	-	2040					138	805	121	926	271	655
21	2040	-	2041					138	851	128	979	291	688
22	2041	-	2042			670		158	1085	163	1248	337	241
23	2042	-	2043					158	1140	171	1311	361	950
24	2043	-	2044					158	1363	205	1568	387	1181
25	2044	-	2045				491	173	1432	215	1647	415	740
26	2045	-	2046				516	188	1716	257	1974	446	1012
27	2046	-	2047					188	1803	270	2073	479	1594
28	2047	-	2048					188	2157	324	2481	514	1967
29	2048	-	2049					188	2266	340	2606	552	2054
30	2049	-	2050					188	2711	407	3118	594	2524
	Total			**4,546**	**99**	**670**	**1,007**	**3,979**	**22,310**	**3,346**	**25,656**	**7,276**	**12,256**

IRR - 6.56%

The various sensitivities with regard to increase/decrease in capital costs, O&M costs and fare-box revenues are placed in Table 18.9 below:

Table 18.9 –FIRR Sensitivity

Capital Cost			
10% increase in capital cost	**20% increase in capital cost**	**10% decrease in capital cost**	**20% decrease in capital cost**
6.04%	5.57%	7.15%	7.82%
REVENUE			
20% decrease in Fare Box revenue	**10% decrease in Fare Box revenue**	**10% increase in Fare Box revenue**	**20% increase in Fare Box revenue**
4.81%	5.74%	7.30%	7.99%
O&M COSTS			
10% increase in O&M cost		**10% decrease in O&M cost**	
6.25%		6.86%	

These sensitivities have been carried out independently for each factor.

18.5 FINANCING OPTIONS

18.5.1 Objectives of Funding: - The objective of funding of metro systems is not necessarily enabling the availability of funds for construction but coupled with the objective of financial closure are other concerns, which are of no less importance: -

- Ensuring low project cost
- Ensuring debt funds at low rates of interest
- Creating self sustainable system in the long run by
  - Low infrastructure maintenance costs
  - Longer life span
  - Setting fares which minimise dependence on subsidies
- Recovering returns from both direct and indirect beneficiaries

Rail based mass transit systems are characterised by heavy capital investments coupled with long gestation period leading to low financial rates of return although the economic benefits to the society are immense. Such systems generate externalities, which do not get captured in monetary terms and, therefore, do not flow back to the system. However, experience all over the world reveals that both construction and operations of metro are highly subsidised. Therefore government involvement in the funding of metro systems is a foregone conclusion. Singapore had a 100% capital contribution from the government, Hong Kong 78% for the first three lines and 66% for the later 2 lines. The Phase-I, Phase-II as well as Phase-III of Delhi MRTS project, Chennai and Bengaluru, Mumbai Line-3 metros are funded with a mixture of equity and debt (ODA) by GOI & concerned state governments.

18.5.2 Since the governing objective of setting up these systems is social, the fares have to be set at levels which are publicly and politically acceptable thus setting in the vicious cycle of deficits leading to a fallback on subsidies/government support.

18.5.3 Alternative Models of Financing

The financing option shall depend upon selection of the dedicated agency created to implement the project. The prominent models are: -

(i) Special Purpose Vehicle (SPV) under the State Government Control (Delhi Metro Rail Corporation (DMRC) /Bangalore Metro Rail Corporation (BMRC)

(ii) Built, Operate and Transfer (BOT)

(i) SPV model

The proposed corridor is an independent line from India Gate (SIA) to Ambabari with interchange at Chandpole metro station of the existing network. The funding pattern for India Gate (SIA) to Ambabari project under SPV model with loan assistance from multilateral/bilateral agencies is shown in Table 18.10. Besides, land including R&R should be made available free from all encumbrances by the JDA/JMRCL when the project starts. Accordingly, the funding pattern under SPV model assumed is placed in table 18.10 as under: -

Table 18.10: Funding pattern under SPV model (with all taxes)

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by GOI	615.85	**16.39%**
SD for CT by GOI (50%)	135.69	**3.61%**
Equity by GoR	615.85	**16.39%**
SD for CT by GoR (50%)	135.69	**3.61%**
Bilateral/Multilateral Loan	2,254.63	**60.00%**
Sub-Total (A)	**3,757.72**	**100.00%**
Land including R&R by State Government	461.79	
State Taxes by State Government	227.38	
PPP Contribution	99.25	
Sub-Total (B)	**4546.14**	
IDC	52.12	
Total including IDC	**4598.26**	

(ii) SPV of Government of Rajasthan

The proposed corridor is an independent line from India Gate (SIA) To Ambabari with interchange at Chandpole metro station of the existing network. The funding pattern for India Gate (SIA) To Ambabari project under present model of JMRC as SPV of Government of Rajasthan with loan assistance from multilateral/bilateral agencies is shown in Table 18.11. Besides, land including R&R should be made available free from all encumbrances by the JDA/JMRC when the project starts. Accordingly, the funding pattern under SPV model assumed is placed in table 18.11 as under: -

Table 18.11: Funding pattern under SPV model (with all taxes)

Sources of Funds	Amount (Rs/Crore)	% of contribution
Grant by GOI	398.51	**10.00%**
Equity by GoR	697.27	**17.50%**
SD for GST from GoR	99.75	**2.50%**
Bilateral/Multilateral Loan	2,789.57	**70.00%**

Sources of Funds	Amount (Rs/Crore)	% of contribution
Sub-Total (A)	**3,985.10**	**100.00%**
PPP	99.25	
Land Cost to be borne by SG	461.79	
Sub-Total (B)	**4,546.14**	
IDC	56.35	
Total including IDC	**4602.48**	

(iii) Design-Build-Finance-Operate-Transfer (DBFOT) Model: - In this model, the private firm will be responsible for designing, building, financing, operating and maintaining of the entire project. Such a project shall be eligible for funding assistance under the Viability Gap Funding (VGF) scheme upto 20% of the project cost excluding cost of land and state taxes from the Central Government provided the state government also contributes same or more amounts towards the project. The Metro Rail being a social sector project not many private parties are likely to bid for such a project. Besides, the private operator may demand assured rate of return on his equity, which is in the range of 20% to 22% (pre-tax) or a comfort of guaranteed ridership, sweeteners in the form of huge parcels of land free of cost for commercial exploitations. The funding pattern under the above model has been worked out with a pre-tax Equity Internal Rate of Return (EIRR) @ 18% is shown in the table 18.12 below:

Table 18.12 Funding pattern under DBFOT model (EIRR 18%)
(With all taxes and land cost)

Particulars	Amount (Rs/Crore)	% of contribution
VGF by GoI	816.87	20.00%
VGF by GoR	2330.66	57.06%
Equity by Concessionaire	312.27	7.65%
Concessionaire's debt @12% PA	624.55	15.29%
Sub-Total (A)	**4084.35**	**100.00%**
Land including R&R by State Government	461.79	
Sub-Total (B)	**4546.14**	
IDC	145.78	
Total including IDC	**4691.92**	

The total fund to be contributed by GoI & GoR, excluding bilateral/multilateral loan, is shown in Table 18.13 below under SPV and BOT model.

Table 18.13: Fund Contribution of GOI & GOR (Rs. In crore)

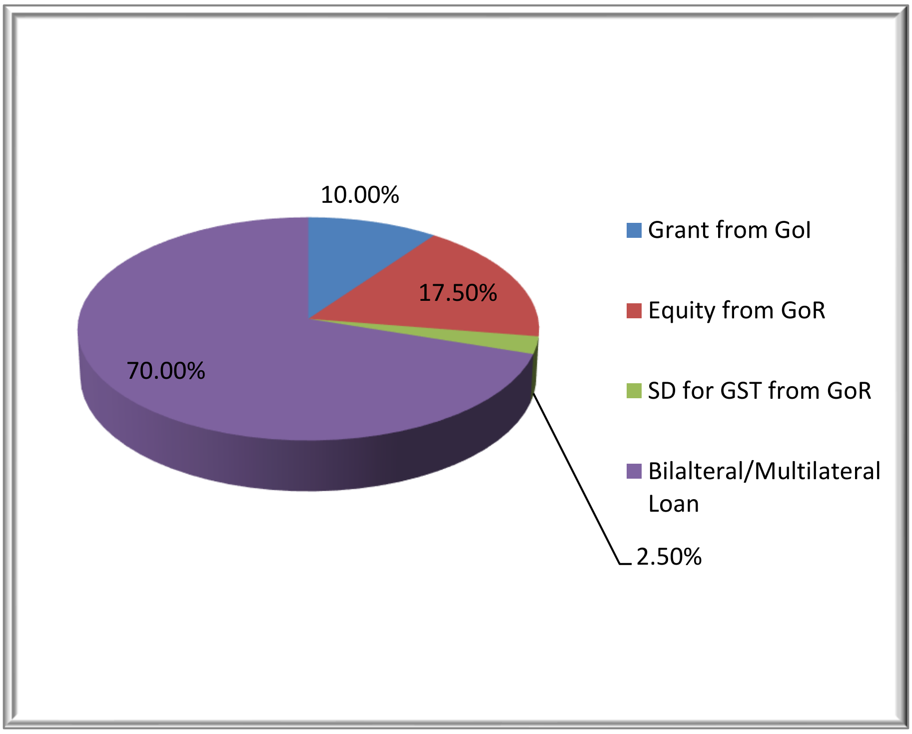
Particulars	SPV Model	SPV of GoR	DBFOT
GoI	751.54	398.51	816.87
GoR	1440.71	1258.81	2792.45
Total	**2192.25**	**1657.32**	**3609.32**

18.6 RECOMMENDATIONS

The project is operationally viable since the FIRR for a period of 30 years period including construction period with all the taxes is 6.56%. However, FIRR is not the only criteria to take up the metro project. As per Metro Rail Policy 2017, issued by the Ministry of Housing and Urban Affairs, (MOH&UA), GOI, apart from financial viability, the economic and social viability of the project is also required to be assessed. The Economic Internal Rate of Return (EIRR) for any metro rail project proposal should be 14% and above for consideration of its approval. Considering the positive FIRR as well as social considerations of requirement of reliable public transport, it is recommended for its implementation. In case of operational losses, the Govt. of Rajasthan will provide funds for the viability gap.

From Table 18.13, it is evident that the VGF required to be contributed by GOI & GoR for executing the project through a DBFOT operator is the highest as compared to the SPV models. The fund requirement under DBFOT model has been made with the assumption of 18% pre-tax EIRR. However, the DBFOT operator may expect the pre-tax EIRR of at least 20%, in such a situation, the VGF amount will only increase further. Out of the two SPV models discussed above, SPV under GoR would require lesser contribution from both GoI and GoR as compared to the SPV model under GoI and GoR and hence, it is recommended to implement the project through SPV model under GoR as per the funding pattern shown in Table 18.11. The funding plan proposed under SPV model in Table 18.11 is graphically presented under:

Funding pattern of SPV model under GoR



Cash Flow under SPV, SPV of GoR and DBFOT models are given in Table 18.14, 18.15 and 18.16 respectively.

Table 18.14

YEAR	Completion Cost	PPP	Additional Cost	Replacement Cost	Depreciation	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow	Equity by CG	Equity by SG	SD for Land by SG	SD for State Taxes	SD for Central Taxes by SG	Cash Availability	Cummulative Cash befor ODA Loan	ODA Loan	Net Cash Available	Cummulative Loan	ODA Loan IDC	Repayment	Balance Loan	Interest	Cash Balance
2020 - 2021	530	9								-521	153.96	153.96	153.93	56.84	-	-2.39	-2.39	2.39	-	2.39	0.02	0.02	2.39		-
2021 - 2022	1338	29								-1309	153.96	153.96	153.93	56.84	-	-790.44	-790.44	790.44	-	792.82	6.35	6.35	792.82		-
2022 - 2023	1810	40								-1769	153.96	153.96	153.93	56.84	-	-1,250.73	-1,250.73	1,250.73	-	2,043.55	19.52	19.52	2,043.55		-
2023 - 2024	868	21			46	33	5	38	33	-842	153.96	153.96		56.84	-	-477.46	-477.46	213.47	-263.99	2,257.02	26.23	26.23	2,257.02		-263.99
2024 - 2025					138	107	16	123	118	6						5.65	-258.35		-258.35	2,257.02			2,257.02	27.08	-21.44
2025 - 2026					138	130	19	149	123	27						26.90	-231.44		-231.44	2,257.02			2,257.02	27.08	-0.18
2026 - 2027					138	139	21	160	128	32						32.12	-199.32		-199.32	2,257.02			2,257.02	27.08	5.04
2027 - 2028					138	170	25	195	134	61						61.39	-137.93		-137.93	2,257.02		83.38	2,173.64	27.08	-49.08
2028 - 2029					138	182	27	209	140	69						68.80	-69.13		-69.13	2,257.02		97.61	2,076.03	26.08	-54.89
2029 - 2030					138	223	33	256	147	109						108.97	39.84		39.84	2,257.02		97.61	1,978.41	24.91	-13.55
2030 - 2031					138	239	36	275	155	119						119.49	159.33		159.33	2,257.02		97.61	1,880.80	23.74	-1.86
2031 - 2032			0		138	306	46	352	172	180						179.79	339.13		339.13	2,257.02		97.61	1,783.19	22.57	59.61
2032 - 2033					138	323	49	372	182	190						190.33	529.46		529.46	2,257.02		97.61	1,685.57	21.40	71.32
2033 - 2034					138	389	58	448	192	256						255.54	785.00		785.00	2,257.02		97.61	1,587.96	20.23	137.70
2034 - 2035					138	411	62	473	192	281						281.48	1,066.48		1,066.48	2,257.02		97.61	1,490.35	19.06	164.82
2035 - 2036					138	496	74	571	205	365						365.46	1,431.94		1,431.94	2,257.02		97.61	1,392.73	17.88	249.96
2036 - 2037					138	525	79	603	220	383						383.36	1,815.29		1,815.29	2,257.02		97.61	1,295.12	16.71	269.03
2037 - 2038					138	634	95	729	236	494						493.55	2,308.84		2,308.84	2,257.02		97.61	1,197.51	15.54	380.40
2038 - 2039					138	670	101	771	253	518						518.15	2,826.99		2,826.99	2,257.02		97.61	1,099.90	14.37	406.17
2039 - 2040					138	805	121	926	271	655						654.88	3,481.87		3,481.87	2,257.02		97.61	1,002.28	13.20	544.07
2040 - 2041					138	851	128	979	291	688						687.96	4,169.84		4,169.84	2,257.02		97.61	904.67	12.03	578.32
2041 - 2042			670		158	1085	163	1248	337	241						241.13	4,410.97		4,410.97	2,257.02		97.61	807.06	10.86	132.66
2042 - 2043					158	1140	171	1311	361	950						950.14	5,361.11		5,361.11	2,257.02		14.23	792.82	9.68	926.23
2043 - 2044					158	1363	205	1568	387	1181						1,180.74	6,541.86		6,541.86	2,257.02		-	792.82	9.51	1,171.23
2044 - 2045				491	173	1432	215	1647	415	740						740.46	7,282.31		7,282.31	2,257.02		-	792.82	9.51	730.94
2045 - 2046				516	188	1716	257	1974	446	1012						1,012.24	8,294.55		8,294.55	2,257.02		-	792.82	9.51	1,002.72
2046 - 2047					188	1803	270	2073	479	1594						1,594.48	9,889.02		9,889.02	2,257.02		-	792.82	9.51	1,584.96
2047 - 2048					188	2157	324	2481	514	1967						1,966.78	11,855.81		11,855.81	2,257.02		-	792.82	9.51	1,957.27
2048 - 2049					188	2266	340	2606	552	2054						2,053.57	13,909.37		13,909.37	2,257.02		-	792.82	9.51	2,044.05
2049 - 2050					188	2711	407	3118	594	2524						2,524.48	16,433.85		16,433.85	2,257.02		-	792.82	9.51	2,514.96
Total	**4546**	**99**	**670**	**1007**	**3979**	**22310**	**3346**	**25656**	**7276**	**12256**	**615.85**	**615.85**	**461.79**	**227.38**	**-**	**14,176.83**	**99,515.67**	**2,254.63**	**1,01,772.69**	**63,778.33**	**52.12**	**1,516.32**	**40,564.66**	**443.20**	**14,526.45**
										6.56%															

Table 18.15

YEAR	Completion Cost	PPP	Additional Cost	Replacement Cost	Depreciation	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow	Grant by CG	Equity by SG	SD for Land by SG	Cash Availability	Cummulative Cash befor ODA Loan	ODA Loan	Net Cash Available	Cummulative Loan	ODA Loan IDC	Repayment	Balance Loan	Interest	Cash Balance
2020 - 2021	530	9								-521	132.84	232.42	153.93	-1.90	-1.90	1.90	-	1.90	0.02	0.02	1.90		-
2021 - 2022	1,338	29								-1,309	132.84	232.42	153.93	-789.95	-789.95	789.95	-	791.85	6.34	6.34	791.85		-
2022 - 2023	1,810	40								-1,769	132.84	232.42	153.93	-1,250.24	-1,250.24	1,250.24	-	2,042.08	19.50	19.50	2,042.08		-
2023 - 2024	868	21			46	33	5	38	33	-842				-842.23	-842.23	747.49	-94.75	2,789.57	30.48	30.48	2,789.57		-94.75
2024 - 2025					138	107	16	123	118	6				5.65	-89.10		-89.10	2,789.57			2,789.57	33.47	-27.83
2025 - 2026					138	130	19	149	123	27				26.90	-62.20		-62.20	2,789.57			2,789.57	33.47	-6.57
2026 - 2027					138	139	21	160	128	32				32.12	-30.07		-30.07	2,789.57		52.66	2,736.91	33.47	-54.01
2027 - 2028					138	170	25	195	134	61				61.39	31.32		31.32	2,789.57		136.01	2,600.89	32.84	-107.47
2028 - 2029					138	182	27	209	140	69				68.80	100.12		100.12	2,789.57		185.84	2,415.05	31.21	-148.25
2029 - 2030					138	223	33	256	147	109				108.97	209.09		209.09	2,789.57		185.84	2,229.20	28.98	-105.85
2030 - 2031					138	239	36	275	155	119				119.49	328.58		328.58	2,789.57		185.84	2,043.36	26.75	-93.10
2031 - 2032			0		138	306	46	352	172	180				179.79	508.37		508.37	2,789.57		185.84	1,857.51	24.52	-30.57
2032 - 2033					138	323	49	372	182	190				190.33	698.71		698.71	2,789.57		185.84	1,671.67	22.29	-17.80
2033 - 2034					138	389	58	448	192	256				255.54	954.24		954.24	2,789.57		185.84	1,485.83	20.06	49.63
2034 - 2035					138	411	62	473	192	281				281.48	1,235.73		1,235.73	2,789.57		185.84	1,299.98	17.83	77.81
2035 - 2036					138	496	74	571	205	365				365.46	1,601.18		1,601.18	2,789.57		185.84	1,114.14	15.60	164.01
2036 - 2037					138	525	79	603	220	383				383.36	1,984.54		1,984.54	2,789.57		185.84	928.29	13.37	184.14
2037 - 2038					138	634	95	729	236	494				493.55	2,478.09		2,478.09	2,789.57		185.84	742.45	11.14	296.57
2038 - 2039					138	670	101	771	253	518				518.15	2,996.24		2,996.24	2,789.57		185.84	556.60	8.91	323.40
2039 - 2040					138	805	121	926	271	655				654.88	3,651.12		3,651.12	2,789.57		185.84	370.76	6.68	462.36
2040 - 2041					138	851	128	979	291	688				687.96	4,339.08		4,339.08	2,789.57		185.84	184.91	4.45	497.67
2041 - 2042			670		158	1,085	163	1,248	337	241				241.13	4,580.22		4,580.22	2,789.57		133.18	51.73	2.22	105.73
2042 - 2043					158	1,140	171	1,311	361	950				950.14	5,530.36		5,530.36	2,789.57		49.83	1.90	0.62	899.69
2043 - 2044					158	1,363	205	1,568	387	1,181				1,180.74	6,711.10		6,711.10	2,789.57		-	1.90	0.02	1,180.72
2044 - 2045				491.07	173	1,432	215	1,647	415	740				740.46	7,451.56		7,451.56	2,789.57		-	1.90	0.02	740.43
2045 - 2046				515.62	188	1,716	257	1,974	446	1,012				1,012.24	8,463.79		8,463.79	2,789.57		-	1.90	0.02	1,012.21
2046 - 2047					188	1,803	270	2,073	479	1,594				1,594.48	10,058.27		10,058.27	2,789.57		-	1.90	0.02	1,594.45
2047 - 2048					188	2,157	324	2,481	514	1,967				1,966.78	12,025.05		12,025.05	2,789.57		-	1.90	0.02	1,966.76
2048 - 2049					188	2,266	340	2,606	552	2,054				2,053.57	14,078.62		14,078.62	2,789.57		-	1.90	0.02	2,053.54
2049 - 2050					188	2,711	407	3,118	594	2,524				2,524.48	16,603.09		16,603.09	2,789.57		-	1.90	0.02	2,524.45
Total	**4,546**	**99**	**670**	**1,007**	**3,983**	**22,310**	**3,346**	**25,656**	**7,276**	**12,256**	**398.51**	**697.27**	**461.79**	**13,813.53**	**1,03,552.79**	**2,789.57**	**1,06,342.36**	**78,154.18**	**56.35**	**2,844.02**	**33,509.01**	**368.06**	**13,447.37**
										6.56%													

Table 18.16

Market ROI 12%

Financial Year	Completion Cost	VGF	Concessionare Cost	Additional Cost	Replacement Cost	Depreciation	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow	Concessioner Equity	Availability of cash	Cummulative Cash	Cummulative Loan	Loan	IDC	Cummulative Loan Including IDC	Repayment	Bal Loan	Int	Cash Balance
2020 - 2021	530.23	360.90	169.33	-	-	-	-	-		-	-169.33	78.09	-91.24	-91.24	91.24	91.24	5.47	96.71		96.71		-78.09
2021 - 2022	1,337.90	1,082.70	255.20	-	-	-	-	-		-	-255.20	78.09	-177.11	-268.35	268.35	177.11	21.58	295.40		295.40		-78.09
2022 - 2023	1,809.66	1,443.60	366.06	-	-	-	-	-		-	-366.06	78.09	-287.96	-556.31	556.31	287.96	49.48	632.84		632.84		-78.09
2023 - 2024	868.34	721.80	146.54	-	-	46.02	33.36	5.00	38.37	33.36	-141.53	78.09	-63.44	-619.75	619.75	63.44	69.29	765.57		765.57	30.62	-103.71
2024 - 2025	-		-	-	-	138.07	107.20	16.08	123.28	117.64	5.65				-			765.57		765.57	91.87	-86.22
2025 - 2026	-	-	-	-	-	138.07	129.97	19.50	149.46	122.56	26.90				-		-	765.57		765.57	91.87	-64.97
2026 - 2027	-			-	-	138.07	139.20	20.88	160.08	127.95	32.12							765.57		765.57	91.87	-59.74
2027 - 2028	-			-	-	138.07	169.78	25.47	195.25	133.86	61.39							765.57		765.57	91.87	-30.48
2028 - 2029	-			-	-	138.07	181.84	27.28	209.11	140.31	68.80							765.57		765.57	91.87	-23.07
2029 - 2030	-			-	-	138.07	222.90	33.43	256.33	147.36	108.97							765.57		765.57	91.87	17.10
2030 - 2031	-			-	-	138.07	238.73	35.81	274.54	155.05	119.49							765.57	76.56	689.02	91.87	-48.94
2031 - 2032	-			-	-	138.07	305.92	45.89	351.80	172.01	179.79							765.57	76.56	612.46	82.68	20.55
2032 - 2033	-			-	-	138.07	323.40	48.51	371.91	181.57	190.33							765.57	76.56	535.90	73.50	40.28
2033 - 2034	-			-	-	138.07	389.13	58.37	447.50	191.97	255.54							765.57	76.56	459.34	64.31	114.67
2034 - 2035	-			-	-	138.07	411.37	61.71	473.07	191.59	281.48							765.57	76.56	382.79	55.12	149.81
2035 - 2036	-			-	-	138.07	496.27	74.44	570.71	205.25	365.46							765.57	76.56	306.23	45.93	242.96
2036 - 2037	-			-	-	138.07	524.63	78.69	603.32	219.97	383.36							765.57	76.56	229.67	36.75	270.05
2037 - 2038	-			-	-	138.07	634.23	95.13	729.36	235.82	493.55							765.57	76.56	153.11	27.56	389.43
2038 - 2039	-			-	-	138.07	670.47	100.57	771.04	252.89	518.15							765.57	76.56	76.56	18.37	423.22
2039 - 2040	-			-	-	138.07	805.38	120.81	926.18	271.30	654.88							765.57	76.56	0.00	9.19	569.14
2040 - 2041	-			-	-	138.07	851.40	127.71	979.11	291.15	687.96							765.57		0.00	0.00	687.96
2041 - 2042	-			670.41	-	158.19	1,085.39	162.81	1,248.20	336.66	241.13							765.57		0.00	0.00	911.54
2042 - 2043	-			-	-	158.19	1,140.08	171.01	1,311.10	360.96	950.14							765.57		0.00	0.00	950.14
2043 - 2044	-			-	-	158.19	1,363.38	204.51	1,567.89	387.14	1,180.74							765.57		0.00	0.00	1,180.74
2044 - 2045	-			-	491.07	172.92	1,432.08	214.81	1,646.89	415.37	740.46							765.57		0.00	0.00	1,231.52
2045 - 2046	-			-	515.62	188.39	1,716.22	257.43	1,973.66	445.80	1,012.24							765.57		0.00	0.00	1,527.85
2046 - 2047	-			-	-	188.39	1,802.70	270.41	2,073.11	478.63	1,594.48							765.57		0.00	0.00	1,594.48
2047 - 2048	-			-	-	188.39	2,157.24	323.59	2,480.83	514.05	1,966.78							765.57		0.00	0.00	1,966.78
2048 - 2049	-			-	-	188.39	2,265.94	339.89	2,605.83	552.27	2,053.57							765.57		0.00	0.00	2,053.57
2049 - 2050	-			-	-	188.39	2,711.31	406.70	3,118.00	593.53	2,524.48							765.57		0.00	0.00	2,524.48
Total	4,546.14	3,609.00	937.14	670.41	1,006.68	3,982.71	22,309.51	3,346.43	25,655.94	7,276.00	15,765.71	312.38	-619.75	-1,535.65	1,535.65	624.76	145.82	8,551.98	2,425.33	5,255.24	104.13	16,214.88
																				-		18.05%

CHAPTER 19 - ECONOMIC APPRAISAL

CHAPTER - 19

ECONOMIC APPRAISAL

19.1 INTRODUCTION

Economic appraisal aims to represent a complete view of contribution of upcoming Metro system benefiting the society in form of monetary value. Thus, calculating Economic Internal Rate of Return measures viability of the project.

Economic benefits are social and environmental benefits which are quantified and then converted into money cost and discounted against the cost of construction and maintenance for deriving Economic Internal Rate of Return (EIRR). This part of study quantifies benefits by saving of time, saving in cost of public and private transport, saving in fuel consumption, increasing safety of passengers, reduction in traffic congestion and reduction in air pollution. Thus, EIRR is viewed from socio-economic angle.

Jaipur Metro corridor from India Gate (SIA) to Ambabari is proposed to be operational from 2023. Thus, economic benefits are estimated from this year onward for coming 30 years. 2051 is considered as horizon year for the project.

19.2 OPTION EVALUATION

An option collating with financial analysis is evaluated for the second phase of metro project. Summary Table for evaluation is as follows.

Table 19.1: Summary of Estimated EIRR

Name of Corridor	Length (km)	Calculated EIRR
India Gate (SIA) - Ambabari	23.51	14.86%

The considered mode wise traffic values for the horizon year 2023 are presented in the following table.

Table 19.2: Travel Demand Forecast for 2023 with Metro (Optimistic Scenario)

Mode	Daily Trips
Car/ Taxi	8,29,687
Two Wheeler	19,69,639
Three Wheeler	3,93,949
Bus	4,94,206
Metro	2,03,162

19.3 ECONOMIC ANALYSIS APPROACH

Economic appraisal for the study is based on principles of Social Cost Benefit Analysis. Incremental costs and benefits are considered for estimation of “with” or “without” the system in two alternative scenarios. The benefit streams are calculated according to the market price by converting it using proper shadow prices, wherever applicable. In favour of expected externalities and anomalies on pricing system of real world this conversion is carried out. Economic Net Present Value as the sum of differences between discounted benefits and cost flows is calculated. Estimation of net cost/ benefit and economic viability in terms of Economic Internal Rate of Return is prepared with Discounted Cash Flow Method. The adopted framework for economic analysis is shown in the following figure.

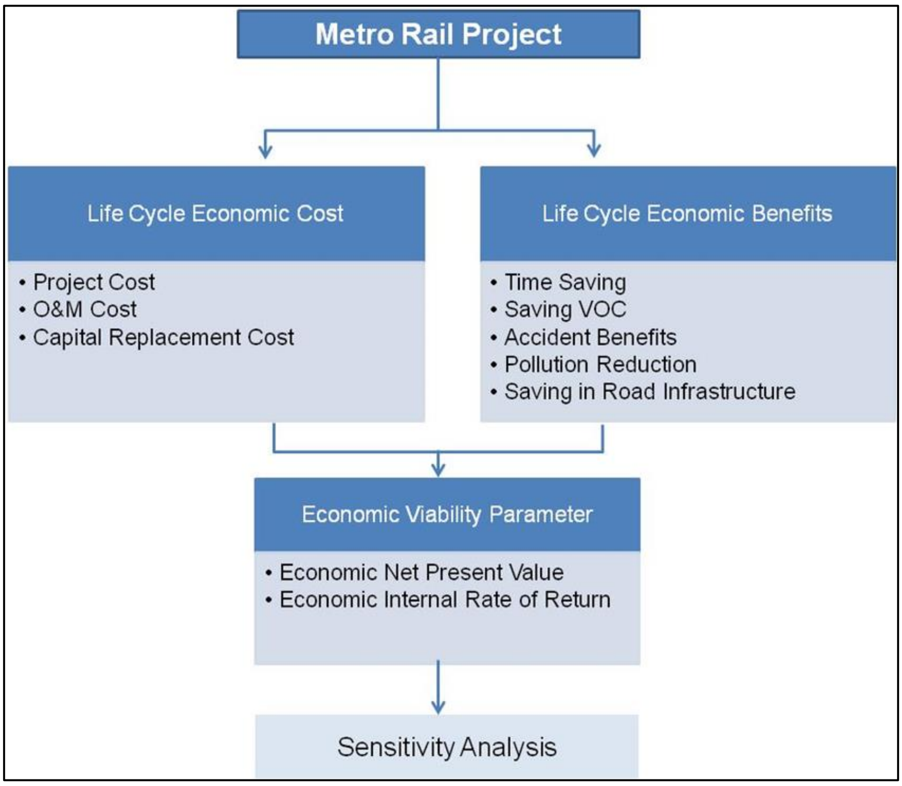


Figure 19.1: Analytical Framework for Economic Appraisal

The assumptions that have been considered for carrying out the EIRR estimation is provided in the following table.

Table 19.3: Evaluation Assumptions

Parameter	Assumption
Price Level	January-2020
First year of operation	2023
Last year of operation	2051
Construction period	3 years (2020-2023)
Daily to annual factor	365

19.4 COST ESTIMATION

Total cost of project comprises of capital cost, operation/ maintenance cost and capital replacement cost. While calculating capital cost infrastructure cost including civil engineering, land, track, power supply, traction system, signaling, telecommunication and cost of rolling stock are considered. Cost of operation and maintenance is calculated based on metro operation in other parts of the country.

Estimated capital cost for this corridor is Rs. 4,546 Crores with assumption of escalation factor of 5% per annum. However, with PPP receipts of Rs. 99 Crores, net capital cost is Rs. 4,447 Crores. The summary of Cost Estimates is shown below:

Table 19.4: Estimated Cost to Economy for India Gate (SIA) to Ambabari Corridor

Component	Cost in Rs. Crores
Completion Cost	4,546
Operating Cost	33 in first operational year and total 7,276 till 2050
PPP Receipts	99
Replacement Cost (till 2050)	1,007
Additional Cost (till 2050)	670
Total Cost (till 2050)	**13,400**

19.5 ESTIMATION OF BENEFITS

Metro System operation will contribute to various socio-economic benefits causing reduction Starting of metro system operation will show significant reduction on road traffic thus will contribute to various socio-economic benefits. It may reduce the number of buses in the public transport and number of private vehicles on road. It may increase the overall speed of traffic by mitigating congestion. It will show significant reduction in fuel consumption thus decrease air pollution. It may reduce number of road accidents and ensure safe passenger movement.

The estimated streams of benefit in this analysis has following components:

- Capital and Operating Cost of Public and Private vehicle depending on current congestion norms and total volume of passenger traffic in absence of metro operation.
- Saving in Capital and Operating Cost of Public and Private vehicle based on estimated shift of passenger trips to metro from other modes of transport.
- Saving in time of passengers travelling in metro by increasing travel speed
- Saving in time of passengers in other modes by reducing congestion in traffic on road
- Saving in Road accidents and air pollution after introduction of metro
- Saving in road infrastructure and development cost to cope up with future travel demand without metro operation

Some of the social benefits could be evaluated due to lack of universally acceptable norms. These benefits include:

- Increased accessibility of catchment area

- Reduction in road stress
- Economic stimulation in the micro region of the infrastructure
- Increase in overall mobility
- Business Opportunities
- Improving the image of the city

19.5.1 Saving in Capital & Maintenance of Public Vehicles

With starting of metro operation, a significant number of buses will be reduced from public transportation system. The value would be saved in form of capital and maintenance cost of public vehicles. Estimated savings in capital and maintenance costs for public transportation buses are Rs. 52 Crores in 2023, Rs. 161 Crores in 2031 and Rs. 457 Crores in 2041. Cost for fuel, maintenance, installation cost and depreciation are considered while calculating expenditure in public transportation buses.

19.5.2 Saving in Road Infrastructure

The travel demand of the city will increase according to population and development. This also drives a huge demand of road infrastructure. After starting of Metro system, demand for road infrastructure can also be reduced for future years as there will be significant shift of travel from road to metro. The benefit is valued as Rs. 195 Crores in 2023, Rs. 498 Crores in 2031 and Rs. 1,413 Crores in 2041.

19.5.3 Saving in Operating Cost of Private Vehicles and IPT Fares

There will be considerable saving for the road users in terms of operating cost of their private vehicles as well as in higher IPT fares for selected IPT modes like taxi and auto rickshaw. Cost for fuel, maintenance, installation cost and depreciation are considered while calculating vehicle operating cost for private vehicles. To estimate savings for IPT user's fare, difference of their existing IPT mode fare and metro fare have been considered. Estimated savings in operating cost of private vehicles and IPT fares in 2023, 2031 and 2041 are Rs. 97 Crores, Rs. 248 Crores and Rs. 698 Crores respectively.

19.5.4 Passenger Time Saving

Following metro operation, traffic congestion is expected to decrease thus travel time of commuters on road in both public and private transportation will be saved. Estimated passenger travel time savings on road in the form of value of time are Rs. 213 Crores in 2023, Rs. 556 Crores in 2031 and Rs. 1,578 in 2041. Value of time has been considered based on average per capita income of Jaipur city in 2015 and has been escalated accordingly. Following parameters from primary survey and CTTS for Jaipur Region, 2018 were used for estimation of vehicle operating cost and value of time saving.

Table 19.5: Parameters for Benefit Estimation in Terms of Vehicle Operating Cost and Time Saving

Mode	Average Speed (km/hr) in 2019	Occupancy	ATL (km)	VOC/ km (Rs.)	VoT/ Passenger (Rs./hr)
Car/ Taxi	30	2.48	6.60	12.55	115.10
Two Wheeler	40	1.47	7.86	4.51	
Three Wheeler	25	2.68	4.61	9.23	
Bus	20	25.54	6.83	1.75	
Metro	40	-	-	2.00	

19.5.5 Road Accident Cost Saving

As per CTTS for Jaipur Region, 2018 there are 500 fatal accidents and 1,600 injury accidents in Jaipur city in 2016. Metro operation is expected to reduce traffic from road significantly and thus reduction of road accident is also anticipated. The cost of accident includes medical and insurance expenses and damage to vehicle which can be saved by reduction of road accident due to metro operations. The value of benefit for 2023, 2031 and 2041 are Rs. 2.71 Crores, Rs. 6.92 Crores and Rs. 19.65 Crores respectively.

19.5.6 Savings from Air Pollution Reduction

Reduced traffic on road due to implementation of metro will lead to lesser vehicular emission. This will improve the quality of environment by reduction of air pollution. The amount estimated as saving is Rs. 6 Crores in 2023. Further in 2031 and 2041 are Rs. 14 Crores and Rs. 41 Crore could be saved. Emission estimates considered for estimation of reduced air pollution benefits are shown in table below:

Table 19.6: Estimated Emission in gm/vehicle-km

Horizon Year	CO_2	CO	NO_X	SO_2	PM	HC
2023	18,517	680	272	28	25	323
2031	32,060	1,178	472	48	44	560
2041	55,888	2,053	822	83	76	976

19.6 RESULT OF ECONOMIC ANALYSIS

Cost and benefits for horizon years after commencement of metro operation is estimated and elaborated in the Table below. The years of construction is assumed as 2020 to 2023. Estimated total cost is subtracted from total benefit to arrive at net benefit. The cash flow is prepared in discounting process to evaluate internal rate of return. The result proves this project to be economically viable. Estimated EIRR for Jaipur Metro Rail Corridor from India Gate (SIA) to Ambabari is 14.86%.

Table 19.7: EIRR Estimation for Jaipur Metro Rail Corridor from India Gate (SIA) to Ambabari

Financial Year	Capital	Running Expenses	Replacement Costs	Total Costs	Road Infrastructure Savings	Capital and O&M Savings from Buses	VOC Savings	VoT Savings	Accident & Pollution Savings	Total Savings	Net Cash Flow	Discount Rate (12%)
2021	521			521							-521	-465
2022	1,309			1,309							-1,309	-1044
2023	1,769			1,769							-1,769	-1259
2024	847	33		881	195	52	97	213	8	565	-316	-201
2025		118		118	20	54	102	223	9	409	291	165
2026		123		123	21	57	107	234	9	429	307	155
2027		128		128	23	60	113	246	10	451	323	146
2028		134		134	24	63	118	258	10	473	340	137
2029		140		140	25	66	124	271	11	497	357	129
2030		147		147	26	69	131	285	11	522	375	121
2031		155		155	27	73	137	299	12	548	393	113
2032		172		172	498	161	248	556	21	1,484	1,312	337
2033		182		182	52	169	260	584	22	1,088	906	208
2034		192		192	55	177	273	613	23	1,142	950	194
2035		192		192	58	186	287	644	25	1,199	1,008	184
2036		205		205	61	196	301	676	26	1,259	1,054	172
2037		220		220	64	205	317	710	27	1,322	1,102	161
2038		236		236	67	216	332	745	28	1,388	1,153	150
2039		253		253	70	226	349	783	30	1,458	1,205	140
2040		271		271	74	238	366	822	31	1,531	1,259	131
2041		291		291	77	250	385	863	33	1,607	1,316	122
2042	670	337		1,007	1,413	457	698	1,578	60	4,207	3,200	264
2043		361		361	148	480	733	1,657	63	3,082	2,721	201
2044		387		387	156	504	770	1,740	67	3,236	2,849	188
2045		415	491	906	164	529	808	1,827	70	3,398	2,491	147

Financial Year	Capital	Running Expenses	Replacement Costs	Total Costs	Road Infrastructure Savings	Capital and O&M Savings from Buses	VOC Savings	VoT Savings	Accident & Pollution Savings	Total Savings	Net Cash Flow	Discount Rate (12%)
2046		446	516	961	172	556	848	1,918	73	3,567	2,606	137
2047		479		479	180	583	891	2,014	77	3,746	3,267	153
2048		514		514	189	612	935	2,115	81	3,933	3,419	143
2049		552		552	199	643	982	2,221	85	4,130	3,577	134
2050		594		594	209	675	1,031	2,332	89	4,336	3,743	125
Total	**5,117**	**7,276**	**1,007**	**13,400**	**4,266**	**7,555**	**11,747**	**26,428**	**1,012**	**51,008**	**37,608**	**1,286**

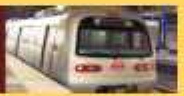
EIRR	NPV
14.86%	**1,286**

19.7 SENSITIVITY ANALYSIS

Sensitivity analysis with probable contingencies has been carried out. EIRR is calculated with a) 10% cost overrun, b) 10% increase in Maintenance Cost, c) 10% reduction in benefits and d) 10% increase in all cost components along with 10% reduction in benefits. Calculated EIRR for all these conditions are show in the following table.

Table 19.8: Sensitivity Analysis and EIRR for Jaipur Metro Rail Corridor from India Gate (SIA) to Ambabari

Sensitivity	EIRR
10% cost overrun	13.78%
10% increase in Maintenance Cost	14.66%
10% reduction in benefits	13.66%
10% reduction in benefits and 10% rise in cost	12.62%



CHAPTER 20- TRANSIT ORIENTED DEVELOPMENT (TOD) AND VALUE CAPTURE FINANCE (VCF)

CHAPTER – 20

TRANSIT ORIENTED DEVELOPMENT (TOD) AND VALUE CAPTURE FINANCE (VCF)

20.1 BACKGROUND

India is urbanizing at a rapid pace with urban population rising much faster than its total population. Level of urbanisation has increased from 17.29% in 1951 to 31.6 % in 2011. India is competing with the fastest growing countries in the world. The urban population in India, which is nearly 377 million is poised to grow to 600 million by 2030. The urban population of India contributes 65% of country's Gross Domestic Product (GDP), which is expected to grow to 75% in the next 15 years. With India witnessing a high economic growth, Indian cities are growing at a rate faster than other cities in the world.

Urbanization has led to horizontal growth of the cities thus creating problems of urban sprawl. This has resulted in increase of trip lengths and higher usage of private vehicles, problems of pollution and increased demand of infrastructure. To address these issues, many cities have strengthened their public transport by developing mass rapid transit systems (MRTS) such as metro rails and Bus Rapid Transit Systems (BRTS). It is however, important to efficiently use these systems by integrating the land use with the transport infrastructure to make the cities livable, healthy and smart.

New Metro Rail Policy 2017 emphasizes that "Transit Oriented Development (TOD)" with proposed intermodal integration, universal accessibility, adequate walkways and pathways for Non-Motorized Transport (NMT), stations for public bike sharing, commensurate parking lots for cycles and personal vehicles, as well as adequate arrangement for receiving and dispatch of feeder buses at all metro stations. The commitment by the State Government to adhere the guidelines issued by the central government w.r.t. TOD and adoption of VCF framework should be an integral part of the project proposal. The commitment should inter alia include commitment of transfer of the financial benefits accruing in the influence zone of the metro alignment on account of the TOD policies and VCF framework directly to the Special Purpose Vehicle (SPV)/agency implementing the metro rail project. The project report should specify the proposed quantum of such benefits being transferred to the project. This requirement would form a mandatory part of all metro rail project proposals.

Commercial/property development at stations and on other urban land has been used as a key instrument for maximizing revenues in metro rail/ railway systems in cities around the world. Notable examples are Hong Kong and Tokyo. Metro rail implementing agencies should endeavor to maximize revenue through commercial development at stations and on land allocated for this purpose.

The McKinsey report has estimated that around Rs. 325,000 crore of urban infrastructure investments are required annually. The High Powered Expert Committee Report 2011 projects urban infrastructure requirement at 0.75%, which will increase to 1.5% of the GDP by 2032 (Rs. 97,500 crore to Rs. 195,000 crore annually). Presently, national Urban Missions are investing about Rs. 32,500 crore annually leading to an investment gap of nearly Rs. 65,000 crore.

Ordinarily, own sources of revenue in ULBs can be classified into three categories, (a) taxes levied by the municipality, (b) user charges levied for provision of civic services, and (c) fees and fines levied for performance of regulatory and other statutory functions. Octroi, which was one of the main sources of own income of the ULBs has been abolished, resulting in a serious dent on ULBs' resources. On the other hand, property tax, which is at present the main source of own resources is underused and has issues related to its narrow tax base, exemptions, etc. Furthermore, the State Governments are increasingly fixing the rate for services being provided by ULBs, even though these functions are mandated to be performed by ULBs under the 74th Constitutional Amendment. Overall, this has led to increased dependency on State Governments and reduction in efforts made by ULBs to mobilize resources.

Land is the most fundamental asset that is owned and managed by the States/ULBs and is a resource to generate revenues. Traditionally, States/ULBs have relied on direct sale of lands to raise funds, which is a less efficient form of resource mobilization, as compared to value capture. It is not that States/ULBs have not used Value Capture methods to raise resources. In fact, States/ ULBs are using different Value Capture methods, especially in urban areas, such as impact fee, betterment charges, etc. For example, the Mumbai Metropolitan Region Development Authority (MMRDA) and City and Industrial Development Corporation Limited (CIDCO) of Maharashtra have used different Value Capture methods to finance infrastructure development in the urban areas. Similarly, Haryana and Gujarat have successfully used land pooling schemes, where owners agree to exchange their lands for infrastructure services.

While States/ULBs have been developing and using some of the Value Capture Finance (VCF) methods, the Central Government Ministries/Departments have not yet systematically used VCF methods as a revenue generation tool. One reason is that land is a State subject and VCF Policies have to be made by the concerned State Governments. A promising way is to link the location and construction of the projects by the Central Government Ministries and their agencies with the existing VCF Policy of the generated within the area of influence of the projects. Alternatively, the State VCF Policy could be revised whenever new projects are being planned in order to capture full value being generated due to proposed investment in projects.

There is an increasing focus on creation of infrastructure by Ministries/Departments of Government of India and their agencies. For example, the Ministry of Ports is constructing a series of projects as part of the Sagarmala program. Moreover, the Delhi-Mumbai Industrial Corridor (DMIC) is being developed by the Department of Industrial Policy and Promotion (DIPP) and the Metro Rail projects by the Ministry of Urban Development (MoUD). All these projects have an area of influence in which they lead to increase in value of lands and buildings, creating opportunities for using value capture methods to mop up additional resources.

20.2 OBJECTIVES OF TOD

TOD integrates land use and transport planning to develop compact growth centers within the influence zone of 500-800 m on either side of the transit stations i.e. areas within walking distance, to achieve the following objectives:

- To promote the use of public transport by developing high density zones in the influence area, which would increase the share of transit and walk trips made by the residents/ workers to meet the daily needs and also result in reduction in pollution and congestion in the influence area.

- To provide all the basic needs of work/ job, shopping, public amenities, entertainment in the influence zone with mixed land-use development which would reduce the need for travel.

- To establish a dense road network within the development area for safe and easy movement and connectivity of NMT and pedestrians between various uses as well as to transit stations.

- To achieve reduction in the private vehicle ownership, traffic and associated parking demand.

- To develop inclusive habitat in the influence area so that the people dependent on public transport can live in the livable communities within the walkable distance of transit stations.

- To integrate the Economically Weaker Sections (EWS) and affordable housing in the influence zone by allocating a prescribed proportion of built-up area for them in the total housing supply.

- To provide all kinds of recreational/entertainment/ open spaces, required for a good quality of life in the influence area.

- To ensure development of safe society with special attention to safety of women, children, senior citizen and differently abled by making necessary amendments to the building bye laws.

- To prevent urban sprawl by accommodating the growing population in a compact area with access to the transit corridor, which would also consolidate investments and bring down the infrastructure cost for development.

- To reduce carbon footprints by shifting towards environmentally friendly travel options for the line haul as well as for access and egress trips.

20.3 PRINCIPLES OF TOD

TOD focuses on compact mixed use development around transit corridor such as metro rail, BRTS etc. International examples have demonstrated that though transit system facilitates transit oriented development, improving accessibility and creating walkable communities is equally important. Based on the objectives of National Urban Transport Policy, this TOD policy defines 12 Guiding Principles and 9 Supportive tools, as shown in Figure 20.1 and 20.2, for realizing the objectives of TOD.

Figure 20.1: TOD Principles

20.4 APPROACH FOR TOD IMPLEMENTATION

- **Influence Zone**
  The area in the immediate vicinity of the transit station, i.e. within a walking distance, having high density compact development with mixed land use to support all basic needs of the residents is called the influence zone of a transit station/ corridor.

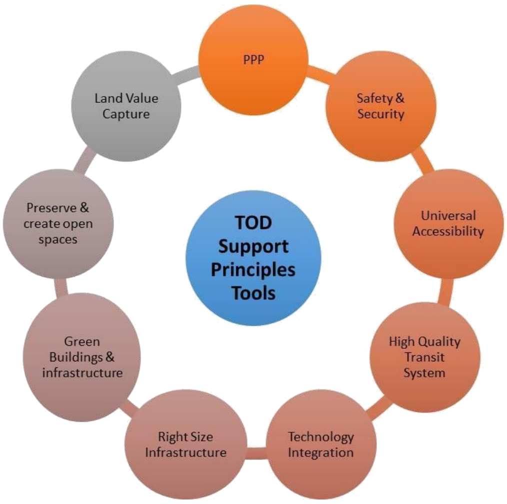


Figure 20.2: TOD Support Principles Tools

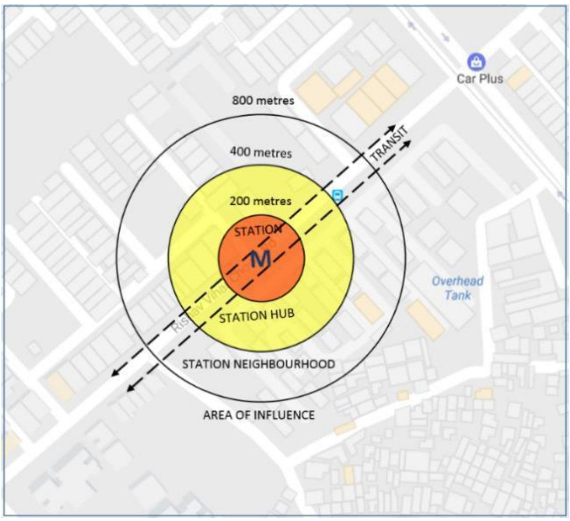


Figure 20.3: TOD Influence Zone

Influence zone is either established at a transit stations or along the transit corridors. It is generally up to a radius of nearly 500-800m of the transit station. Where the distance between the transit stations is less than 1 km and there is overlap in the influence area, it can be identified as a delineated zone (around 500m) on either side of the transit corridor within 10 - 12 minutes walking distance.

The area of influence, where the TOD is planned for implementation, should be demarcated and notified through master plan and local area plans before implementation. If in any case the TOD is to be implemented in a phased manner, the influence area of the TOD can also be notified in phases. The principles for delineating the influence area should be clearly indicated so that there is no speculation or confusion regarding the influence zone.

- **High Density Compact Development**
  TOD promotes densification in the influence area by providing higher Floor Area Ratio (FAR)/ Floor Space Index (FSI) and higher population & job density as

compared to the area around and beyond the influence areas. To ensure sustainable development, the minimum FAR should be 300 - 500%, and can be higher, depending on the city size. This will promote higher concentration of people within the walking distances of transit station, thereby increasing the ridership of the public transport and resulting in increased fare revenue, pollution and congestion reduction.

It is not necessary to keep the density and FAR norms consistent for the influence areas across the city. It can vary depending on the infrastructure available, land use zoning, transit capacity etc.

City will follow green building norms, adopt renewal sources of energy such as solar and waste to energy options, adopt rain water harvesting and ground water recharge techniques, which would encourage water conservation, utilization of clean energy and promote sustainable waste management so as to make them self-sustaining through efficient use of resources and infrastructure.

- **Mixed Use Development**

  Mixed land use should be stipulated for development/ redevelopment in the TOD zone as it would reduce the need for travel by providing most of the activities such as shopping, entertainment and public amenities such as schools, parks, playgrounds, hospitals etc. within the walking distance of the residents. It would also improve the accessibility of the transit facilities and at the same time link origins and destinations, i.e. residences with work places or activity nodes. This would ensure better utilization of transit fleet by distributing loads in both directions, rather than creating unidirectional peak hour flows.

  A blend of land-uses help in the optimization of physical infrastructure and resources, as all components like roads, parking, water, sewerage etc., remain functional at all times of the day.

  The TOD benefits cannot be realized with the kind of developments that encourage the use of personalized vehicles. It is therefore imperative to restrict developments such as low-density housing, low-rise development, warehouses, petrol pumps/CNG stations, cremation ground and surface/Multilevel parking etc. in the influence area.

  Mix of uses within the TOD can be achieved either by horizontal mixing i.e. separate activities in separate plots/ buildings or vertical mixing i.e. combining different activities within the same building.

  To ascertain mixed use development along with the required street network and open spaces, the minimum plot area in the influence zone should be defined. The developer may, however, be permitted to undertake construction in a phased manner. In case, the individual landowners want to collaborate for development as per TOD norms, necessary provisions may be made to facilitate it. The landowner(s) may also be permitted to collaborate with developers in case they lack the required experience and institutional & financial capacity to undertake such development as per TOD norms. However, care needs to be taken that the amalgamated plots are redesigned to allow finer network of streets and dispersion of open spaces.

The mix of uses to be proposed shall be decided as per the local conditions and the trends in real estate market, however, the minimum percentage of built up area for housing, commercial and other amenities should be fixed. The use of balance built up area may depend on the prevailing market conditions and demand of the city.

(i) Value Capture Methods

A comparative study on land based financing tools being used in India and the world shows a large number of diverse VCF tools being used. The main types of VCF methods are given below.

Land value tax – is considered the most ideal Value Capture tool which apart from capturing any value increment, helps stabilize property prices, discourage speculative investments and is considered to be most efficient among all Value Capture methods. Maharashtra and Tamil Nadu, through State laws, have expanded the scope of this mechanism to cover urban land also. Globally, land value tax is widely used in Denmark, Australia, and New Zealand.

Fees for changing land use (agricultural to non-agricultural) – land revenue codes provide for procedures to obtain permission for conversion of land use from agricultural to non-agricultural use.

Betterment levy – one-time upfront charge on the land value gain caused by public infrastructure investment. This occurs in two forms – revenue source for improvement schemes and for specific projects. In India, the Mumbai Metropolitan Regional Development Authority (MMRDA) Act, 1974 provides for levying betterment charges for specific projects. The Hyderabad Municipal Corporation Act, 1955 originally provided for the levy of betterment charges to meet the costs of internal infrastructure and services in the case of development projects. In the late nineties, the Government of Andhra Pradesh amended the Act to enhance the scope of such levy to include external betterment. Under this concept, the municipal authority is empowered to collect external betterment charges at the time of according approval to layouts or sub-divisions of plot or issue of building permit for the laying of trunk water lines, development of freeways/major roads, percent of the land value gain attributable to public investment.

Development charges (Impact fees) are area-based and link the development charge to the market value of land by carrying out periodic revisions. This is the most widely used land based fiscal tool in States. States like Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Madhya Pradesh levy Impact Fee and collect it upfront while granting development permissions. Impact fee is widely used to fund infrastructure in the United States. The Government of Andhra Pradesh in the late nineties also permitted Hyderabad Municipal Corporation to levy Impact Fees to mitigate the impacts of construction of commercial buildings, which lead to increase in traffic and necessitate decongestion measures. This is meant to address citywide problems emanating from high-density commercial development and is expected to be utilized for the Capital Improvement and Decongestion Plan. This includes works such as road widening, link roads, slip roads, parallel roads, junction improvements including traffic signals, flyovers, rail over-bridges, rail under-bridges, modern lighting on major roads, development of major storm water drains, riverfront and parks and for Geographic Information System (GIS) applications.

Transfer of Development Rights (TDRs) – used for trading development rights. Maharashtra, Karnataka and Gujarat have enabling laws for using TDRs for developing open spaces, promoting affordable housing, etc. In New York City, TDRs are given for preservation of the property owners for loss in revenue on their properties.

Premium on relaxation of rules or additional FSI/FAR – widely used in States such as Maharashtra, Karnataka, Gujarat, Tamil Nadu, etc. to allow for additional development rights beyond the permissible limits in the State Town Planning Laws and Regulations. Sale of additional Floor Area Ratio (FAR) is an important Value Capture tool in Brazil and France. The French Land-use Policy restricts the landowner's building right to a low baseline FAR and additional FAR has to be purchased.

Vacant Land Tax (VLT) – is applicable on those landowners who have not yet initiated construction on their lands. In Andhra Pradesh, the Greater Hyderabad Municipal Corporation (GHMC) imposes a tax of 0.5% of the registration value of the land if not used exclusively for agriculture purpose or is vacant without a building.

Tax Increment Financing (TIF) **–** is one of the most popular Value Capture tools in many developed countries, especially the United States. In TIF, the incremental revenues from future increases in property tax or a surcharge on the existing property tax rate is ring-fenced for a defined period to finance some new investment in the designated area. Tax Increment Financing tools are especially useful to finance new investments in existing habitations. Some of the Smart City Proposals have planned for TIF in their area-based developments (ABD).

Land Acquisition and Development – acquiring and developing land could be adopted as a useful Value Capture method to mobilize resources. In Hyderabad, impact fees are levied on all new developments within a one-kilometer wide growth corridor on both sides of the Outer Ring Road (ORR). Another innovative 'Road widening Scheme' is being implemented in Hyderabad in which the Municipal Corporation gives additional FAR and relaxes zoning for property owners who give land free of cost for road widening.

Land pooling System (LPS) – is a form of land procurement where all land parcels in an area are pooled, converted into a layout, infrastructure developed, and a share of the land, in proportion to original ownership, returned as reconstituted parcels. In India, States such as Gujarat and Haryana have used land assembly programs where the owners agree to exchange their barren lands for infrastructure-serviced smaller plots. Gujarat has used these tools to guide the development of Ahmedabad city and its surrounding infrastructure. The State of Andhra Pradesh has used LPS to get land for Amravati, its new Capital City. Such LPS are also a common feature in countries like Japan and Germany.

(ii) Types of Value Capture

Tools like betterment levy, development charge, etc. have been extensively used across States whereas some tools like TDRs and VLT have been used less frequently. Value capture methods can be used in an area or can be specific to a project. Area-based value capture attempts to capture the basic appreciation of the value of the area as a result of infrastructure development, while project-based value captures the appreciation of land and building values in the area of influence of the project. The area of influence determines the geographic extent of immediate positive impact of project investments. Table 20.1 gives the different VCF methods that can be applied to the two types of interventions.

Area-based application of Value Capture is best suited for urban areas. The area could be a locality, city or a larger planning area. On the other hand, project-based value capture can be used for projects being implemented by Ministries/Departments/Agencies of the Government of India. Some examples are given below.

- Ministry of Railways for high-speed rail projects and expansion of railway network through SPVs.
- Ministry of Road Transport and Highways for the phased implementation of the Indian National Expressway Network.
- Department of Industrial Policy and Promotion for setting up of Special Economic Zones (SEZs) and industrial corridors such as the Delhi Mumbai Industrial Corridor (DMIC).
- Ministry of Power for setting up power generation plants.
- Ministry of Shipping for projects requiring significant land resources such as cargo terminals, constructions of ferry and cruise terminals, and establishment of free trade zones.

Table 20.1: Value Capture Methods and Scale of Intervention

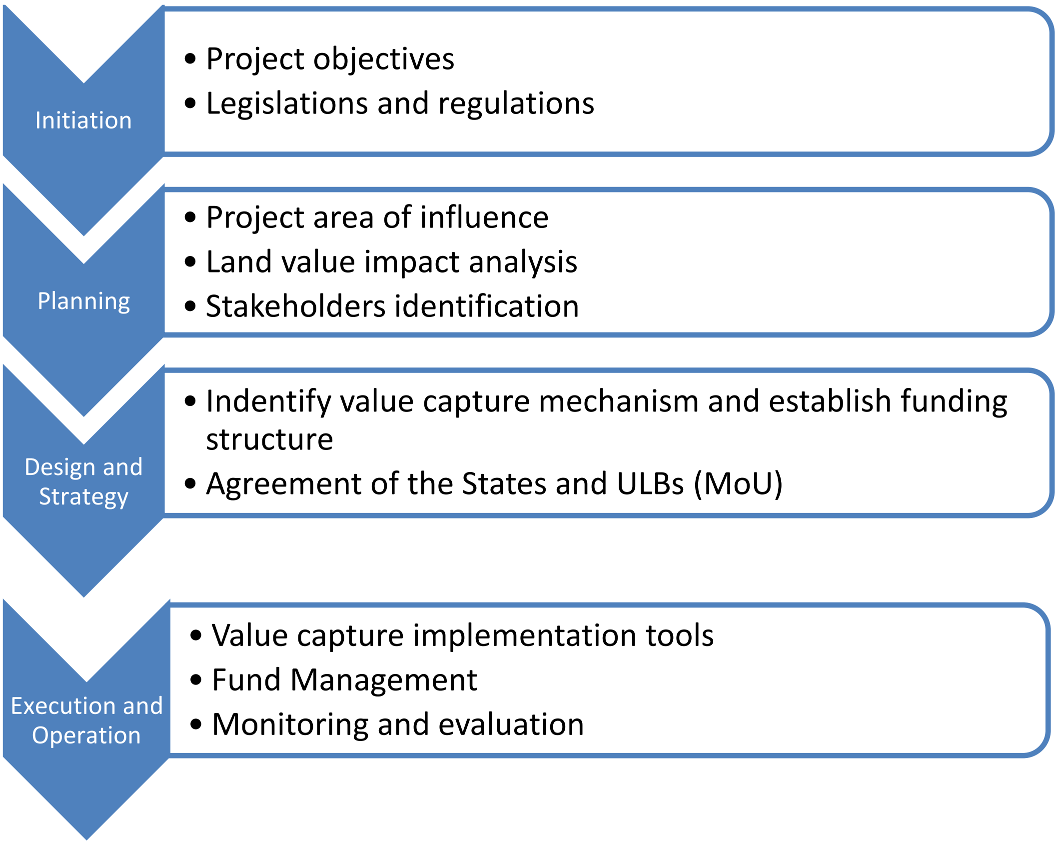
S. No.	Value Capture Method	Frequency of Incidence	Scale of Intervention
1.	Land value tax	Annual rates based on gain in land value uniformly	Area-based
2.	Fees for changing land use (agriculture to non-agricultural)	One-time at the time of giving permission for change of land use	Area/Project-based
3.	Betterment levy	One-time while applying for project development rights	Area/Project-based
4.	Development charges (Impact fees)	One-time	Area-based
5.	Transfer of Development Rights	Transaction-based	Area/Project-based
6.	Premium on relaxation of rules or additional FSI	One-time	Area (Roads, railways)/Project(Metro)

S. No.	Value Capture Method	Frequency of Incidence	Scale of Intervention
7.	Vacant land tax	Recurring	Area-based
8.	Tax increment financing	Recurring and for a fixed period	Area-based
9.	Land Acquisition and Development	One-time upfront before project initiation	Area/Project-based
10.	Land Pooling System	One-time upfront before project initiation	Area/Project-based

(iii) Application of VCF Methods to Area

In order to capitalize on the full range of VCF tools to mobilize additional resources, the States/ULBs will have to use the Scope-Coverage-Optimization Model of Value Capture. Scope refers to the type of existing and new tools which can be used in the State/ULBs. Coverage is replication of an existing tool to all parts of the State; and Optimization is related to use of scientific methods to assess, levy and collect taxes from a range of VCF tools. Below, are given the steps for States/ULBs to assess the opportunities for using VCF tools to generate additional resources.

Figure 20.4: Steps Required for Project-based VCF



Scope - Different types of Value Capture tools being used in other States and countries reviewed and decided on the type which could be used in the Jaipur Area. Optimization - VCF methods based on an examination of the rates will be levied by State.

Coverage – Presently VCF tools are applied to small parts of the corridor and can easily be extended to other Areas. These will be identified and scaled-up.

After studying the scope, optimization possibilities and coverage of the Value Capture methods, the State will examine if existing Acts, rules, regulations and bye-laws have to be amended.

Finally, a mechanism for sharing of their venues through value capture between the States/ULBs and other entities will have to be designed and implemented.

(iv) Value Capture Financing (VCF) for TOD

Value Capture is based on the principle that private land and buildings benefit from public investments in infrastructure and policy decisions of the Government. Part of the increment in value of land and building should be captured to fund projects being set up for the public by the Central/ State government and the ULBs. The additional value is generated by actions other than the land owner's direct investment. Land value capture is distinct from the user charges or fees that agencies collect for providing services.

The investment in transit system as well as increase in FAR and provision for mixed use development would result in increase in value of land within the influence zone. Land Value Capture can be used as a mechanism to finance the required upgradation of infrastructure and amenities within the influence zone and expansion of the public transport system.

Value capture financing is an opportunity for the private sector because the projects are planned for the overall development, thus increasing the value and are also backed by the government.

In TOD influence zones, land value capture can be done through enhanced or additional land value tax or one time betterment levy, development charges or impact fee, transfer of development rights (TDRs), or other such mechanisms which have been adopted in various states across the country and abroad.

The resources generated through various mechanism should be credited into a TOD fund created for funding the infrastructure upgradation/ maintenance, enhancement of viability of transit systems, development and maintenance of transit corridor and public transport etc. within and beyond the influence zone. The fund should be in the form of an escrow account, from which financing is provided to various agencies for the identified activities and the balance can be used by the ULBs for other development purposes such as public transport expansion.

The real-estate market can be erratic and therefore caution should be observed while estimating the revenue from land value capture. In case the revenues are lower than expectations, ULBs should prepare alternate financing plans to circumvent problems in implementing TOD.

(v) Statutory Framework

TOD policy should be notified as part of the Master Plan/Development plan of the city. The policy document should clearly outline the importance of the high capacity transit networks in the city's development.

The vision of the Master Plan/ Development Plan should be resonated by all the stakeholders, especially those involved in infrastructure development and preparation of development plans. The building bye-laws and development control regulations would need to be amended to incorporate the changes required for implementing TOD.

The influence zone of the TOD should be clearly notified by the concerned authority to ensure that the infrastructure created in the influence zone is provided in a planned manner, the ULBs and the concerned authorities/agencies should prepare a comprehensive plan integrating all the utilities, physical infrastructure and essential facilities such as roads, sewers, drainage, electric lines, green spaces, police post, fire post, electric sub-stations, etc. The plan would be useful to assess the carrying capacity of the existing infrastructure and the upgradation needed to meet the increased demand once TOD is implemented.

CHAPTER 21- IMPLEMENTATION PLAN

CHAPTER - 21

IMPLEMENTATION PLAN

21.1 INTRODUCTION

Jaipur Metro Rail Corridor from India Gate (SIA) to Ambabari is 23.51 km long elevated corridor having 21 elevated stations.

Estimated Cost of the project at January 2020 price level is Rs. 4133 Crore inclusive of all taxes & duties and land cost. Completion cost with all taxes & duties and land cost and escalation at 5% p.a. works out to Rs. 4546 Crore (excluding IDC) and Rs. 4602 Crore (including IDC).

21.2 POSSIBLE MODELS FOR FINANCING A METRO PROJECT

1. Design-Build-Finance-Operate-Transfer (DBFOT)
2. A Private Public Partnership (PPP) and
3. Fully through Government funding i.e. Government mobilizing all the funds required for the project through equity, grants or loans borrowed by the Government.

Possibilities, implications of the 3 models mentioned above are discussed below:

1. DBFOT model:

Under this model, the private firm will be responsible for financing, designing, building, operating and maintaining of the entire project. The contribution of Government of Rajasthan will be limited to cost of land only. Such a project become eligible for Viability Gap Funding (VGF) upto 20% from the Central Government provided the state government also contribute same or more amount towards the project. The metro being a social sector project not much private parties are available to bid for such a project. Besides quite expectedly the private operator may demand assured rate of return in the range of 16% to 18% or a comfort of guaranteed ridership.

2. PPP model:

There are essentially two variants under this model.

Variant 1:- Here the Government funds the fixed infrastructure cost such as land and basic civil structures and private investor funds all the systems such as rolling stock, signalling, power supply, traction, track, fare collection system and E&M works including station architectural design. An example for this is Delhi Metro Airport line. Under this arrangement, the Government's investment will be about 40 to 45%

of the total cost and the PPP Operator funds the remaining cost. The operator is selected again on competent bidding with viability gap funding who operates and maintains the system to the specified service safety levels. All the Revenues will accrue to the Operator in all the concession period till the project is handed over to the owner. Ridership for this is taken by the Operator fully or shared between the operator and the owner.

Variant 2:- Under this the Government acquires the required land and offers to the concessionaire free of cost. The private partner funds all the rest of the project, operates and maintains the system taking all the revenues and risks. His expected losses are made good through a viability Gap Funding (VGF), by the Government arrived at based on competitive bidding. At the end of concession period the system reverts to the owner. Under the PPP model, Sweeteners are sometime offered to the operator in the form of lands for commercial exploitation. Private management generally ensures better efficiency in the execution and operation of the system compared to a Government agency.

When the project is taken up on DBFOT or PPP model the total cost of the project generally gets hiked up by the Concessionaire adding the availing additional costs.

1. As bulk of the funds will be through borrowings. Interest during construction period will get added on to the projects costs.

2. The funds are available to a private party to which borrowing costs compared to the Government and additional funding cost will get factor to the cost of the project.

3. When a private party executes the project the refunds of the taxes and duties of the two Governments may not be possible. This alone will increase the cost of project by 18 to 20%.

4. Metro projects by themselves will not be financially viable. Commercial exploitation of surplus lands and identified Governments lands along the route has to be necessary to augment the Capex as well as revenue earnings. Making available normal land free to the Concessionaire for commercial exploitation will lead to public criticism and often end up in scandals.

Nowhere in the country a complete DBFOT or PPP model has so far found successful or attractive for the main reason that the fare levels have to be kept low and affordable to the common citizens.

3. Fully through Government funding:

Here, the Government takes full responsibility for funding the project either from its own resources or through borrowings. For convenience and speedy execution a Special Purpose Vehicle is set up and given the mandate to execute the project. The Operation and maintenance of the system can be either directly by the SPV or they can engage an operator for the purpose. Usually a debt equity ratio of 2:1 is followed but there can be variations depending upon the tender's terms and the Government's ability to provide funds. The government's own investment will be in the form, of share holdings in the SPV and borrowings can be either from a Consortium of local banks or from infrastructure funding organizations such as IIFCL, IDBI, etc. or through an external bilateral loan from institutions such as ADB, World Bank, JICA etc. All the loans will need Governmental guarantee to reduce the borrowing cost. The Government can also assist the SPV with interest free subordinate loans. The SPV will have responsibility to service and pay back the loan and if SPV fails the responsibility will then devolve on the Government.

21.3 THE RECOMMENDED FINANCIAL MODEL FOR INDIA GATE (SIA) TO AMBABARI CORRIDOR

World over Metro projects cannot be financially viable and depend upon generous concessions and subsidies. The financial rate of return for this corridor for 30 years life cycle business model including construction period is 6.56%.

The only Metro which has been implemented on BOT model so far is the Rapid Metro in Gurgaon. Financially this Metro has been a total failure since the revenues are not able to meet even the interest payment on the loans raised.

Out of the 3 PPP models in the country, Delhi Airport Line has been a total failure since the Concessionaire has voluntarily withdrawn with claims through arbitration. In the case of Bombay Metro Line No.1 which is only 11 km length had taken more than 6 years for completion and the cost had gone up 2 times. Concessionaire is representing to government for allowing him to charge very high fare in spite of very good ridership leading to loading the public financially.

In the case of the Hyderabad Metro the PPP Concessionaire withdrew from the project and another Concessionaire namely L&T implemented the project. The financial performance of this project is yet to be assessed. Considering the global scenario and the experience in our own country DMRC does not recommend either the BOT model or PPP route for implementing the India Gate (SIA) to Ambabari Corridor.

It is therefore recommended that the project is implemented fully as a Government initiative. By this route the project can be completed at the shortest time and at the lowest cost. This is important because then only ticket can be priced low, affordable to the common citizens and make the system truly a popular public transport.

21.4 INSTITUTIONAL ARRANGEMENTS

Since JMRC is an existing SPV which has already implemented E-W corridor, therefore the State Govt. of Rajasthan may approve the implementation of this project also through JMRC.

21.5 IMPLEMENTATION STRATEGY

When the project is taken up as a Government initiative there are two ways the projects can be implemented. One is – Jaipur Metro Rail Corporation (JMRC) handling the project directly with the help of General Consultants (G.C.). Further multilateral lending agencies generally insist of international consultants to engage as G.C. for assisting for the implementation of the project. International G.C. is required for planning, design, drawing up specifications, preparation of tender documents, finalization of contract and supervision of the project during execution. To engage the G.C. globally tenders would be necessary. For finalizing such a global contract and positioning the Consultants itself takes about 9 to 12 months. G.C. will generally cost about 3½ to 4% of the project cost. Even if G.C. is engaged, still JMRC will need a fairly big organisation to oversee the G.C. work and it will be required to mobilize technical persons with experience & knowledge whose establishment cost itself would be about another 3½ to 4%. Thus about 7 to 8% of the project cost will be spent on total establishment alone.

The 2nd option is JMRC for this project can be a very small lean and efficient organization responsible for land acquisition and mobilization of funds. The entire Metro project can be entrusted on turnkey basis and on deposit terms to an experienced organization such as DMRC who has the experience and track record and competency of technical manpower. DMRC had already implemented elevated section of Jaipur Metro E-W corridor. DMRC is also implementing/implemented on similar basis Kochi Metro for Kerala Government, Greater Noida Metro project for the Greater Noida Authority, Mumbai Metro Corridor from Dahisar (E) to D.N. Nagar Corridor (Line-2A) and Swami Samarth Nagar to Vikhroli (EEH) (Line-6) for MMRDA. In second option there is saving of approximately 10 to 12 months as selection of General Consultants takes this much time. Thus, this Line may be handed over to DMRC for implementation. DMRC generally charges 6% of the project cost for the total turnkey implementation. This will be the cheapest and quickest way of completing the project in time.

21.6 CONTRACT PACKAGES FOR IMPLEMENTATION OF THE PROJECT

The project may be implemented in the nine packages as under.

Package –1: Starting from chainage -0.350km (Dead End of India Gate Station) and upto Durgapura Station (excluding).

Package –2: Starting Durgapura Station (including) and upto SMS Hospital Station (excluding).

Package –3: Starting SMS Hospital Station (including) upto Ambabari Dead end.

Package - 4: Detailed design consultant for corridor including Depot.

Package - 5: Construction of boundary wall for depot, earth work filling and construction of workshop, inspection bay, stabling lines etc.

Package – 6 System Contracts: Supply and installation of traction power system (3rd bay) including sub-station.

Package - 7: Supply and installation of signaling system (CBTC)

Package - 8: Supply and installation of AFC System.

Package - 9: Supply and commissioning of rolling stock.

Any other small package may be decided at the time of implementation of the Project.

21.7 IMPLEMENTATION SCHEDULE

Suggested project implementation schedules are given in Table 21.1 and 21.2 below

Table 21.1 Project Implementation on Turnkey basis (Deposit Terms)

Sl. No.	Item of Work	Completion Date
1	Submission of Final DPR to State Govt.	D
2	Approval of DPR by State Government	D+15 days
3	Submission of DPR for Approval of Ministry of Housing and Urban Affairs (MoHUA).	D+30 days
4.	Sanction of Project by GOI	D+60 days
5.	Appoint an agency on deposit terms	D+30 days
6.	Implementation of the project	D+42 months
7.	Testing and Commissioning	D+43 months
8.	CMRS Sanction	D+44 months
9.	ROD	D+44 months

Table 21.2 Project Implementation Schedule through SPV Model

Sl. No.	Item of Work	Completion Date
1	Submission of Final DPR to State Govt.	D
2	Approval of DPR by State Government	D+0.5 month
3	Submission of DPR for Approval of Ministry of Urban Development (MoHUA).	D+1 month
4.	Sanction of Project by GOI	D+2 months
5.	Selection of GC	D+8 months
6.	Tendering	D+14 months
7.	Implementation of the project	D+41 months
8.	Testing and Commissioning	D+43 months
9.	CMRS Sanction	D+44 months
10.	ROD	D+44 months

21.8 HIGH POWER COMMITTEE

During the implementation of the project several problems with regard to acquisition of land, diversion of utilities, shifting of structures falling on the project alignment, rehabilitation of project affected persons, etc. are likely to arise. For expeditious resolution of these problems, an institutional mechanism needs to be set up at the State Government level. Towards this end, it is recommended that a High Power Committee under the chairmanship of Chief Secretary, Rajasthan should be set up. Other members of this Committee should be Secretaries of the concerned Departments of the State Government and Heads of civic bodies who will be connected in one way or the other with the implementation of the project. This Committee should meet once a month and sort out all problems brought before it by JMRC. It is reliably learnt that for the Delhi Metro also such a High Power Committee was set up and it proved very useful in smooth implementation of the Delhi Metro Rail Project.

21.9 CONCESSION FROM GOVERNMENT

Metro rail projects need very heavy investment. Loans have invariably to be taken to fund a part of the capital cost of the projects. These projects yield low financial internal rate of return. With reasonable fare level, servicing of these loans often pose problems. To make the project financially viable, therefore, the fares need to be substantially increased to socially un-acceptable levels. This results in the ridership coming down significantly, as it is sensitive to increases in the fare level. Thus the very objective of constructing the metro rail system to provide an affordable mode of mass travel for public is defeated. It, therefore, becomes necessary to keep the initial capital cost of a metro project as low as possible so that the fare level of the metro system can be kept at reasonable level. Following are the taxes and duties, which have to be borne by a metro project:

- Custom Duty on all imported rolling stock and other equipment needed for the project.
- GST on all indigenously manufactured rolling stock and other indigenously finished goods required for the project.
- GST on all purchases made for implementation of the project whether directly by the project implementation authority or by the contractors executing the project.
- GST on works contracts to be executed for the implementation of the project.
- Tax on electricity required for operation and maintenance of the metro system.
- Municipal Taxes.

As in the case of Delhi Metro, the State Government should exempt/reimburse the State Goods and Services Tax (SGST) to this Metro project. It should also exempt the following:

In the case of Delhi Metro project, the Union Government has granted exemption from payment of Custom Duty and Excise Duty while the Delhi Government has agreed to give exemption from payment of Sales Tax and on works contracts. Delhi

Metro Rail Corporation is also pursuing with the Government for exemption from tax on electricity being consumed by Delhi Metro for its operation and maintenance.

It is recommended that similar exemptions from taxes and duties be granted by the Central Government/Rajasthan Government for Jaipur Metro. In this connection it may be mentioned that the Central Government has been encouraging infrastructure projects in the country through fiscal and non-fiscal concessions. Cities have emerged as the engines of growth and mass transport systems today are one of the most important pre-requisites for the balanced growth of the city. The Government can demonstrate the importance it attaches to this sector by granting the above concessions which would not only help reduce the initial cost of the project so that Jaipur Metro remains commercially viable during its operation phase but also send strong signals to the effect that it is committed to a safer and pollution free city. Moreover, public transport is employment-friendly and favours social balance in a sustainable way since it allows access to jobs and services to all.

Further to increase revenue from other sources, GoR shall exempt state taxes and levies including any tax on outside advertisement rights, Property transfer/registration charges, land transfer charges, lease charges etc. It is also proposed that GoR shall create a land bank for financing state share for this project.

21.10 LEGAL COVER FOR JAIPUR METRO

Implementation of proposed Metro Corridor may be done under “The Metro Railways (Amendment) Act 2009”. The copies of the Gazette notification and the amendment are put up enclosure to this chapter.

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असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित

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शहरी विकास मंत्रालय

(मैट्रो रेल प्रकोष्ठ)

अधिसूचना

नई दिल्ली, 7 सितम्बर, 2009

का.आ. 2279(अ).—केन्द्रीय सरकार, मैट्रो रेल (संशोधन) अधिनियम, 2009 (2009 का 34) की धारा 1 की उप-धारा (2) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, 7 सितम्बर, 2009 को उस तारीख के रूप में नियत करती है, जिसको उक्त अधिनियम के उपबंध प्रवृत्त होंगे।

[फा.सं. के-14011/40/2003-एमआरटीएस/मैट्रो]

विमल कुजूर, अवर सचिव

MINISTRY OF URBAN DEVELOPMENT

(Metro Rail Cell)

NOTIFICATION

New Delhi, the 7th September, 2009

S.O. 2279(E).—In exercise of the powers conferred by sub-section (2) of Section 1 of the Metro Railways (Amendment) Act, 2009 (34 of 2009) the Central Government hereby appoints the Seventh September, 2009 as the date on which the provisions of the said Act, shall come into force.

[F. No.K-14011/40/2003-MRTS/Metro]

BIMAL KUJUR, Under Secy.

3269 GI/2009

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इस भाग में भिन्न पृष्ठ संख्या दी जाती है जिससे कि यह अलग संकलन के रूप में रखा जा सके।
Separate paging is given to this Part in order that it may be filed as a separate compilation.

MINISTRY OF LAW AND JUSTICE
(Legislative Department)

New Delhi, the 27th August, 2009/Bhadra 5, 1931 (Saka)

The following Act of Parliament received the assent of the President on the 26th August, 2009, and is hereby published for general information:—

THE METRO RAILWAYS (AMENDMENT) ACT, 2009

No. 34 OF 2009

[*26th August*, 2009.]

An Act further to amend the Metro Railways (Construction of Works) Act, 1978 and to amend the Delhi Metro Railway (Operation and Maintenance) Act, 2002.

BE it enacted by Parliament in the Sixtieth Year of the Republic of India as follows:—

CHAPTER I
PRELIMINARY

1. (*1*) This Act may be called the Metro Railways (Amendment) Act, 2009. Short title and commencement

(*2*) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint.

CHAPTER II

AMENDMENT TO THE METRO RAILWAYS (CONSTRUCTION OF WORKS) ACT, 1978

Amendment of section 1.

2. In the Metro Railways (Construction of Works) Act, 1978 (hereafter in this Chapter referred to as the Metro Railways Act), in section 1, in sub-section (*3*), for the portion beginning with the words "such other metropolitan city" and ending with the words "to that city accordingly", the following shall be substituted, namely:— 33 of 1978.

"the National Capital Region, such other metropolitan city and metropolitan area, after consultation with the State Government, and with effect from such date as may be specified in that notification and thereupon the provisions of this Act shall apply to the National Capital Region, such metropolitan city or metropolitan area accordingly.".

Substitution of words "metropolitan city" by words "metropolitan city, metropolitan area and National Capital Region".

3. In the Metro Railways Act, for the words "metropolitan city" occurring in clause (*h*) of sub-section (*1*) of section 2, clause (*c*) of sub-section (*1*) of section 4 and clause (*a*) of sub-section (*1*) of section 32, the words "metropolitan city, metropolitan area and the National Capital Region" shall be substituted.

Amendment of section 2.

4. In section 2 of the Metro Railways Act, in sub-section (*1*),—

(*i*) after clause (*h*), the following clause shall be inserted, namely:—

'(*ha*) "metropolitan area" shall have the meaning assigned to it in clause (*c*) of article 243P of the Constitution;';

(*ii*) after clause (*o*), the following clause shall be inserted, namely:—

'(*oa*) "National Capital Region" means the National Capital Region as defined in clause (*f*) of section 2 of the National Capital Region Planning Board Act, 1985;'. 2 of 1985

CHAPTER III

AMENDMENT TO THE DELHI METRO RAILWAY (OPERATION AND MAINTENANCE) ACT, 2002

Substitution of references to "metropolitan city of Delhi" by references to "National Capital Region and any other metropolitan area".

5. Throughout the Delhi Metro Railway (Operation and Maintenance) Act, 2002 (hereafter in this Chapter referred to as the Delhi Metro Railway Act), for the words "metropolitan city of Delhi" wherever they occur, the words "the National Capital Region, metropolitan city and metropolitan area" shall be substituted. 60 of 2002.

Amendment of section 1.

6. In section 1 of the Delhi Metro Railway Act, for sub-sections (*1*) and (*2*), the following sub-sections shall be substituted, namely:—

"(*1*) This Act may be called the Metro Railways (Operation and Maintenance) Act, 2002.

(*2*) It extends in the first instance to the National Capital Region and the Central Government may, by notification, after consultation with the State Government, extend this Act to such other metropolitan area and metropolitan city, except the metropolitan city of Calcutta, and with effect from such date as may be specified in that notification and thereupon the provisions of this Act shall apply to that metropolitan area or metropolitan city accordingly.".

7. In section 2 of the Delhi Metro Railway Act, in sub-section (*1*),— *Amendment of section 2.*

(*i*) for clause (*a*), the following clauses shall be substituted, namely:—

'(*a*) "Central Government", in relation to technical planning and safety of metro railways, means the Ministry of the Government of India dealing with Railways;

(*aa*) "Claims Commissioner" means a Claims Commissioner appointed under section 48;';

(*ii*) for clause (*h*), the following clauses shall be substituted, namely:—

'(*h*) "metropolitan area" shall have the meaning assigned to it in clause (*c*) of article 243P of the Constitution;

(*ha*) "metropolitan city" means the metropolitan city of Bombay, Calcutta, Delhi or Madras;';

(*iii*) after clause (*k*), the following clause shall be inserted, namely:—

'(*ka*) "National Capital Region" means the National Capital Region as defined in clause (*f*) of section 2 of the National Capital Region Planning Board Act, 1985;'. *2 of 1985.*

8. In section 6 of the Delhi Metro Railway Act, in sub-section (*2*), after clause (*b*), the following clauses shall be inserted, namely:— *Amendment of section 6.*

"(*ba*) develop any metro railway land for commercial use;

(*bb*) provide for carriage of passengers by integrated transport services or any other mode of transport;".

9. Section 7 of the Delhi Metro Railway Act shall be renumbered as sub-section (*1*) thereof and after sub-section (*1*) as so renumbered, the following sub-section shall be inserted, namely:— *Amendment of section 7.*

"(*2*) The Commissioner shall function under the administrative control of the Chief Commissioner of Railway Safety appointed under section 5 of the Railways Act, 1989.". *24 of 1989.*

10. For section 12 of the Delhi Metro Railway Act, the following section shall be substituted, namely:— *Substitution of new section for section 12.*

"12. The Chief Commissioner of Railway Safety shall, for each financial year, prepare in such form, and within such time, as may be prescribed, an annual report giving a full account of the activities of the Commissioners during the financial year immediately preceding the financial year in which such report is prepared and forward copies thereof to the Central Government.". *Annual report.*

11. In section 13 of the Delhi Metro Railway Act, for the word "Commissioner", the words "Chief Commissioner of Railway Safety" shall be substituted. *Amendment of section 13.*

12. In section 23 of the Delhi Metro Railway Act, in sub-section (*1*), for the words "Hindi and English", the words "Hindi, English and official language of the State in which such station is located" shall be substituted. *Amendment of section 23.*

13. In section 26 of the Delhi Metro Railway Act, in sub-section (*1*), the words "a small" shall be omitted. *Amendment of section 26.*

14. In section 34 of the Delhi Metro Railway Act, for sub-section (*4*), the following sub-section shall be substituted, namely:— *Amendment of section 34.*

"(4) The Central Government and the State Government shall nominate one member each to the Fare Fixation Committee:

Provided that a person who is or has been an Additional Secretary to the Government of India or holds or has held an equivalent post in the Central Government or the State Government shall be qualified to be nominated as a member."

Amendment of section 38.

15. In section 38 of the Delhi Metro Railway Act, in sub-section (2), for the words "Government of the National Capital Territory of Delhi", the words "State Government" shall be substituted.

Amendment of section 85.

16. In section 85 of the Delhi Metro Railway Act,—

(i) in sub-section (1), for the words "Government of the National Capital Territory of Delhi", the words "State Government" shall be substituted;

(ii) in sub-section (2), for the words "Government of the National Capital Territory of Delhi in the Delhi Gazette", the words "State Government" shall be substituted.

T.K. VISWANATHAN,
Secretary to the Govt. of India.

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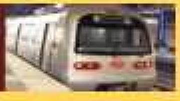


CHAPTER 22 - CONCLUSIONS AND RECOMMENDATIONS

CHAPTER – 22

CONCLUSIONS AND RECOMMENDATIONS

22.1 DMRC submitted DPR for Jaipur Metro Rail Project consisting of 2 corridors (Corridor-1: Durgapura to Ambabari and Corridor-2: Mansarovar to Badi Chaupar) in March 2010. The report submitted in March 2010 got revised in April 2011, in which Corridor-1 extended till Sitapura Industrial Area. In March 2012 it was decided to bifurcate DPR in two parts i.e. Corridor-2: Mansarovar to Badi Chaupar as Phase I and Corridor-1: Sitapura Industrial Area to Ambabari as phase II. Further DPR for Phase II was revised in April, 2014 and July, 2014. As original proposal for Phase II was envisaged in 2011 since then a lot of development has occurred along the corridor. Moreover, as per New Metro Rail Policy 2017, some new elements are to be considered while preparing the DPR. Therefore, the DPR prepared in 2011 cannot be taken up for implementation. Hence JMRC decided for Updation / Review of Detailed Project Report for Jaipur Metro Phase 2 and preparation of DPR for extension of Phase 1B from Badi Chaupad to Ramganj and awarded the assignment to DMRC on 20/06/2019.

22.2 Metro Projects are highly capital intensive on account of the high costs involved. Due to the need to maintain a fare structure within the affordable reach of ordinary citizens, metro projects are ordinarily not financially viable. However, considering the economic gain to the society and the fact that city with a population of more than twenty million cannot survive without an efficient Metro System, implementation of this Metro Corridor is recommended.

The proposal of this corridor is technically feasible but involves acquisition of land as well as rehabilitation of some hutments and shops. This is a socio-economic problem and has to be tackled for execution of the project.

Estimated Cost of the project at January 2020 price level is **Rs. 4133 Crore** with all taxes & duties and land cost. Completion cost with all taxes & duties and land cost and escalation at 5% p.a. works out to Rs. 4546 Crore (excluding IDC) and **Rs. 4602 Crore** (including IDC).

22.3 The project has many positive environmental impacts like reduction in traffic congestion, saving in travel time, reduction in air and noise pollution, lesser fuel consumption, lesser road accidents, etc., with a few negative impacts (especially during implementation phase of the project) for which Environmental Management Plan has been suggested.

22.4 After examining the various options for execution of the project, it has been recommended that the project should be got executed through SPV model under GoR, however AFC system shall be provided through PPP mode.

22.5 The fare structure of Jaipur Metro prevailing in 2019 has been considered during traffic survey and ridership projections, hence the same has been used as base fare for calculation of FIRR of the project as indicated in the Finance Chapter. Subsequently, for the purpose of assessing returns from the project, the fares have been revised with an escalation of 14% once in every two years.

22.6 As in the case of Delhi Metro, the State Government should exempt/reimburse the State Goods and Services Tax (SGST) to JMRC/SPV. It should also exempt the following:

- Tax on electricity required for operation and maintenance of the metro system.
- Municipal Taxes.

22.7 Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR)

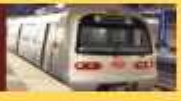
The Financial Internal Rate of Return (FIRR) for the project has been assessed as **6.56%** and Economic Internal Rate of Return (EIRR) works out to **14.86%.**

22.8 Meanwhile the State Government should freeze all future developments along the proposed route of India Gate (SIA) to Ambabari to avoid in-fructuous expenditure.

22.9 It is recommended the State Govt. should set up a non-lapsable, non-fungible Transit Fund to fund the project out of revenues from

- Increased FAR along the Metro corridors.
- A Metro cess on the sale of petrol and diesel in the State.
- Levy of additional charges on the registration of vehicles.
- Levy of additional cess on the Property Tax.
- A onetime green cess on existing vehicles.
- Property development on Government land.

22.10 Further to increase revenue from other sources, GoR shall exempt state taxes and levies including any tax on outside advertisement rights, Property transfer/registration charges, land transfer charges, lease charges etc. It is also proposed that GoR shall create a land bank for financing state share for this project.



APPENDIX

Appendix

DMRC's Response to comments received from JMRC on draft DPR submitted for Jaipur Phase-2 corridor from India Gate (SIA) to Ambabari

Sr. No	JMRC's Comment	DMRC's Response
1	In DPR, it is proposed to have 3 phase LT supply Electric connections at individual Station while estimated load at each station is taken as 100 kW. But as per Jaipur Vidyut Vitran Nigam Limited (JVVNL) tariff conditions, LT supply is given only up to maximum demand of 50 KVA. In this situation JMRC has to take 11KV, HT supply connection which will further required 11KV/415-volt transformer and HT metering arrangement, results in increase capital cost and space requirements at station. Hence DMRC may be requested to review the load requirement at station and to submit the detailed load calculation. I think the load requirement of 100kW is taken on higher side as there is no concourse and Escalators are proposed at stations. JMRC has to keep maximum demand up to 50 KVA or load up to 45 kW (considering PF as 0.9) to obtain LT supply from JVVNL at station. Accordingly, the capacity of the DG sets at station may be reduced as per revised load.	1. It may be observed that the Average Operational Power Demand of DMRC and JMRC Elevated Stations is more than 120 kW (normal operation), the details are as follows: a. The Average actual load of operational Elevated station of DMRC is **137.36kW**. b. The Average load of operational Elevated Stations of JMRC is 123 kW. 2. During normal operation, Electrical Loads comprises of Lifts, Escalators, Air Conditioning (AC), S&T (including AFC), Lighting, Signage and PAP (kiosk and Ad panels etc.) loads except Fire-fighting system. 3. Further, for calculating Auxiliary Loads of Elevated Stations in the proposed corridor, loads for Fire-fighting system, hydraulic system, Air Conditioning (AC) and Escalators have not been considered in load calculations as it was decided to plan Electrical Loads similar to Metrolite System, being Proposed by DMRC (as per discussion with the then MD, JMRC (DS, JMRC)). *Since Air conditioning is not considered for all the rooms based on the above discussions, any Air conditioning needed later for any specific room will increase the Electrical load and cost accordingly.*

Sr. No	JMRC's Comment	DMRC's Response
		4. The detailed calculations were again carried out and checked. 5. It may be observed that the load is approximately 100 kVA. However, the final loads may be estimated at the detailed design stage. It is observed that Electrical load (Maximum Demand) comes out to be around 100 kVA, with following major heads: - S&T - 30 + AFC - 5 = 35 kVA, Lighting = 20 kVA PAP (kiosk and Ad panels etc.) = 20 kVA, Lifts = 20 kVA, Signage = 5 kVA **Total = 100 kVA** 6. Power Factor (pf) for Auxiliary Loads is assumed to be 0.85, accordingly electrical load for elevated station is approx. 85 kW (i.e. 100 kVA x 0.85). Therefore, for the purpose of calculating Power – Energy, the station load is considered to be 100 kW. ***The above are approximate assumed requirements, and since these are for Maximum Demand load, and actual loads are normally lower than MD loads, <u>initially connection of 50 kVA may be planned from DISCOM 'as permitted in Tariff order of DISCOM" to optimise</u> the costs. In case load increases in later years, suitable arrangement***

Sr. No	JMRC's Comment	DMRC's Response
		station wise may be done later as necessary. Remark: JMRC again suggested that maximum LT demand shall be restricted to 50kVA to avoid 11kV HT Connection. Whereas DMRC is of the view that as detailed above, it is not possible to restrict max power demand to 50kVA in the DPR, however JMRC may review and restrict max power demand during detail design stage of elevated stations.
2	In DPR it is mentioned that Escalators are not proposed at stations but in no. of places in DPR the provisions of Escalators are referred for example at para 10.8, 10.13 etc. It should be corrected to avoid any confusion.	Chapter Revised with desired modifications.
3	The sindhi camp RSS is taken as second source of the supply of phase 2, the feasibility of laying 25KV feeding cable from Sindhi camp RSS to feeding post of phase 2 (which may be planned between govt hostels to Chandpole section) may be verified and accessed.	The arrangement is feasible. The cables may be laid through existing viaduct as also done at many locations in DMRC and FP may be planned in New line at a suitable location. The details may be finalised and verified during Detailed Design Stage, based on viaduct alignment, suitability of location of Feeding post on viaduct based on distance with reference to station, inclination, Traction sectioning diagram, etc.
4	There should be provision of crossover/ siding at regular interval for better operations in event of failures/ breakdowns.	Agreed. Present provision of Points/ Crossings has been included in DPR only for Interlocked Stations. (Para 11.4.8 of Signalling Chapter) Crossovers have been planned at India Gate, Kumbha Marg. Mahaveer Nagar, Ram Bagh Circle, Collectorate and Ambabari.
5	There should be provision of BCC.	Provision pertaining to BCC already exists in Para 11.10 of Signalling chapter in DPR as detailed below:

Sr. No	JMRC's Comment	DMRC's Response
		"In order to decrease the risks of disruption due to a local disaster such as fire, flood, building collapse, etc., a Main CTC (OCC) and a fall back CTC (BCC) shall be provided & both shall be located in different areas.
6	Provision of closed loop ticketing in AFC system may be dropped.	The existing AFC system of JMRC is supporting Closed loop smart card and token. Phase II AFC system need to be integrated with existing AFC system for seamless connectivity between existing system and upcoming system. Hence, it is necessary that new AFC system of Phase II should support existing closed loop smart cards in addition to NCMC based cards and QR based singe journey tickets. In addition, as part of Phase II, the existing AFC system of Phase I need to be upgraded to support NCMC based open loop cards and QR based single journey. The transition to NCMC based open loop system cannot be done overnight, as it will need replacement of large number of close loop cards with NCMC based cards and associated issues of refund of the card store value/card security. Issue of NCMC based cards has KYC requirements also. Based on above, it is suggested that JMRC should continue use of closed loop cards in Phase II in addition to NCMC based cards.
7	Back up of CCTV to be provisioned for 1 month.	Back up storage of CCTV is to be provisioned for 7 days in DMRC. Back up storage of CCTV can be increased by increasing the storing capacity of NVR (Network Video Recorder) as per the requirement during detailed design stage.
8	Provision of communication between passenger and OCC may be thought about.	The communication link between Passenger and OCC is PEC (Passenger Emergency Control alarm).

Sr. No	JMRC's Comment	DMRC's Response
		Passenger can directly communicate to OCC by pressing PEC in case of DTO/UTO mode of signaling system. Up to ATO Mode of Operation passenger can talk to Train Operator by pressing PEC for seeking any assistance.
9	Consideration may be given for keeping a provision of about Rs 50 Crore for unforeseen expenditure due to public issues, religious unforeseen shifting of temple etc., tree replantation, court cases and unpredicted works of public sentiments, negotiation for vacation of shop, houses etc. during execution.	Any such expenditure should be met out of R&R provision and contingency.
10	In reference to chapter – 8, the depot has been considered self-sufficient. There was a suggestion from CRS (WC) regarding limited facilities.	Comments regarding suggestion from CRS (WC) are not understood and also it is not clear as to how CRS (WC) has commented about future depot proposal. If, it is based on comments on facilities in the existing depot, specific concern may please be communicated. The Depot chapter has been prepared based on the experience and practice being followed in DMRC. As there is no operational connection between East – West and North -South Corridors. Hence, full-fledged depot is required for North - South Corridor.
11	In Para 0.9.2, the axle load 16 T has been considered same as for phase 1. Therefore, it is seen that there is no any revision/reduction as discussed during previous deliberations. That means the RS proposed will be same as in phase 1.	The referred para 0.9.2 is related to JMRC Phase-2 corridor (India Gate (SIA) - Ambabari). The Rolling stock proposed is based on the MoUHA Guidelines "Standardization of broad parameters of Rolling Stock for Metro Railways in India" in April 2017. The proposed rolling stock with respect to axle load only (i.e. 16T) is same. However, the performance parameter and configuration of Rolling Stock is entirely different from JMRC Phase-1 corridor.

<table>
<tr><th>Sr. No</th><th>JMRC's Comment</th><th>DMRC's Response</th></tr>
<tr><td></td><td></td><td>Few of them are highlighted as under:
<table><tr><th></th><th>Configuration</th><th>Unit Consist</th><th>Percentage of motorization</th><th>Train Operation</th></tr><tr><td>Phase-1</td><td>DTC+MC+ MC+DTC</td><td>2-Car</td><td>50%</td><td>ATP/ATO</td></tr><tr><td>Phase-2</td><td>DMC+TC+ DMC</td><td>3-Car</td><td>67%</td><td>ATP/ATO/ UTO</td></tr></table></td></tr>
<tr><td>12</td><td>The name of the railway station towards Sikar should be Bhaton Ki Gali.</td><td>Changed.</td></tr>
<tr><td>13</td><td>There is no railway station named Goner on Sawai Madhopur line between Sanganer and SheodaspuraPadampura.</td><td>There is Goner phatak (railway crossing) only between Sanganer and Sheodaspura station. Inadvertently, it is mentioned as Goner Station. Corrected.</td></tr>
<tr><td>14</td><td>IMPORTANT: The old entry of Jaipur Airport (Entry – 1) is under major renovation and proposed to be used for passengers' entry as read in some local vernaculars in the past. If the route is diverted as shown in the route plan through Pinjrapol Gaushala, this airport entry will be deprived of metro which will be a major setback in route economy. Considering the Funnel Area also, the possibility should be explored to divert from Airport flyover towards Sanganer Setu with a smooth curve on slip road behind Thaneshwar Temple and on a wide road and then adopting the same return route of DPR scheme.</td><td>The possibility of diverting alignment from airport flyover to towards Sanganer Setu was explored at the time of finalisation and it was concluded that it is not a technically viable option. Therefore, two options of the alignment have been given in the DPR. First option is detouring the alignment from Pinjara Pol Gau Shala and second option is to take it straight along the Tonk Road by the side of airport flyover and make it underground in air funnel area.

Option one has been recommended in the DPR with dedicated bus service and integrated fare between Sanganer Setu Metro Station and domestic terminal of Jaipur airport.</td></tr>
<tr><td>15</td><td>The B-2 Bypass Metro station is around 3.00 km from Airport Entry 2 which is considered more in a Tier – II city like Jaipur. It may attract few flight users.</td><td>Similar to domestic terminal international terminal also have been considered with dedicated bus service and integrated fare between B-2 Bypass Metro station and International terminal of</td></tr>
</table>

Sr. No	JMRC's Comment	DMRC's Response
		Jaipur airport. It is not feasible to make seamless connectivity with both the terminals without making certain length of this corridor underground. The entire corridor has been kept elevated to cut the cost and time of the project after having a number of discussions with JMRC.
16	Load bearing capacity of parapet as well as viaduct should be sufficient to accommodate large size hoardings because large size hoardings are real Revenue catcher for the prospective licensee	Agreed. It may be considered at the time of detailed design of the viaduct.
17	Provision for power supply cable for advertisement hoardings through in-built cable tray so that licensee needs not to interfere inside via duct structure for installation of cable etc.	This may be finalised during Detailed Design Stage.
18	If possible, provision of fixtures be made while construction of via duct so that future licensee can use these fixtures to place its advertisement panels. (Like OHE tower placement arrangements.)	It is not encouraged to fix any fixtures on main viaduct structure keeping in view its long life. However, it may be considered on columns.
19	Any other civil related issue regarding fixing of advertisement panels on via duct should be discussed at this stage	It is not encouraged to fix any fixtures on main viaduct structure keeping in view its long life. However, it may be considered on columns.
20	On pillars also pre fixed fixtures for placement of advertisement panels (two on each pillar) should be provisioned so that future licensee should not need to fix panels as per existing belt method	Agreed. It may be considered at the time of detailed design of the viaduct.

21) Other Comments:

Sr. No	DPR Reference	Subject/Chapter /Department	Clarification Sought	DMRC's Response
1.	General	Telecom Towers for wireless communications related to Metro	In place of Ground base towers, Roof Top telecom towers can be planned on station buildings to save cost of tower and to save the land requirement for tower.	Ground based or Roof top telecom. Towers can be decided based on-site conditions during detailed design stage.
2.	Station Planning	Station Design / Civil	Each station building can have a small inbuilt ATM Space facing road.	This may be decided at the time of detailed design after assessing the demand.
3	General	State Government/ Municipal Taxes	It should be clearly stated in the DPR that all the state government taxes and levies including any tax on outside advertisement rights, Property transfer/registration charges, land transfer charges, lease charges etc. shall be exempted by GOR.	Incorporated in Conclusion chapter.
4.	General	Depot	The land earmarked for the depot has sufficient land which is more than actual requirement. In this regard, following suggestions are made: 1. The portion of the depot land identified for property development should be road facing. 2. The canteen if planned in depot should have restricted entry from road side or should be planned near the gate. 3. In the land identified for property development, small building facing road may be constructed to have provision for some of the office accommodation and to rent out for public utilities like bank,	This may be decided at the time of detailed design.

Sr. No	DPR Reference	Subject/Chapter /Department	Clarification Sought	DMRC's Response
			etc. 4. The entry for office / staff quarters / PD area should be different for the depot entry	
5	Land acquisition	Land for casting yard	It will be better if the land for one of the Casting yards is identified in the depot itself as sufficient land is identified there. Also, one of the casting yards can be planned in Nilay Kunj land of JMRC, if possible.	One casting yard may be considered in the proposed depot land in the area earmarked for property development. PD may be done after commissioning of the corridor.
6	Land acquisition	Land for temp offices	It will be better if the lands for temporary offices are identified in JMRC land parcels at Dev Nagar and Lal Kothi as both the land parcels are on the phase 2 route.	Agreed. It should be done by JMRC at the time of implementation of the Project.
7	Station Planning	Kumbha Marg	Goverdhannagar seems to be repeated. Two big hospitals NH and RUHS are nearby	Corrected.
8	Station Planning	Mahaveer Nagar Station	Station is also near to Durgapura Station which will be a main source of passengers. Also, Jaipuria Hospital Medical College is nearby.	Incorporated.
9	Station Planning	Gopal Pura Station	Station is near to Dev Nagar land of JMRC. If we can move station by 500 M, we can have integration with this land parcel. Also, there is no Gopal Pura nearby. Hence, station name should be changed to Dev Nagar or otherwise.	It is not clear in which direction 500m shifting of the station is required. Location of station has been kept closer to Gopal Pura Bypass Road. Station name changed to Dev Nagar.
10	Station Planning	Tonk Fatak	No Bapu Nagar nearby. Laxmi Mandir and Bajaj Nagar are nearby. Also, kendriya school is nearby.	Corrected.

Sr. No	DPR Reference	Subject/Chapter /Department	Clarification Sought	DMRC's Response
11	Station Planning	Ram Bagh Circle	No Anandpuri and kartarpura nearby. Santok Ba Durlabhki hospital and JDA & SMS Stadium are nearby.	Corrected.
12	Station Planning	Narayan Singh Circle	Name Repeated twice.	Corrected.
13	Finance	Land requirement for financing the project.	The DPR should envisage a land bank to be created by GOR for JMRC for financing the GOR funding.	Agreed.