



# 0. EXECUTIVE SUMMARY

## 0.1 INTRODUCTION

Mumbai, the financial capital of India has/ is expected to witness phenomenal growth in population and employment. The job opportunities it offers have served as a major attraction for immigration from hinterland of Maharashtra as well as from all parts of the Country. Mumbai Metropolitan Region (MMR) extending over an area of 4,355 sq.km. MMR is assessed to have population and employment in the year 2031 as 34.0 million and 15.3 million respectively.

Four-fold growth of population since 1951 has been largely accommodated in the suburbs while the highest concentration of jobs has remained in the Island City. The physical characteristics of the City are such that the suburbs have been constrained to spread northwards only, and all transport facilities are concentrated within three narrow corridors. Today's major challenge is to provide connectivity and promote growth by providing adequate inputs to the infrastructure which would improve the quality of life of the residents.

Mumbai Metropolitan Region Development Authority (MMRDA) has been striving to strengthen the mass transport network and improve the travel quality. A comprehensive project i.e. Mumbai Urban Transport Project (MUTP) was setup as a continuation of the Bombay Urban Transport Project (BUTP) under which Mumbai Railway Vikas Corporation Ltd. (MRVC) a joint venture of Ministry of Railways and Govt. of Maharashtra was set up for implementation of rail related projects.

In the third phase of MUTP, a fast corridor on Harbour Line connecting CST and Panvel and new suburban lines between Virar to panvel are envisaged. While the new double line corridor proposed between Virar-Panvel would facilitate introduction of suburban services in this potential-growth area, the additional tracks with fast running air conditioned trains in CSTM-Panvel would be an option for the existing and upcoming developments. These services will also facilitate better connectivity to proposed International Navi Mumbai Airport.

It has therefore, been decided to carry out techno-economic survey and prepare a DPR for new suburban corridor from **Panvel to Virar**, under MUTP-Phase III (**Fig 0.1**)

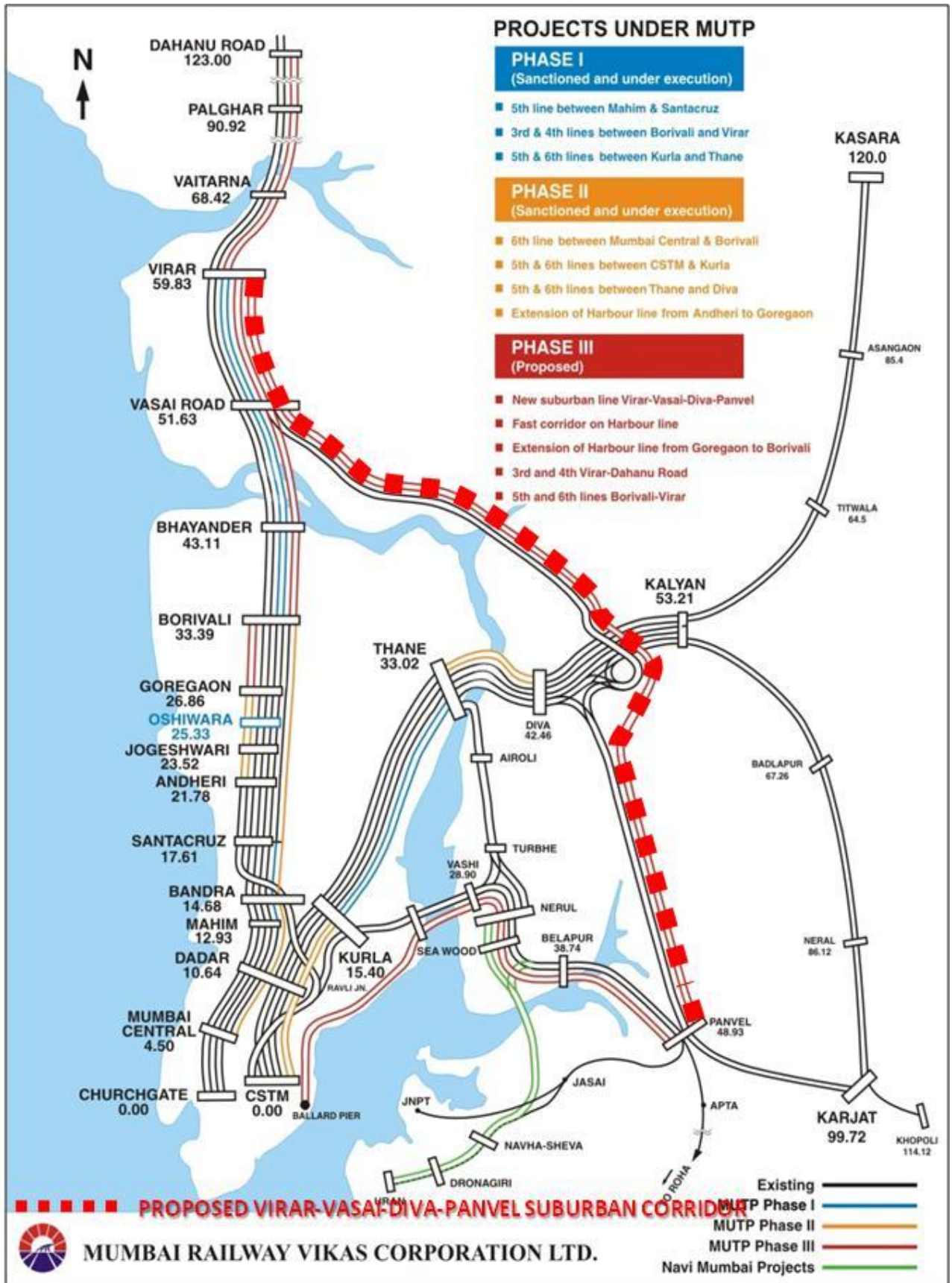


Figure 0.1: Proposed Panvel - Virar Suburban Corridor along with other proposed projects of MUTP



**0.2 RIDERSHIP ESTIMATION**

The passengers on the proposed suburban Corridor would come from two sets of existing transport systems;

- Shift of passengers from existing MEMU/ DEMU rail services (likely to be entirely replaced with the proposed suburban rail services)
- Shift of passengers travelling within the immediate influence area on the parallel major roads along the Corridor by various road modes including bus, taxi, auto and private modes

However, a major component of the expected ridership on the proposed Corridor will come from the natural growth of passengers due to future developments/ landuses in the immediate catchment areas of the Corridor/ Stations.

The catchment area is poised to grow tremendously in the coming decades. The present pace of landuse development is slow, but is likely to pick up in the near future. The availability of the proposed suburban Corridor will also act as a catalyst to spur the development pace in the catchment area within the construction period.

Primary traffic volume surveys were conducted in the immediate catchment area of the corridor to update the available data and to appreciate and quantify the traffic & transport characteristics of commuter travel

The passengers will be provided with a more frequent sub-urban rail service that will also serve a larger catchment, due to higher number of stations which will replace the existing DEMU/ MEMU services translating into all non - long distance rail passengers traveling on the proposed Suburban Corridor.

The shift from various road modes is expected to be upto 50% of the total road passenger traffic. This assumption also takes into account the increased level of congestion in the years to come.

The number of induced passengers due to the larger catchment is expected to be about 50 % of the total estimated shift from existing rail passengers.

The Corridor is expected to have a daily ridership of about 4.59 lakh in the first year of operation, i.e. 2021, 9.92 lakh in 2031 and 17.76 lakh in 2041 (**Table 0.1**).

**Table 0.1: Ridership Estimates**

CORRIDOR	Avg. Daily Passengers (In Lakh)			
	2012	2021	2031	2041
Panvel- Virar	1.95	4.59	9.92	17.76

The maximum section load in terms of Peak Hour Peak Direction Trips (PHPDT) on the proposed suburban rail Corridor would be upto 14,300 for Virar - Vasai Road – Diva/ Kopar section and upto 10,600 for Diva/ Kopar - Panvel section in the first year of operation i.e. 2021. The corresponding figures by the year 2041 will be upto 55,300 and 41,100 respectively.



## 0.3 SYSTEM DESIGN

### 0.3.1 Traction System

Keeping in view the ultimate traffic requirements, uniformity, standardization and other techno-economic considerations, 25kV ac traction system is considered to be the best solution and hence, proposed for adoption. Suitable measures will be required for mitigation of EMI & EMC caused by 25 kV single-phase traction currents.

### 0.3.2 Signaling and Train Control

Train services carrying a large number of passengers at very close headways require a very high level of safety enforcement. At the same time heavy investment in infrastructure and rolling stock necessitates optimization of its capacity to provide the best services to the public. These requirements of the suburban rail are planned to be achieved by continuous train detection by using track circuits /digital axle counter and continuous supervision of train movements by centralised control.

Signaling & Train Control system on the Virar – Panvel suburban corridor is planned for design headway of 3 minutes so as to meet sustained train operations at up to 5 minutes interval during peak hours. These requirements of the train are planned to be achieved by adopting a State of art solid state interlocking i.e. computer based interlocking with track circuits / digital axle counter for train vacancy detection and Computer based Centralized Train Operation and Train Management system.

### 0.3.3 Telecommunication

The purpose of Telecommunication System is to serve the Operative and Administrative communication requirements of proposed Railway corridor from Virar-Panvel suburban corridor. The proposed telecommunication system will be based on the optical fiber network and helpful in meeting the train operational requirement such as supplementing the Signaling system for efficient train operation, Exchange of managerial information, Crisis management during emergencies and Passenger Information System

### 0.3.4 Rolling Stock

Rolling Stock proposed for Virar- Panvel suburban corridor shall be Broad Gauge, 100 Kmph maximum speed, Stainless steel body, Automatic Voice Announcement System, well ventilated etc. The detailed specifications of the rolling stock and its procurement may be decided on the basis of the project implementation mechanism. The broad features of Rolling Stock which may be followed are presented in **Table 0.2**



**Table 0.2 Broad Features of Rolling Stock**

S. No.	Parameter	Details
1	Basic Unit	One Motor coach (MC) and one Trailer coach (TC) and one driving coach (DC).
	12-Car Train Composition	DC-MC-TC-TC-MC-TC-TC-MC-TC-TC-MC-DC
2	Coach construction	Light weight stainless steel body
3	Tare Weight	DC (32.0 T), TC (32.0 T), MC (52.0 T)
4	Axle load	20.5 T
5	Propulsion system	3 phase drive system with VVVF control
6	Type of traction supply	25KV AC Overhead collection
7	Passenger Loading (SDCL)	DC (28.0 T), TC (34.0 T), MC (27.0 T)
		Loading Equivalent to 16 standing passenger /m2

**0.4 CIVIL ENGINEERING**

**0.4.1 Engineering Survey**

The Topographical Survey was conducted covering complete Railways Area along the proposed corridor and 20 m strip of private area has been also surveyed on both side of Railway Land Boundary, wherever found feasible.

The Survey work was carried out along the existing Panvel- Nilaje, Kopar-Juchandra section as well as along the new alignment between Dativali- Kopar and Juchandra –Vasai Road . Survey for proposed Car Depot at kalwar was also carried out.

**0.4.2 Planning and Design Norms**

The proposed corridor will consist of two broad gauge (BG) lines at 5.3 m centre to centre for at grade construction. Track centres of 4.725m have been adopted for Elevated portion of alignment. The alignment is in conformity with letter No. 2010/Proj./Genl./3/3 dated 23.12.2011, for Standards of Track Structure for Metro Railway/MRTS system for Broad gauge including details of curvature, gradients, turnouts, switch expansion joints etc.

**0.4.3 System Parameters**

The broad parameters of study has been decided after detailed evaluation of all available options geographically in context of transport needs of area and projected.

- Category of line : Group ‘C’
- Track Gauge : Broad Gauge (1676 mm)
- Track Centre : 5300 mm (BG)
- Traction : 25 kV ac OHE
- Rolling Stock : Normal EMU Stock, 3660 mm wide
- Speed potential of the section : 100 kmph
- Maximum degree of curvature : 1.00° fully transitioned, preferably relaxable





- Obligatory Points : up to 5.8° at difficult locations  
: i. Proposed two lines shall pass through all existing stations.  
ii. Propose traffic facilities, junction Arrangements and yard plans.
- Width of Formation : i. Minimum width in embankment 12.150 m  
ii. Minimum width in cutting (excluding side drains) 11.550 m  
Width in embankment and cutting shall be increased on curves based on extra ballast and extra clearance required on curves.
  - Side slopes : H : V
    - i. Cutting : 1 : 1
    - ii. Embankment : 2 : 1
- Ruling Gradient : Existing ruling gradient of the section shall be proposed.
- Gradient in yards : Preferably level, however if yards are located on Gradients, then gradient shall generally be not steeper than 1 in 1200 or consistent with the prevailing gradient in existing yard.
- Track centre : 5.30 m
- Level Crossings : Level crossings to be avoided. DFCCIL in Panvel Juichandra section have proposed ROBs /RUBs on the existing level crossings on their alignment.
- Track structure

**0.4.4 Geometric Design Parameters**

**Horizontal Curves**

- The minimum adopted curve radius for main running lines is 300 m for at-grade/elevated. In exceptional cases, for elevated section the radius of 200 m has been used at some locations.
- Radius of curves at stations shall not be less than 1000 m in elevated and at-grade sections.
- Cant deficiency (Cd) allowed may not exceed 100 mm and the Actual Cant (Ca) may not normally exceed 125 mm.

**Vertical curves**

- Minimum radius of vertical curves at change of grade points (wherever change of grade is steeper than 0.4%) to be adopted, is 2500-m in normal circumstances and 1500 m in exceptional situations. There should be no overlap between vertical curves and transition curves. The minimum length of vertical curves is to be 20 m.

**0.4.5 Alignment Description**

- Proposed new Suburban corridor from Panvel to Virar is to run along the existing Panvel – Diva – Vasai line of Central Railway and then Vasai Road to Virar of



Western Railway, to be accommodated generally, within the existing right of way, elevated/at-grade, in order to avoid/minimize acquisition of private land/property. The corridor proposed is to have double line track, with a capacity to run 12 coach trains.

- From Panvel to North of Nilaje, the alignment is proposed at-grade. Between Nilaje and Kopar, the alignment is proposed elevated. Between Kopar and north of Juchandra, the alignment is again proposed as at-grade. Between south of Vasai Road and Virar, the alignment is again proposed as Elevated.
- There is planned Dedicated Freight Corridor (DFC) running almost parallel to existing corridor between Panvel to Juchandra section. The DFC is planned on east of existing double line track
- Between Nilaje - Kopar section, which is 7.90 Km, the alignment is proposed elevated for about 6.40 Km. The alignment crosses the Dombivli – Diva Central Railway main line corridor, connecting loops and Panvel - Diva Central Railway main line corridor as elevated. For crossing Panvel - Diva corridor, a ramp with a grade of 1:200 (0.50%) has been proposed to become elevated. In remaining section i.e. 1.50 Km, the alignment is proposed at grade, where generally adequate space is available to accommodate new sub-urban corridor.
- The alignment of proposed corridor in Vasai Road - Virar section is proposed elevated due to land constraints. Also future proposal of 5th/6th line between Borivali to Virar is kept in mind while proposing the alignment of Panvel - Virar corridor. There are 2 ROBs in this section. Thus, the vertical profile of the proposed corridor is decided by giving due considerations to these fixed structures. In general, the ground clearance of ROBs above the existing Rail level is 7.5 m to 8.0 m and required clearance for the proposed corridor above ROBs is 5.50 m. Therefore, the proposed alignment of the new sub-urban corridor is planned at a height of 16.50 m to 17.0 m including depth of deck.
- With a view of minimizing land/property acquisition requirement, it is recommended to adopt general arrangement of two proposed corridors (i.e. Panvel - Virar and Borivali-Virar 5th/6th line) between Vasai Road- Virar sections just over one another. This scheme could be feasible if elevated construction is done first with provision of At Grade track on either side of proposed pier.

#### **0.4.6 Utilities and Services**

There are in all seven organizations/departments owning these utilities apart from various departments of Railways. Details of owning departments are mentioned in **Table 0.3**.



**Table 0.3: Utility Owning Departments**

S. No.	ORGANIZATION/DEPARTMENT	Area	UTILITY SERVICES
1	Kalyan – Dombivali Municipal Corporation	Nilje-Kopar	Water Pipe line and sewer line and Drainage system
2.	Thane Municipal Corporation	Nilje	Water pipe line
3.	Mahanagar Gas Ltd. (MGL)	PNVL - VR	Gas pipe lines
4.	Mahanagar Telephone Nigam Ltd. (MTNL)	PNVL -Kalamboli	PIJF cables & Optical Fiber cables.
5.	MSETCL/Torrent power	Kopar – Kaman	Electrical lines, H.T and L.T lines
6.	MSEDCL	Panvel – Bhiwandi Road	Electrical lines, H.T and L.T lines
7.	STEM water distribution	PNVL - VR	Water pipe lines

**Management of Utilities**

While planning for diversion of utility services viz. sewer lines, water pipelines, cables, etc., during construction of new suburban corridor, 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.
- Where permanent diversion of the affected utility is not found feasible, 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.

**0.4.7 Geo Technical Investigation**

The geotechnical investigations were carried out from Panvel to Virar along the alignment of proposed new suburban corridor for entire length of 70.15 km. The bore logs were taken at about every 500 m tentatively so as to cover the entire corridor and to get fairly accurate idea of ground characteristics. Some inaccessible areas or areas of private land are not covered in GT investigations.

The locations of bore holes were selected in such a way so as to cover the entire alignment of the proposed corridor mostly along the existing line. The distance between successive bores is kept generally about 500m. Site specific requirement of bore locations were met by making suitable shift in bore location. Numbering of bores are done in a sequential manner from one end and inaccessible areas/private area locations left out, although number is assigned for future identification for the bore. Full Geotechnical investigations details are being made available separately.

**0.4.8 Land Requirement**

Abstract of land requirements for different components of corridor are given in Table below. For running sections Govt. land 5.25 hact. and private land 14.27 hact is required. For stations, Private land 5.55 hact. and Govt land 2.34 hact is required. Private land 34.80 hact is required for the proposed depot at kalwar. This entire requirement excludes land already in possession of Railways.





Govt. Land of 10.00 hact is temporarily required for construction depots for elevated corridor portion.

**Table 0.4: Land Requirement**

S. No	Description	Pvt. Land in SQM	Govt. Land other than railway in SQM	Total land in SQM
1	Running section	142732	52539	<b>195271</b>
2	Kalwar Depot	348000	-	<b>348000</b>
3	Station area	55501	23439	<b>78940</b>
	<b>Total</b>	<b>546233</b>	<b>75978</b>	<b>622211</b>
			<b>Say</b>	<b>62.22 Hact</b>

**0.5 PLANNING FOR INTERMODAL INTEGRATION AND DISPERSAL FACILITIES**

**0.5.1 Concept**

**The Transport Integration measures are proposed to**

- facilitate efficient transfer and dispersal of passengers from/ to the proposed system
- provide for effective inter-modal interchange of the passengers with the feeder modes including walk

In conjunction with the projected ridership, planning of inter-modal integration is carried out for the year 2041.

The modal distribution of the feeder trips at the station for the proposed system is likely to be similar to as presently observed at the major stations such as Panvel , Kopar, Nalasopara, Vasai and Virar . However, the quantum of passenger dispersal volumes in the station areas would increase significantly in the future. With the increase in passenger traffic dispersing via the road network for their feeder trips, it is vital that adequate traffic dispersal facilities are available at the stations in terms of capacity of roads, footpaths/ pedestrian facilities, bus stops, IPT stands, Pick-Drop Areas and Parking to cater to the projected requirements

**0.5.2 Existing Traffic Dispersal**

The major issue in the dispersal of passengers around the station areas at the present major stations such as Virar, Panvel and Vasai Road is of general traffic congestion caused by intermixing of pedestrians with vehicular traffic, narrow streets – partially encroached by parking and street vendors, unorganised IPT/ bus stands, lack of defined pick/drop areas and inadequate parking facilities. However at minor stations, due to presently low level of passenger traffic, transport infrastructure such as defined footpaths, organized parking and bus/ IPT stands are generally missing.

**0.5.3 Traffic Dispersal Facilities**

The present transport infrastructure and dispersal facilities would need to be augmented to handle the additional volumes. Up-gradation/ widening of roads and walkways, pedestrian cross-over facilities, skywalks, new/ augmented bus/ IPT stands, planned pick-up/ drop-off areas, one-way traffic movement, additional access facilities, parking facilities and increased frequencies of public transport are the prominent measures suggested for this purpose.



The traffic dispersal and proposed arrangements and infrastructure for future inter-modal transport integration and traffic dispersal for the thirteen existing stations along the Corridor have been prepared at conceptual level. The sites for future stations have no developments and road network at present – as and when these stations are developed, similar arrangements/ facilities in relation to the station precincts and surrounding developments can be provided there.

**0.6 TRAIN OPERATION PLAN**

The salient features of the proposed train operation plan for Virar- Panvel suburban corridor are:

- Train operation plan which has been envisaged with 12-Car rake.
- Running of normal services for 19 hours of the day (5 AM to 00:00AM i.e. midnight) with average station dwell time of 30 second.
- Make up time of 5-10% (on the tangent track) with 8-12% coasting.
- Scheduled average speed for corridor shall be 45kmph.

Transport demand provided for proposed corridor for different years 2012, 2021, 2031 and 2041 is described in **Table 0.5**, and **Table 0.6**

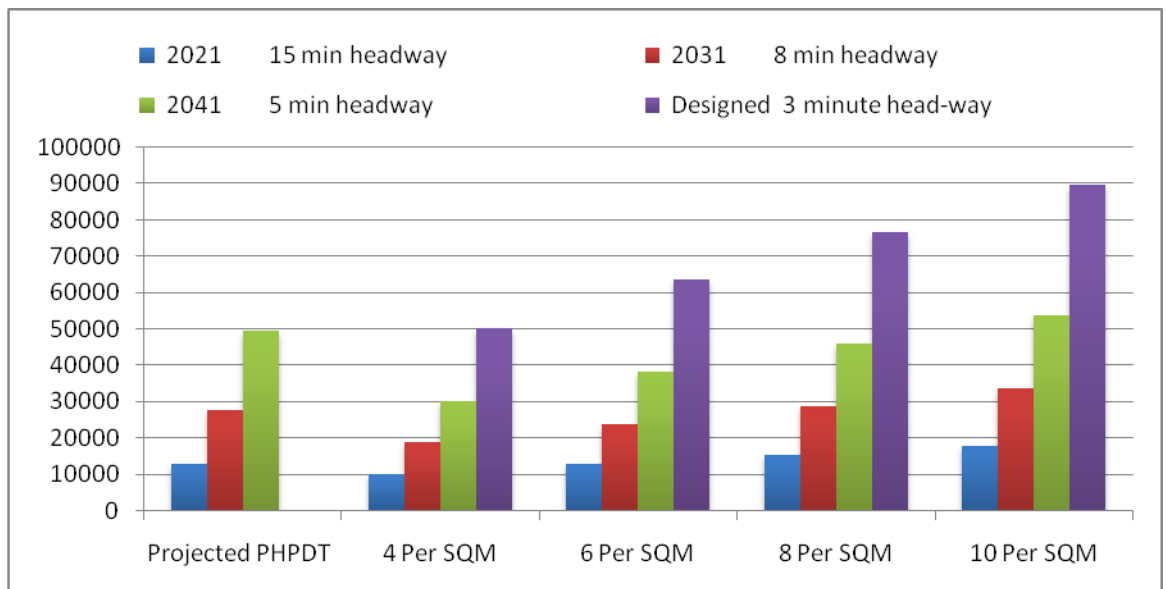
**Table 0.5: Projected PHPDT data**

Growth of PHPDT in Virar-Dahanu Road Section				
Year →	2012	2021	2031	2041
Panvel-Diwa	4500	10600	23000	41100
Diwa-Virar	6100	14300	30900	55300

**Table 0.6: Ridership Data**

Daily Ridership in lakhs				
Year →	2012	2021	2031	2041
Daily Ridership	1.95	4.59	9.92	17.76

Year wise Projected PHPDT and Passenger Carrying Capacity with different headways i.e. 15 min, 8 min, 5 min and designed headway of 3 minutes is shown below





Based on Train length and headway as decided above to meet Peak Hour Peak Direction Traffic Demand in different years, Rake requirement has been worked out in **Table 0.7**.

**Table 0.7: Year Wise Car and Rake Requirement**

Year	2021	2031	2041	Designed
<b>No. of Cars / Train</b>	12	12	12	12
<b>Headway in min</b>	15	8	5	3
<b>Bare Rake Requirement</b>	16	28	42	68
<b>Traffic Spare @5%</b>	1	2	2	4
<b>Maint. Spare @8%</b>	2	3	4	6
<b>Total Rakes</b>	19	33	48	78
<b>Total Coaches</b>	228	396	576	936
<b>Motor Coach</b>	76	132	192	312
<b>Driving Coach</b>	38	66	96	156
<b>Trailer Coach</b>	114	198	288	468

**0.7 MAINTENANCE FACILITIES**

The Virar-Panvel Suburban corridor would require a dedicated Depot cum workshop facility for the maintenance of the rakes. The total coach holding would increase to about 660 i.e 55 Rakes of 12 car in the horizon year 2041 to meet the traffic demand. All the rakes will be serviced at main Depot cum workshop for the scheduled inspections, major schedules viz Periodical overhaul (POH) and major unscheduled repairs. The main depot will also house Operation Control Centre (OCC), Administrative Building, maintenance facilities for Civil – track, buildings, water supply; Electrical – traction, E&M; Signalling & Telecomm.; etc. apart from necessary facilities viz stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, heavy interior/under frame/roof cleaning etc. for the rolling stock operational on the corridor.

For starting the morning services, some rakes will have to be kept at terminal stations and stabling facilities for the remaining rakes will have to be provided at the depots.

The layout plans of proposed Main Depot cum Workshop at Kalwar will be evolved for maintenance & POH of 93 Rakes of 12 car length. All the systems at the depot would be designed to cater for 12 Car composition trains in order to serve the ultimate passenger traffic on Virar-Panvel suburban corridor.

**0.8 POWER SUPPLY**

Power supply is required for operation of suburban rail system for running of trains, station services (e.g. lighting, ventilation, air-conditioning, lifts, escalators, signaling & telecom, fire fighting etc) and workshops, depots & other maintenance infrastructure within premises of suburban rail system. The power requirements of a suburban rail system are determined by peak-hour demands of power for traction and auxiliary applications.



The proposed corridor will be a predominantly a suburban corridor but it will also be available for goods operation and long distance mail express trains during margins available in the time table and also to meet any emergency situations. Suburban trains require more energy as compared to mail express or goods train. Therefore capacity of the power supply system shall be designed by assuming entire line capacity is utilized for suburban services i.e. 12 car services with headway of 3.0 minutes. Specific energy consumption data for suburban trains for different types of services ie fast-local, slow-locals or semi-fast-locals are available based on trial done on Central Railway suburban system with Siemens rakes. Specific energy consumption is dependent on interstation distance.

MVA demand for proposed corridor has been calculated with the help of following formulae,

$$\text{Demand in MVA} = \text{km} * (\text{SEC}/1000) * \text{Train wt.} * (\text{Trains}/\text{hr.}) * 2 * 1.05 / \text{p.f}$$

Factor of 1.05 has been taken into account to consider requirement for station auxiliaries and S & T demand @ 3% and other losses in system @ 2%, similarly, power factor of 0.9 has been considered to convert energy (KWH) into demand (KVA).

Keeping in view the above norms, projected demand of new corridor and existing corridor in various horizon years is summarized in **Table 0.8**;

**Table 0.8 Projected Power Demand**

Demand Due to	Year	Demand in MVA				
		PNVL	Kopar	KHRB	BSR	Total
12-Car-15 min	2021	3.59	4.12	3.91	2.25	13.87
12-Car-8 min	2031	6.75	7.77	7.34	4.24	26.1
12-Car- 5 min	2041	10.83	12.42	11.78	6.78	41.81
12-Car-3 min	Designed	18.09	20.75	19.65	11.32	69.81
Existing corridor in 2031		15.87	10.34	13.79	9.33	49.33
Both corridor in 2031		19.46	14.46	17.70	10.8	63.20
Total requirement with 3 min service in new Corridor		45.7	26.94	33.58	17.6	123.05

At present, traction power requirement of existing section is met by three traction substations at Panvel, Kharbao, and Vasai Road and these traction substations are equipped with two transformers of 21.6 MVA rating and their present loading is around 10 MVA each. Therefore possibility has been explored to utilize existing TSS to feed power for proposed corridor also.

**Table 0.9: Feeding Zone proposed for of TSS**

TSS	PANVEL	Kopar	KHARBAO	VASAI ROAD
<b>Feeding Zone</b>	Panvel- Dhansar Jasai-Panvel	Dhansar- Bhivandi Rd	Bhivandi Rd- Juchandra	Juchandra-Virar Naigaon-Virar
<b>KM</b>	12.7+16=37	18.7	24.94	5+14=19



## 0.9 ENVIRONMENT IMPACT ASSESSMENT

### 0.9.1 Environmental Baseline Data

#### LAND ENVIRONMENT

##### Landuse

Landuse pattern along the alignment is generally residential and commercial, with large parts of the alignment being surrounded by open area.

##### Soil Quality

Representative soil samples were collected from two locations namely (i) Navade and (ii) Bhiwandi. The analysis of test result indicates that soil is slightly alkaline, non-saline in nature, having good fertility and texture is medium loam to sandy loam.

##### Seismicity

Mumbai falls in Zone-III (however very near to Zone –IV) of Seismic Zoning Map of India.

#### WATER ENVIRONMENT

Water samples were collected from 2 different locations along the alignment. The test results when compared with the prescribed limits of various parameters as per IS 10500:1991 indicated that sample collected from handpump at Navade has all the parameters within permissible limit while samples collected from Ulhas River are saline in nature having high total dissolved solid.

#### AIR ENVIRONMENT

##### Air Quality

Ambient Air Quality Monitoring (AAQM) has been carried out by setting up ambient air quality monitoring stations at six locations i.e. near Navade Railway Station, Nilaje Railway Station, Datiwali Railway Station, Bhiwandi Railway Station, Vasai road Railway Station and Virar Railway Station along the project alignment. The results show that PM10 level at Virar Railway station exceeds the specified limit established by CPCB.

##### Noise Level Quality

Noise levels were measured at six locations i.e. near Navade Railway Station, Nilaje Railway Station, Datiwali Railway Station, Bhiwandi Railway Station, Vasai road Railway Station and Virar Railway Station along the project alignment by sound level meter. It is observed that the noise level at all locations exceeds the specified limit of 65 dBA (day) and 55 dBA (night) for commercial category due to large vehicular movement throughout the day.

#### ECOLOGICAL ENVIRONMENT

##### Flora and Fauna

Approximately 125 trees are likely to be disturbed due to construction of proposed



project. The type of species observed is Gulmohar, Peepal, Coconut, Palms, Neem, etc. No rare or endangered species of trees have been noticed during field studies.

**Mangroves**

The proposed alignment passes through the mangrove stretch of 4825 sqm area.

**0.9.2 Positive Environmental Impacts**

**Employment Opportunity**

Approximately 2000 persons are likely to work directly or indirectly for construction of the project. In post-construction phase, approximately 3100 people will be employed for increased railway operations.

**Benefits to Economy**

Introduction of this suburban rail corridor in Mumbai city will result in the reduction in number of buses and usage of private vehicles. This, in turn will result in significant social and economic benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers, pollution load, accidents and travel time, etc.

**Reduction in the Number of Vehicle Trip Kms on the Road**

With the introduction of this suburban rail corridor, about 38 lakh vehicle trip Kms per day could be reduced in the year 2021, which would go upto 165 lakh vehicle trip Kms per day by 2041.

**Reduction in Air Pollution**

The reduction of vehicular traffic and decongestion on Mumbai roads due to the project would lead to reduced air pollution. Reduction in level of different air pollutants like PM, NOx, HC, CO and CO2 for the years 2021, 2031 and 2041 is given in **Table 0.10**.

**Table 0.10: Reduction in Level of Air Pollutants**

Emission Reduction	Year		
	2021	2031	2041
Particulate Matter (PM)	94.42	219.70	393.44
Oxides of Nitrogen (NOx)	1128.99	2622.81	4696.98
Hydrocarbons (HC)	897.67	2205.38	3901.63
Carbon Monoxide (CO)	1469.18	3555.34	6366.98
Carbon Dioxide (CO <sub>2</sub> )	4766	11625	20687

**0.9.3 Negative Environmental Impacts**

Acquisition of Land : About 62.23 hac of land (7.60 hac Government land & 54.63 hac Private land) will be required.

Displacement of People : About 75 families are likely to be affected due to the acquisition of land.

Loss of Trees : Approximately 125 trees along the project alignment are likely to be lost due to proposed project. Total loss of carbon credit is 2.72 per year due to cutting of 125 trees. No rare or endangered species of trees have been noticed during field studies.





Loss of Mangroves : About 4825 sqm mangrove areas are likely to be affected due to construction of proposed corridor.

Loss of Historical and Cultural Monuments : No loss of Historical and Cultural Monuments is anticipated.

Impacts on Water Bodies :The proposed alignment is passing through Ulhas River, Mutali River and 20 numbers of nalas. The construction of pillars/abatement/culvert on river and nalas may cause temporary impact. However, during construction specific precautions would be taken by disposing the excavated earth/debris immediately generated during construction to have minimal impact of the construction activities.

#### 0.9.4 Environmental Monitoring Plan

This will comprise mechanism for monitoring of water quality, soil quality, air quality and noise levels and setting up environmental management system.

#### 0.9.5 Resettlement Action Plan

##### Entitlements for R&R

Every eligible household losing a dwelling place shall be allotted a dwelling unit of minimum of 25 sq.m. at an alternate site. Similarly, every PAH losing a commercial structure shall be eligible for an alternate place for commercial use of equivalent area.

##### Grievance Redressal Mechanism

The Project Implementation Authority will designate a senior officer at the local level to consider any grievance of PAFs in consultation with the concerned NGO.

Institutional Arrangement

### 0.10 COST ESTIMATES

#### 0.10.1 Capital Cost Estimates

The cost estimates have been prepared covering Civil, Electrical, Signaling and Tele Communication works, Rolling stock, Environmental protection, Rehabilitation works, etc. The cost estimates are worked out at March '13 price level.

The overall capital cost amounts to **Rs. 6506.61 Crore** for Panvel-Virar suburban corridor at March'2013 price level including design charges @ 2%, general consultancy and project management services charges @ 6% and 5% contingencies on. These costs cover all taxes, like excise duty, custom duty, VAT, etc.

The abstract capital cost estimate is presented in **Table 0.11**



**Table 0.11: Capital Cost Estimate for PNVL- VR Suburban Corridor**

S. No.	Item	Unit	Qty.	Rate (Rs . Cr)	Amount (Rs.Cr.)
1	Land				788.76
2	Alignment and Formation				2134.67
3	Station Buildings				582.78
4	P-Way				268.02
6	Traction & power supply incl. OHE, ASS etc.				215.14
7	Signalling and Telecom.				245.49
8	Relocation of Govt. Structures				50.00
9	Environmental, R&R ( Hutments)				12.01
10	Utilities				150.21
11	Development of Traffic Integrations and dispersal facilities				110.00
12	Depot				300.00
13	Total of all items (2 to12) except Land				4068.78
14	Design charges @ 2 % on all items except land				81.38
15	D & G Charges @ 8.5% on all items except land				345.85
16	Total of all items including Design and D&G. Charges (except land)				4496.00
17	Rolling Stock	Each	228	4.00	912.00
	<b>Total of item 16 &amp; 17</b>				<b>5408.00</b>
18	Total Cost including land				6196.77
19	Contingencies @ 5 %				309.84
20	Gross Total				6506.61

**0.10.2 Operation & Maintenance Estimate**

The year wise total Operation and Maintenance cost along with the additional cost for procurement of coaches and the replacement cost is indicated in **Table 0.12**.

**Table 0.12: Operation and Maintenance Cost (PNVL-VR Section)**

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replacement Cost
2021	163.76	163.22	67.06	394.04	
2022	171.95	171.38	67.06	410.38	
2023	180.54	179.94	70.41	430.90	
2024	189.57	188.94	70.41	448.93	
2025	199.05	198.39	73.93	471.37	
2026	209.00	208.31	107.20	524.52	190.07
2027	219.45	218.72	112.56	550.74	
2028	230.43	229.66	112.56	572.65	
2029	241.95	241.14	118.19	601.28	
2030	254.04	253.20	118.19	625.44	
2031	266.75	265.86	146.90	679.50	1455.52
2032	280.08	279.15	146.90	706.13	
2033	294.09	293.11	154.24	741.44	



Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replacement Cost
2034	308.79	307.77	154.24	770.80	
2035	324.23	323.16	154.24	801.63	
2036	340.44	339.31	161.95	841.71	
2037	357.47	356.28	161.95	875.70	
2038	375.34	374.09	170.05	919.48	
2039	394.11	392.80	170.05	956.95	
2040	413.81	412.44	178.55	1004.80	
2041	434.50	433.06	272.69	1140.26	3267.39
2042	456.23	454.71	272.69	1183.63	2449.99
2043	479.04	477.45	286.33	1242.82	
2044	502.99	501.32	286.33	1290.64	
2045	528.14	526.39	300.65	1355.17	
2046	554.55	552.70	300.65	1407.90	
2047	582.27	580.34	315.68	1478.29	
2048	611.39	609.36	315.68	1536.42	
2049	641.96	639.82	315.68	1597.46	
2050	674.06	671.82	331.46	1677.33	
2051	707.76	705.41	331.46	1744.63	9501.87

**0.11 FINANCIAL ANALYSES**

**0.11.1 Financial Analysis**

**COSTS**

**Capex**

The construction period is taken as 7 years starting from 2014-15 and System/ Corridor will be operational by 2021. For the purpose of calculating the Financial Internal Rate of Return (FIRR), the completion cost of Rs. 8026 Crore @ 5 % inflation has been considered.

**Additional Capex**

The total additional investment cost of Rs. 16864.84 Crore has been estimated. The additional investment has been provided in the years 2026, 2031, 2041, 2042 and 2051 to take care of increased requirement of Rolling Stock and related equipment.

**Opex**

The total O&M cost in the year 2021-22 is estimated at Rs. 394 Crore.



## **REVENUES**

### **Fare box revenue**

It has been estimated that about 4.59 lakh passengers would use the Corridor in the year 2021-22. This will increase to about 17.76 lakh passengers by 2041-42 and 26.29 lakh passengers by 2051-52.

Fare box revenue has been assessed on the basis of suburban fare structures – with fares assumed to increase by 10 % after every 5 years.

The fare box revenue for the year 2021-22 is estimated at Rs. 142 Crore, which will increase to Rs. 1745 crore in 2049-50.

### **Other sources of revenues**

Other sources of revenues could be commercial development and advertisement at station buildings- which have been taken @ 5% of the fare box revenues.

### **Financial Internal Rate of Return (FIRR)**

The project is assumed to be funded entirely by the Indian Railways. The Financial Internal Rate of Return (FIRR) has been worked out upto the year 2051.

The project has negative FIRR with even O&M expenses not being met by the revenue stream. This can be made positive with non-fare box revenue being increased to about 155 % (presently taken as 5 %) of fare-box revenue each year.

Alternatively, if only O&M costs are considered (i.e. capital costs being considered as sunk money), the project can have breakeven with non-fare box revenue upwards of about 45 % of fare-box revenue.

### **0.11.2 Economic Analysis**

The economic appraisal has been carried out within the broad framework of Social Cost – Benefit Analysis Technique. It is based on the incremental costs and benefits and involves comparison of project costs and benefits in economic terms under the “with” and “without” project scenario. In the analysis, the cost and benefit streams arising under the above project scenarios have been estimated in terms of market prices and economic values have been computed by converting the former using appropriate shadow prices. This has been done to iron out distortions due to externalities and anomalies arising in real world pricing systems.

The annual streams of project costs and benefit have been compared upto the year 2051 to estimate the net cost/ benefit and to calculate the economic viability of the project in terms of EIRR. The Economic Internal Rate of Return (EIRR) for the project has then been



arrived using Discounted Cash Flow technique to the net benefit stream at economic prices.

The EIRR works out to 24.66 %.

A sensitivity analysis of the EIRR with 10% cost overrun and 10% reduction in traffic materialization (separately) has been carried out. The EIRRs under these scenarios are given in **Table 0.13**.

**Table 0.13: EIRRs - Sensitivity Analysis**

Sensitivity Parameter	EIRR (%)
Basic EIRR	24.66
With increase in cost by 10%	23.61
With decrease in traffic by 10%	23.50
With increase in cost by 10% & decline in traffic by 10%	22.48

it is recommended that controls should be exercised to keep the construction cost under check.

**0.11.2 Implementation Strategy**

The proposed Panvel – Virar Corridor is an augmentation of the suburban railway network, which will have the same fare levels and acceptability as the Mumbai suburban System.

The Project has negative FIRR, but a good economic rate of return. Considering the social and developmental benefits that the Project may provide, IR may decide to implement the Project through Government financing.

To implement the Project in a short period, it is necessary that actions on all major activities are taken in parallel. The major activities involved in the implementation of the project are:

- Approval of the Feasibility Report by IR
- Approvals from other agencies viz MMRDA, CIDCO, NMMC, VVMC, etc.
- Arrangement of Finances
- Preliminary activities
  - Land Acquisition (Temporary and Permanent)
  - Utility Diversions
  - Traffic Diversion arrangements
- Fund allocation and Organization for Implementation