



PEER REVIEW/CONCURRENT EVALUATION OF DPR AND BID PROCESS MANAGEMENT FOR THE MUMBAI COASTAL ROAD PROJECT

PHASE II & PHASE III REPORT

March 2016

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Municipal Corporation of Greater Mumbai

Peer Review/ Concurrent Evaluation of Detailed Project Report and Bid Process Management for Mumbai Coastal Road Project

Phase II & Phase III Report

March 2016

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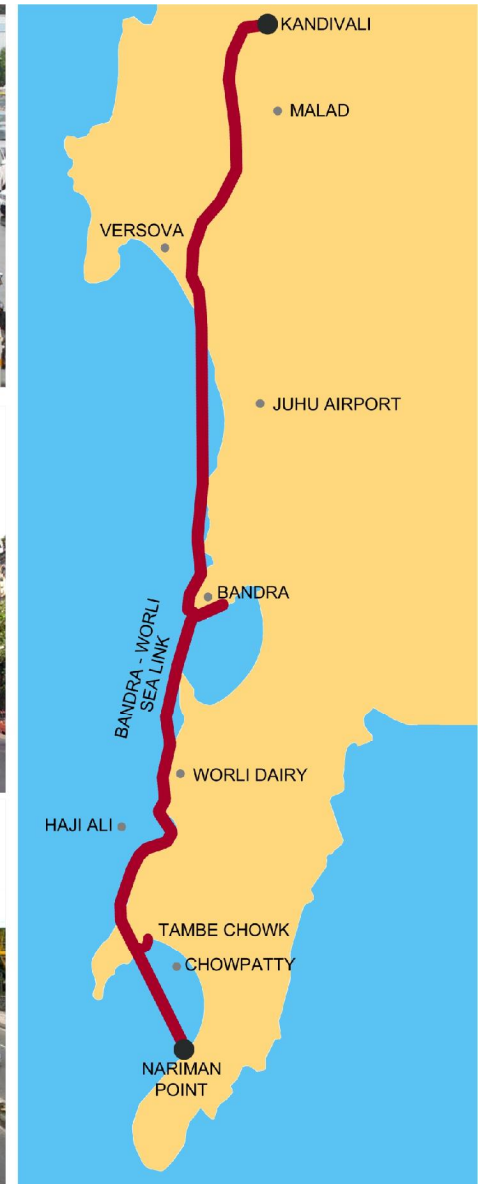
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INTRODUCTION



1 INTRODUCTION

1.1 Project Background

Comprehensive Traffic Studies (CTS) carried out for Mumbai city identified requirement of new arterial road along the Western Coast as part of transportation networks. Govt. of Maharashtra constituted a Joint Technical Committee under the Chairmanship of Municipal Commissioner, Municipal Corporation of Greater Mumbai (MCGM) on 30 June 2011 to study and make recommendations on the subject of coastal roads in Mumbai. The Committee recommended a 35.6 km. coastal route comprising road; based on reclamation, bridges, elevated roads and tunnels on western side of Mumbai. The proposed location is shown in Figure 1-1.

MCGM has appointed consortium of M/S STUP Consultants Pvt. Ltd and M/s. Ernst & Young Pvt. Ltd for Preparation of Feasibility Report, DPR Preparation and Bid process management for the proposed Mumbai Coastal Road Project. The Draft DPR has suggested a length of 34.56 km for the coastal road.

Frischmann Prabhu India Pvt. Ltd. has been appointed as Consultant for Peer Review/ Concurrent Evaluation of Draft DPR.

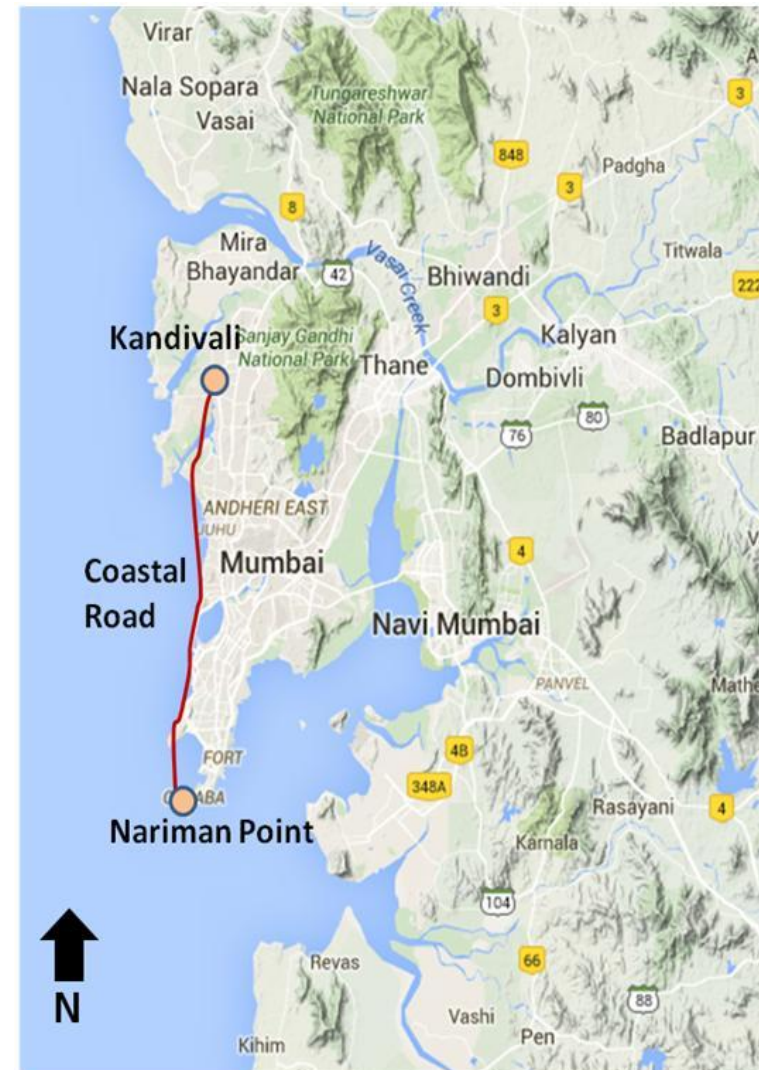


Figure 1-1 Location of Mumbai Coastal Road

1.2 Scope of Consultancy Work

Scope of work of Peer review is clearly defined in TOR. The implementation of proposed consultancy work is as under, but not limited to this. Scope of services shall include Peer Review/ concurrent evaluation of the Draft DPR and Bid Process Management including bid document for its correctness and to suggest, improvement, and alternatives if any especially on points mentioned below:

1. Draft Detailed Project Report (DPR).
2. The alignment/ capacity of roads from point of view of traffic study by carrying out fresh traffic survey, estimate traffic on Coastal road & dispersal system and nuisance to the public during construction of Coastal road.
3. The design from the point of view of safety, smoothness of traffic & economical aspects.
4. The environment impact assessment as done under the DPR including assessment of erosion/ flooding of coastal areas.
5. The reclamation methods as suggested under DPR.
6. The BRTS system proposed under Coastal road DPR.
7. Structural designs, specification from the point of view of safety, Environment Impact and cost effectiveness.
8. Effect of Draft DP 2034, other road networks & proposed land use on the Coastal road.
9. Effect of ongoing/proposed infrastructural projects (including Metros) by MMRDA, MSRDC, and Railway Projects etc.

10. Traffic adequacy of existing Bandra-Worli Sea Link as a part of Mumbai Coastal Road Project and check feasibility of avoiding the sea link toll plaza.
11. Design, construction methodology & risk analysis for all structures in Coastal Road.
12. Engineering survey & geotechnical investigation & any additional tests/ changes etc. The geotechnical investigation to be confirmed by taking 10 % stratified Random sampling.
13. Suggestion & objections received from Public, on the available DPR data.
14. Bid process management including tender/ contract document.
15. To propose phasing of work initially from the point of view of traffic priority, technical feasibility & homogenization with whole project.

1.3 Phases of Development

As per the discussion held with Client, the alignment has been divided in to three phases of development as detailed below:

Phase I

- | | | |
|-----------|---|--|
| Section 2 | : | Priya Darshini Park to Mahalaxmi |
| Section 3 | : | Mahalaxmi to Baroda Palace |
| Section 4 | : | Baroda Palace to Worli End of Sea Link |
| Section 5 | : | Bandra End of Sea Link to Khar Danda (Carter Road) |

Phase II

Section 1 : Jagannath Bhosale Road to Priya Darshini Park including Tambe Chowk connectivity¹

Section 6 : Khar Danda to Versova (Seven Bungalows)

Phase III

Section 7A : Versova(Seven Bungalows) to Institute of Fisheries (Madh Island Interchange)

Section 7B : Institute of Fisheries to Kandivali Junction

1.4 About this report

This report presents comments and suggestions based on the draft DPR for Phase II & III in order to facilitate further action by the DPR Consultant/Client. Aspects related to Traffic & Transportation, Environmental Impact Assessment and Tunnel Design were covered for the project as a whole in the Peer Review Report- Phase I. In this report aspects specific to Phase II & III are presented.

The estimation of traffic demand on any new facility is a crucial step since the requirement and extent of the same form the base for further studies such as alignment studies. After evaluating possible alignment options the methods of developing the facility are to be examined and finalized in such manner as to be viable from the point

¹ Phase II of construction as envisaged by MCGM does not include the section between Jagannath Bhosale road and Priyadarshini Park which is proposed as an undersea tunnel in the draft DPR. While options for this section are being worked out by the DPR consultant, comments on options presented in draft DPR/JTC report and suggestions on the same are presented in this report.

of view of ease of construction, environmental and economic considerations. The report structure is as follows:

Chapter 2 - Traffic & Transportation

Chapter 3 - Alignment Studies

Chapter 4 - Reclamation

Chapter 5 - Tunnel Design

Chapter 6 - Environmental Impact Assessment

Chapter 7 - Construction Cost Estimate

The above Chapters present the correctness of the Draft DPR and subsequent documents/drawings made available. Further, the comments, suggestions and improvements for each of the issues identified are enumerated.

However, the key issues are summarized and presented below:

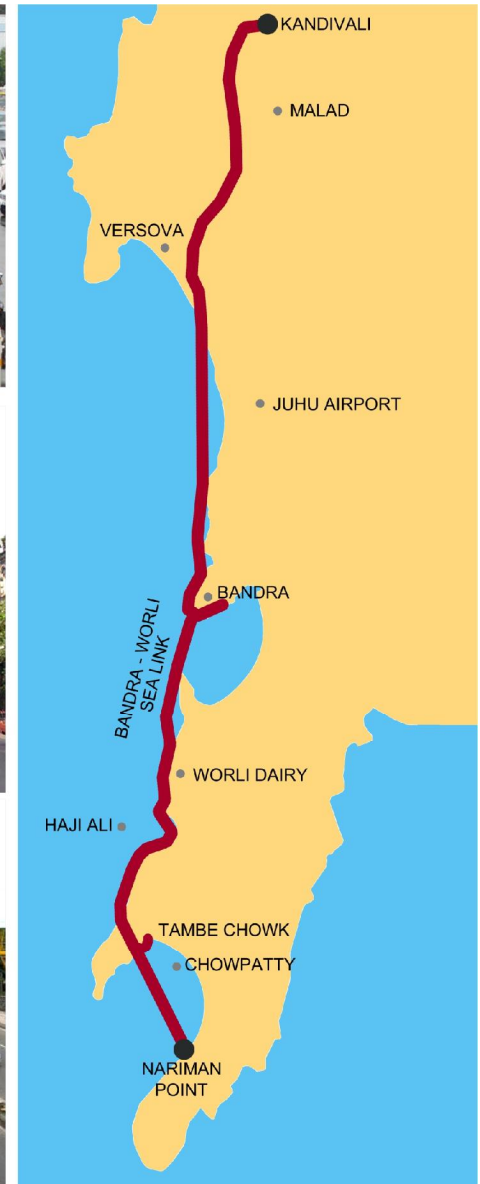
1.5 Summary of Key Issues - Peer Review

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
1	Lane Capacity and Configuration	4+4 and 2+2 lane configuration suggested	The estimation of traffic and provision of the lanes is not substantiated based on scientific methods. In the light of fresh traffic surveys, analysis and results the traffic demand and lane requirement has been reassessed under different scenarios.	Based on the studies the bare minimum lane requirement of coastal road is 4+4 lanes. However, it is desirable to provide a 5+5 lane configuration.
2	Road Alignment	Section- 1, 6 and 7	There is scope for evaluating some more Options of alignment in these sections.	The Options are suggested, which should be further explored.
3	Interchanges	Different arms of interchanges considered.	At some of the interchanges, arms for particular turning movement are not provided	Recommendations given at respective sections shall be considered.
4	Relaxation or Departure from Standards	Very limited or no information available	Relaxation or Departure are essential prior to freezing the alignment and need to be approved by Client	Approved List of relaxation / Departure from standard shall be produced and included in tender document.
5	Adequacy of Reclamation/ Tunnelling/ Geotechnical/ Bathymetric Surveys	Various Surveys have been identified in the DPR.	Limited number of surveys carried out to date	Additional surveys will be required to ensure that the contract is devised and executed with the minimum of uncertainties and the minimum of programme and cost impacts.

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
6	Choice of type of design for each section-Tunnel/ Reclamation/ Bridge/ Bridge on stilts/ Elevated road	The DPR is proposing specific methodologies, techniques and routes	The tunnelling methods are prescriptive and reclamation proposals are simplistic and probably not applicable to this situation.	Methodologies/ techniques need to be rigorously justified based on available evidence, clearly stated preferences, or based on facts obtained in the study to date.
7	Materials Investigation – Concrete/Bulk Fill Material	Investigations are very limited.	There are significant shortfall in material volumes identified in excess of any other use of spoil arising from MML3 and/or CR Tunnelling etc.	As a matter of urgency, identify suitable resources conforming to appropriate specifications
8	Logistics	Not identified as a significant constraint	Logistics is a highly significant constraint given restrictions of land transportation and difficulties of marine operations. No fabrication areas have been identified by the DPR.	Logistics is highly influential factor on the construction methodology and the logistical constraints/ limitations need to be investigated as soon as possible by a Project Master Plan. Consideration of an enabling contracts to front load the works.
9	Tunnelling Methodology	Prescriptive Methodology without geotechnical basis.	Alternative methodologies should not be excluded by the tender process.	Execute detailed geotechnical investigations to ensure selection of optimal methodology.
10	Reclamation	The DPR includes various design options for reclamation. Hydraulic Modelling	Design options inappropriate and potentially costly No design criteria has been specified for reclamation and extreme environmental conditions	Additional modelling to be carried out to consider extreme environmental conditions for an appropriate return period.

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
		(NIO, GoI) is limited. The contract packages include both reclamation, bridges and road	The contract packages could be simplified to suit contractor's specialist capabilities.	Review contract packaging through the Master plan.
11	Programme/Critical Path	Not discussed in sufficient detail	Need to consider overall contract programme (irrespective of different construction packages)	Consider optimum selection of single or multiple package options and identify critical path
12	Safety and Security	Not discussed in sufficient detail	The safety and security of the coastal road facility is paramount.	Safety and security related documents and plans required.

TRAFFIC & TRANSPORTATION



2 TRAFFIC & TRANSPORTATION

2.1 Background

The need for implementation of the Mumbai Coastal road project is established through various transportation studies for the Mumbai Metropolitan Region (MMR) and Greater Mumbai in the past and reiterated in recent studies.²

Vital Transportation infrastructure projects such as the Mumbai Metro, expected to bring a sea change in the travel pattern of the city are in various phases of implementation. With this background, the peer review studied the related work carried out in draft DPR stage through worksheets and reports submitted. The gaps identified were conveyed to MCGM and the draft DPR consultant through meetings.

Traffic surveys were carried out afresh to study the current travel characteristics. Traffic Demand Assessment for the base year and forecasts for Alternative scenarios in the horizon year of 2034 were prepared and presented in the *Peer Review Report - Phase I submitted* on 17th February 2016. Based on the above, Lane requirements for the various sections of the coastal road were also suggested. Technical reports on Traffic Demand Assessment and Dispersal are being prepared which present the work related to Traffic and transportation in detail.

This section of report discusses the traffic and transportation aspects focussing on Coastal road sections in Phase II & Phase III

The various points are broadly discussed under the following heads:

1. Traffic Demand Forecast

² Draft DP for Greater Mumbai - 2034, CTS for MMR - 2008, CMP for Greater Mumbai-Draft Final report- 2016

2. Lane Requirement

3. Comments on BRTS

2.2 Traffic Demand Forecast

Traffic Demand forecast undertaken in the peer review derives the base year demand from the observed Origin Destination pattern of the current traffic flows on the road network. Traffic demand Forecasts are made for the horizon year (2034) under different scenarios of land use planning parameters and transport infrastructure levels which are consistent with the Draft DP for Greater Mumbai 2034 and Comprehensive Mobility Plan (CMP) for Greater Mumbai (Draft Final Report, January 2016).

Transportation network is modelled using state of the art transportation planning software, VISUM in order to simulate travel patterns.

The scenarios developed for traffic demand estimation, forecasts for horizon year and network assignments with coastal road and other networks are explained in ensuing sections.

2.2.1 Scenarios for Traffic Demand Forecast

Scenarios are proposed to visualize the range of future traffic on the Mumbai coastal road and thus provide the decision maker with the range of traffic risk.

The Mumbai coastal road is envisaged as part of an urban system where traffic is primarily generated by the interaction between residences and activity centres through the transportation network/ modes of transport. Thus, future land use plans and planned transport infrastructure are essential inputs required for traffic forecast. As part of Draft Development Plan preparation and ongoing

efforts of MMRDA on revision of Regional Plan, Planning parameters for the horizon period up to 2034 for Greater Mumbai and Rest of the Region have been assessed using 2011 census database and various methods of forecast. For Greater Mumbai, the population and employment forecasted for the horizon year 2034 are 14.0 million and 8.0 million respectively and the same have been considered in the present study.

Table 2-1 Horizon year Planning Parameters for Greater Mumbai

	Horizon Year Planning parameters
Population 2034	14 Million
Employment 2034	8 Million

Source: CMP, 2016

The Comprehensive Mobility Plan (CMP) for Greater Mumbai has assessed Planning parameters at disaggregate level based on the land use and transport network considerations keeping the overall growth scenario in line with the Draft DP-2034. The zone level planning parameters for the peer review study aligns with the CMP in order to take into account the proposed developments.

Capacity enhancements in the suburban rail network, development of new corridors (Suburban, metro and monorail) and growth of private vehicles would play a major role in the choice available to travellers in Mumbai in the horizon year. Hence, these factors have been considered as part of CMP/Draft DP and the same are adopted while development of alternative scenarios in this study.

Alternative scenarios have been considered for combinations of three parameters:

1. Base Traffic Level (B)
2. Transportation Network availability (T)
3. Car Usage (C)

Table 2-2 Parameters for Traffic scenario development

Parameter	Levels considered
Base Traffic Levels (B)	B1 -Morning Peak B2- Evening Peak B3- Average Peak
Transportation Network availability (T)	T1-Limited Transportation Network availability T2-Fully developed Multimodal Transportation Network
Car usage (C)	C1-High Growth in Car usage C2- Medium Growth in Car usage C3 – Low growth in Car usage

Base Traffic Levels are derived from matrices for different peaks obtained from traffic surveys.

Transportation Network availability (T) refers to the available road & rail network in the horizon year.

Limited Transportation Network availability (T1) includes the Base year transport network + on-going construction and committed projects.

Fully developed Multimodal Transportation Network (T2) includes the following:

Base year transport network + Draft Development Plan proposed road network + On-going construction and committed projects (Monorail, Metro line II and III) + proposed potential Metro corridors based on Mumbai Master Plan study and CTS for MMR study. New links worth special mention in this network scenario are:

1. MTHL
2. Sewri Worli Link (Road & Metro)
3. Goregaon Mulund Link Road (GMLR)

Car usage (C)

Past trend in Car growth has been high. However, in the future, implementation of proposed transit corridors (Suburban, metro, monorail etc.) will encourage travellers to use public transport depending on the accessibility, efficiency and reliability of the network available in the horizon year. Considering this, three car growth scenarios are envisaged i.e. High Car usage, Medium Car usage and Low Car usage.

Various combinations of the above three parameters were used for traffic assignment as explained below with maximum peak and average peak matrix and the critical results are presented.

2.2.2 Estimation of Traffic Diverted onto the Coastal Road – VISUM Modeling

Based on the various characteristics of the network and traffic as discussed above, a State-of-Art tool, VISUM was used for model development. Various network parameters were modelled as Links, Nodes and Zones. Individual Links, Intersection and Zonal Characteristics were fed into the model in the form of link attributes

such as Link Flows, Speeds, Impedances; Nodal Capacities, Turn Capacities, Turn Penalties; Zonal Characteristics, etc. Using these base attributes, the skim matrices were derived. The horizon year Fully developed road Network is shown in Figure 2-1 and the same is used for horizon year traffic assignment.

The model was validated using the Network peak observations of flow as well as Origin Destination matrix. The matrices were corrected using the tool TFlowFuzzy, which is used to validate the CTVC counts on specific links with flows estimated by the VISUM Model. Once the Matrices were validated, the growth factors were applied in order to arrive at the horizon year Productions and Attractions for individual zones. The future Productions and Attractions so derived were then distributed to get the future year matrix. This matrix was assigned on the network scenarios to estimate the flow on the proposed coastal road using user equilibrium method. The traffic assignment for the critical maximum peak scenario is shown in Figure 2-2.

It is observed that significant diversions are observed from the current arterials in the island city portion such as the Marine drive and Peddar road. The level of service on these arterials has improved due to the diversion of traffic onto coastal road. Moving further northward towards the sections in the suburbs, the diversions to the coastal road are comparatively lower. The suburban productions and attractions are spread over a wider area on either side of the current major arterial road, i.e. Western Express Highway. Longer Travel distances (east west distances) are involved in travelling from these activity centres to the coastal road than in the island city. As already observed in the section describing future planning parameters growth nodes in the North West and commuting South will be the major beneficiaries of the coastal road.

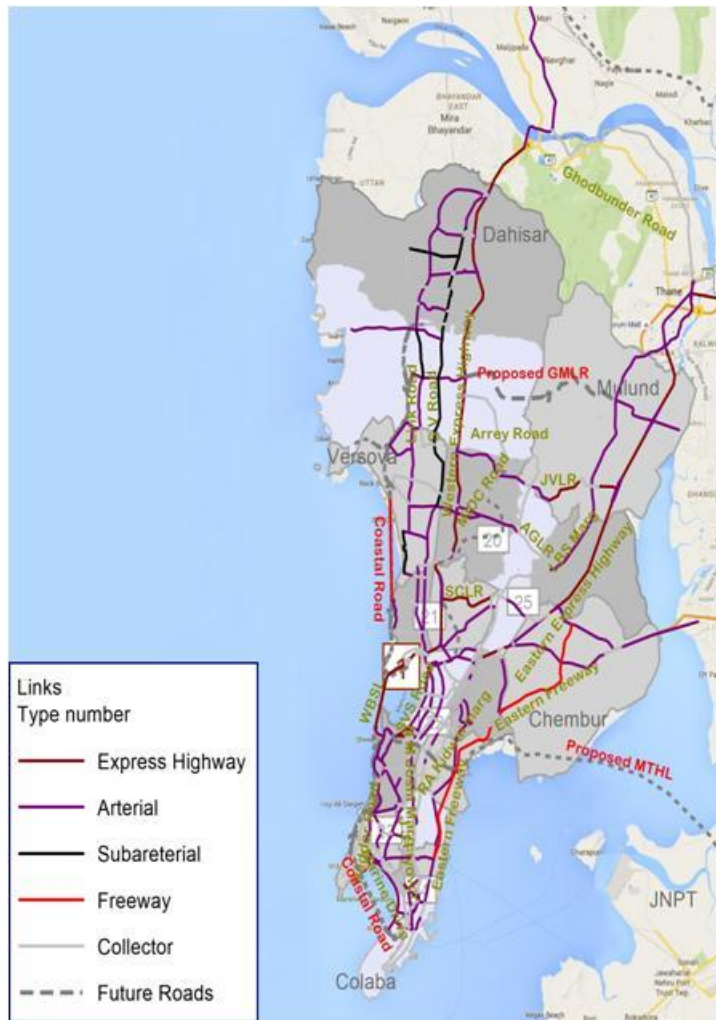


Figure 2-1 Horizon year fully developed Road Network



Figure 2-2 Traffic Assignment - Maximum Peak Scenario

2.3 Lane Requirement

Based on the assignments the requirement for number of lanes is worked out as follows:

Sr. No.	Phase	Section	Peak Hour Traffic (in PCU)		Lane Requirement	
			Max Peak Scenario	Average Peak Scenario	Max Peak Scenario	Average Peak Scenario
1	Phase II	Nariman Point(Jagannath Bhosale Road) to Amarson Garden(Priya darshini Park)	6600	6000	3 + 3 Lanes	3 + 3 Lanes
2	Phase I	Amarson Garden to Haji Ali	13700	8800	6 + 6 Lanes	4 + 4 Lanes
3	Phase I	Haji Ali to BWSL	12500	8100	6 + 6 Lanes	4 + 4 Lanes
4	Phase I	BWSL to Carter Road	10800	8700	5 + 5 Lanes	4 + 4 Lanes
5	Phase II	Carter Road (Khar Danda) to Versova	11300	8600	5 + 5 Lanes	4 + 4 Lanes
6	Phase III	Versova to Madh Island Interchange	11000	8200	5 + 5 Lanes	4 + 4 Lanes
7	Phase III	Madh Island Interchange to Oshiwara Interchange	11600	7100	5 + 5 Lanes	3 + 3 Lanes
8	Phase III	Oshiwara Interchange to Malad Interchange	14000	9800	6 + 6 Lanes	5 + 5 Lanes
9	Phase III	Malad Interchange to Kandivali Interchange	8700	5900	4 + 4 Lanes	3 + 3 Lanes

In the horizon year, the coastal road warrants a minimum requirement of 4+4 Lanes without BRTS and therefore it is desirable to provide 5+5 lane configuration to cater to the demand of BRTS.

Nariman point to Amarson garden section requires minimum of 3+3 Lanes without BRTS and 4+4 lanes with BRTS.

2.3.1 Comments on Draft DPR Alignment based on Lane Requirement

Phase II

1. Jagannath Bhonsale Road to Amarson Garden

In the draft DPR, alignment from Jagannath Bhosale Chowk to Amarson Garden is planned as a 2+2 lane underwater tunnel. This alignment will need augmentation to 4+4 configuration, from traffic point of view.

2. Tambe Chowk Connectivity

Traffic assignment shows significant traffic volume joining the Coastal road at Amarson garden interchange. Connectivity from Tambe Chowk to Amarson Garden is recommended as a 2+2 Lane configuration in order to relieve the feeder roads to the interchange.

3. Khar Danda to Versova

This section is an undersea tunnel (4+4 Lanes) in the draft DPR.

As per the traffic assignments this section requires 5+5 Lanes for the horizon year 2034.

Phase III

1. Versova to Institute of Fisheries (Madh Island Interchange)

This section is proposed as an elevated road in the draft DPR. The lane requirement for this section is 5+5 lanes including BRTS.

2. Institute of Fisheries (Madh Island Interchange) to Kandivali Junction

This section is a combination of bridges and land filled roads on mangroves. A minimum of 4+4 Lanes is required with a desirable provision for 5+5 Lanes.

2.4 Bus Rapid Transport System (BRTS)

2.4.1 Background

In this section, Bus Rapid Transit system (BRT) as proposed in Draft DPR has been reviewed in terms of its operational and service planning aspects to ensure an integrated system with seamless travel.

While designing a high quality BRT system, many components must be planned in an integrated manner. A vital component of the process is an operations planning exercise followed by physical infrastructure with well-planned Intelligent Transport Systems (ITS) and Information and Communications Technology (ICT) systems that not only enhance passenger convenience but also improve the system efficiency and thereby help in reducing costs.

A well-designed BRT system with dedicated lanes, correct positioning of stations, intersection improvements, comfortable and reliable system and the right passenger interface at station can result in higher speeds and hence travel time savings for the commuters.

2.4.2 BRT Network Typologies

The three main types of BRT operations and vehicle routing are:

- Open Systems
- Closed Systems - Hybrid Systems and Absolutely Closed Systems

In Open systems, Buses use the exclusive lanes or corridor wherever the lanes overlap with an existing route. In Closed Systems, the exclusive BRT lanes/corridors will be used by the BRT buses only. Closed systems can be further divided into, Hybrid Systems and Absolutely Closed Systems. In Absolutely Closed BRT systems, BRT buses remain inside the exclusive bus lane network at all times. No part of their route is outside the BRT network for example, Latin American systems like Transmilenio in Bogotá and Metro bus in Mexico City.

2.4.3 Review of Proposed BRT System in Draft DPR

The need for having the BRTS corridor along the Coastal Road has been studied and the following is the summary of observations.

Table 2-3 Summary of BRT System

Sr. No.	Review Aspect	Draft DPR	Peer Review Observation	Recommendations/ Suggestions
1	Operational Demand and Supply	Articulated Buses with Fleet size of 600 buses has been estimated with low floor heights Average Stopping Time:1 min Frequency: 20 sec for each bus station	The use of scientific / approved techniques to arrive at the operational demand and the required supply is not evident in the report. Articulated Buses require minimum turning radius of about 12.5m and at most of the interchanges the same is provisioned. But detailed circulation study needs to be carried out.	The operational demand and the required supply need to be substantiated as per standard practice.
2	Type of Network System Proposed	Not clearly mentioned	Types of BRT Network Typology need to be developed based on demand and supply characteristics.	Need to provide merits and demerits to select the optimal system.
3	Physical Segregation of Bus Lane	One lane each on either side near curb for buses has been provided	Adequate reasons for such a selection vis-à-vis other options not provided.	Need to provide merits and demerits to select the optimal segregated lane location.
4	Bus Terminals/Bus Bays	Transparent Bus Stop Shelter provided at each of the platform with CCTV Monitoring, Direct Pedestrian Access, and Real Time Information. 3 Terminals have been proposed at NCPA, Worli and Kandivali	Requirement of Number Bus Terminals/Bays and its locational aspect with the number of bus shelters in each bay will have to be studied scientifically based on operational demand and accessibility studies and space availability.	Details of demand and accessibility to be provided.

Sr. No.	Review Aspect	Draft DPR	Peer Review Observation	Recommendations/ Suggestions
		Rest of the locations have Bus bays (12 nos.).		
5	Dedicated Loop Back Facility with Turning Radius	Loop Back Facility is available at NCPA Interchange	The sufficiency of loop back facility will be dependent on the operational demand and kind of service typology being proposed.	It may be useful to provide dedicated loop back facility at all terminal locations. However, this can be validated only from the estimated operational demand and travel pattern.
6	Pedestrian Accessibility	At all Bus Bays/Terminals, connection from Coastal road and Mainland is worked out. FOB's have been provided near Bus bays/Terminals	FOB's have been provided near Bus Terminals/Bays but a continuous walkway arrangement as explained in BRT report of DPR is not very clear and does not segregate the pedestrian traffic with railings etc. Access Planning should be carried out as an integrated part of the BRT system and given utmost importance as the same will determine the safety and accessibility of the commuters.	In spite of high PT demand and affinity to walk by Mumbai commuters, usage of FOB in general has been observed to be low. Unless lifts, escalators are provided, it becomes inaccessible for people with disability, old age group and children. The detailed plans of the same are essential.
7	Integration of nearest Bus stops with BRTS	Not specified with respect to integration of existing bus stops (Feeder buses) with BRTS routes	In case of Trunk-Feeder services, proper Feeder buses will have to be deployed from the attraction/production centres to the nearest bus stops	The details of operational and service planning of Feeder Services also needs to be worked out for seamless connectivity
8	Multi Level Car Park Locations and Integration with BRTS	MLCPs have been provided at most of the locations	Integration strategy of MLCP locations from existing road to coastal road is not clear	Traffic circulation plans are to be provided for safe and efficient movement of traffic between MLCP and existing road(s)

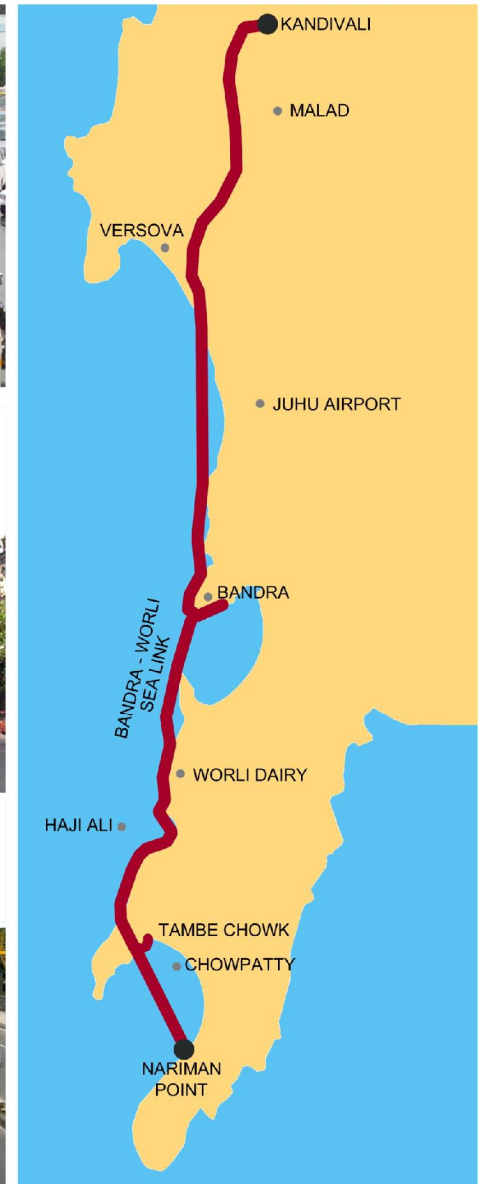
Sr. No.	Review Aspect	Draft DPR	Peer Review Observation	Recommendations/ Suggestions
9	Taxi/Auto Integration	Taxi/Auto stands have been provided at most of the locations	Integration of Taxi/Auto stands from existing road to coastal road is inadequate and needs to be clarified	Comprehensive circulation plans showing integration of commuter/ IPT/PT is required
10	ITS/ICT System	CCTV System connected to SCADA for detection of violation & Incident Response Transparent Bus Stop Shelter provided at each of the platform with CCTV Monitoring and Real Time Information on the next Buses	Only Incident response system and Passenger Information System at stations are mentioned.	Comprehensive Safety and security related documents and plans required

2.5 Summary of Key Issues - Traffic and Transportation

The key issues related to traffic and transportation is summarised below:

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
1	Lane Capacity and Configuration	4+4 and 2+2 lane configuration suggested	The estimation of traffic and provision of the lanes is not substantiated on scientific methods. In the light of fresh traffic surveys, analysis and results the traffic demand and lane requirement has been reassessed under different scenarios.	Based on the studies, for the horizon year, the coastal road warrants a minimum requirement of 4+4 Lanes without BRTS and therefore it is desirable to provide 5+5 lane configuration to cater to the demand of BRTS as well.
2	BRTS- Operational Demand and Supply System	Bus Rapid Transit System is proposed on outer lane of the coastal road with the objective of bringing in public transport related benefits. FOBs MLCPs and IPT stands have been shown in the interchange plans of the Coastal road where the BRTS terminals are located.	Evidences of a detailed study on the BRTS system is not observed in the reports submitted as part of draft DPR. Access & Circulation Planning should be carried out as an integrated part of the BRT system and given utmost importance as the same will determine the safety and accessibility of the commuters.	The operational demand and the required supply need to be substantiated as per standard practice. Success of such a facility depends on well planned pedestrian facilities integrating multilevel car parks, IPT stands and bus stops of feeder bus routes. The details of the same may be provided for further review.
3	Safety and Security	Not discussed in sufficient detail	The safety and security of the coastal road facility is paramount.	Safety and security related documents and plans required.

ALIGNMENT STUDIES



3 ALIGNMENT STUDIES

3.1 General

Mumbai is surrounded by Arabian Sea on the East, South and west side. Mumbai being an island has no room to expand. To have a better connectivity between Island city to main land, sea links are planned on the Western side and Trans harbour link on the East. During the meeting held in Mumbai on 15th April 2011 by Hon. Minister MOEF, GOI, the proposal of reclamation based Coastal road encircling Mumbai was presented to Honourable Minister. The proposal envisioned a coastal road on reclamation which not only provided a speedy connectivity but also enhanced the quality of the city environment through the reduction in pollution and respiratory diseases and provision of excellent green space adjoining the road on either side and thus providing a much needed recreational space in addition to the road that connects the various parts of the city. Hon. Union Minister (MOEF) suggested that the proposal needed a closer examination through a committee whose recommendations could be made available to the Government for taking up further action in the matter. Accordingly, the Govt. of Maharashtra formed a committee under its Resolution dated 30th June 2011 with following Terms of Reference.

- a. To examine the various options in the construction of a coastal road including road on stilt or sea link in Mumbai.
- b. To evaluate options on the basis of technical feasibility and environmental impact and impact on the neighbourhoods.
- c. To recommend the best option which provides improved mobility, enhances environment and leads to sustainable development of open spaces/ greenery.

3.2 Peer Review Methodology

3.2.1 Alignment / Interchange Review

The Alignment review is divided under following sections,

1. Surveys
2. Typical Cross Section
3. Alignment of road
4. Interchanges / Junctions

The review methodology for Alignment and Interchange broadly remains same, with only change of applicable design parameters in accordance with the relevant IRC codes. Where IRC codes fall short, relevant references to international standards like Design Manual for Road and Bridges (DMRB), AASHTO, or any other relevant code etc. have been taken into account. The review has been carried out as per best industry practice.

3.2.2 Design Standards

The review has been undertaken based on IRC SP: 99 2013-Manual of Specifications and Standards for Expressways. The same has been adopted by DPR consultant for design of project road. The other relevant IRC code as applicable and mentioned in Manual has also been referred. The peer review has taken into account all such similar codes applicable for undertaking a comprehensive review. A reference has been made to various relevant International standards wherever applicable.

3.2.3 Typical Cross sections

The typical cross sections proposed by the DPR consultant are reviewed in terms of lane capacity and the overall capacity of the road with due consideration of the future growth. Lane drop or Lane gain requirement shall be explored in view of the projected peak hour traffic.

3.2.4 Geometric Design Standards

The main road alignment has been reviewed based on the provisions of IRC SP: 99-2013 as proposed by the DPR consultant. The design speed proposed by DPR consultant is 100 or 80 kmph. The geometric parameters are reviewed to conform to the relevant design standard. Any improvement or shortfalls have been highlighted and reported accordingly.

3.2.5 Interchanges / Junction Review

Total 12 nos. of Interchanges have been proposed by DPR consultant at following locations:

Phase I

- Amarson Garden Interchange (Bhulabhai Desai Road)
- Haji Ali Junction Interchange (Lala Lajpat Rai Road)
- Bandra Worli Sea link Interchange (Worli End)
- Bandra Worli Sea Link - Toll Plaza Interchange (Bandra End)
- Carter Road Interchange (Danda Village)

Phase II

- Jagannath Bhosale Marg Interchange
- Tambe Chowk Interchange (Walkeshwar Road)

Phase III

- Versova Interchange
- Madh Island Interchange (Institute of Fisheries Education)
- Oshiwara Interchange
- Malad Interchange
- Kandivali Interchange

The proposal of the interchanges has been reviewed in terms of capacity, traffic movement, and location. DPR consultant has proposed interchanges without any conflict of traffic.

The outcome of the feasibility review shall be adoption of alignment proposed in the DPR or an alternative suggestion which can be further explored by the DPR consultant.

3.2.6 Cross sections

The typical cross sections proposed by the DPR consultant has been reviewed in terms of lane capacity and the overall capacity of the road with due consideration of the future growth. The requirement shall be explored in view of the projected peak hour traffic.

3.2.7 Geometric Design Standards

The ramps and loops of interchange have been reviewed based on the provisions of IRC SP:99-2013 as proposed by the DPR consultant. The provisions of IRC 92 are also taken into consideration. The design

speed proposed by DPR consultant is 40 kmph for Interchange loops and ramps. The design speed and other geometric parameters have been reviewed to conform to the relevant design standard. Any improvement or shortfalls are highlighted and reported for further improvement in designs.

3.3 Alignment

It is observed that the DPR consultant has developed various options for each of the sections above. DPR consultant has also given due consideration to the options proposed by the Joint Technical Committee (JTC) report of December 2011.

It is aimed to review all the various options with their pros and cons including the options proposed by JTC. Our initial approach is to review the feasibility of the alignment before going into details of the geometry proposed.

The review has aimed to recommend the best possible alignment under given constraint(s). All issues like heritage values, proximity to high rise buildings, religious importance, health and safety, constructability, sustainability, recreational value, environment and social assessment, design for maintenance etc has been taken into account.

Based on the outcome of the review of alignment, the suitability of alignment proposed in the DPR shall be confirmed or an alternative suggestion shall be given for further study.

3.4 Surveys

3.4.1 Topographic Survey

The basic objective of the topographic survey would be to capture the essential ground features along the alignment in order to consider improvements and for working out improvements, bypass, green field alignment, rehabilitation and upgrading costs.

Collection of details for all features such as structures (bridges, culverts etc.) utilities, HFL, HTL, existing roads, electric and telephone installations (both O/H as well as underground), huts, buildings, fencing and oil and gas lines etc. falling within the extent of survey or property boundary is important.

The topographic survey was carried out by DPR Consultant between November 2014 to January 2015 and details have been provided by the DPR Consultant in Volume IV - Topographic Survey Report.

Our observations on the topographic survey report and drawings are already provided under phase I report submitted in February 2016.

3.5 Project Alignment

Joint Technical Committee, Government of Maharashtra has recommended 2 nos. of alignment options in their Report dated December 2011. The project alignment starts from Jagannath Bhosale Marg and terminates at Kandivali Junction. Further, DPR Consultants have developed another 4 nos. of options and presented in their Draft Detailed Project Report dated February 2015. Based on Lane capacity evaluations, DPR Consultant has proposed the project alignment as Expressway with eight lane road except the section from Nariman point to Tambe Chowk which is having four lanes. The review of lane capacity has been described in Chapter 2.

The various options have been developed by DPR consultant based on Satellite imageries and levels extracted from Google Earth Pro Software, assisted by site visits/ reconnaissance survey.

The review of alignment options has been carried out by peer review consultant by considering parameters mentioned below:

1. Topography of the project area
2. Conformation with Design Standards
3. Storm water and sewage discharge locations
4. Connectivity at important locations along the alignment through Interchanges
5. Suitability for siting of structures
6. Availability of Construction Material and Ease of construction
7. Cost of construction, maintenance and operation.
8. Shifting of Utilities
9. User Safety aspect
10. Requirement of various environment, CRZ and forest clearances etc.
11. Aesthetics of project road
12. Rehabilitation and resettlement of project affected people
13. Location of Religious, Heritage and Archaeological structures along the alignment.
14. Social aspects

The review of alignment options has been carried out by peer review consultant by considering above mentioned parameters.

3.6 Project Sections

The project alignment is divided in 7 nos. of project sections based on traffic pattern and construction aspects. There are various alignment options developed by Joint Technical Committee and DPR Consultants for each of the sections. The merits and demerits have been identified for each option. The same has been reviewed and accordingly conclusions and recommendations have been presented. The project sections are presented in the figure below:

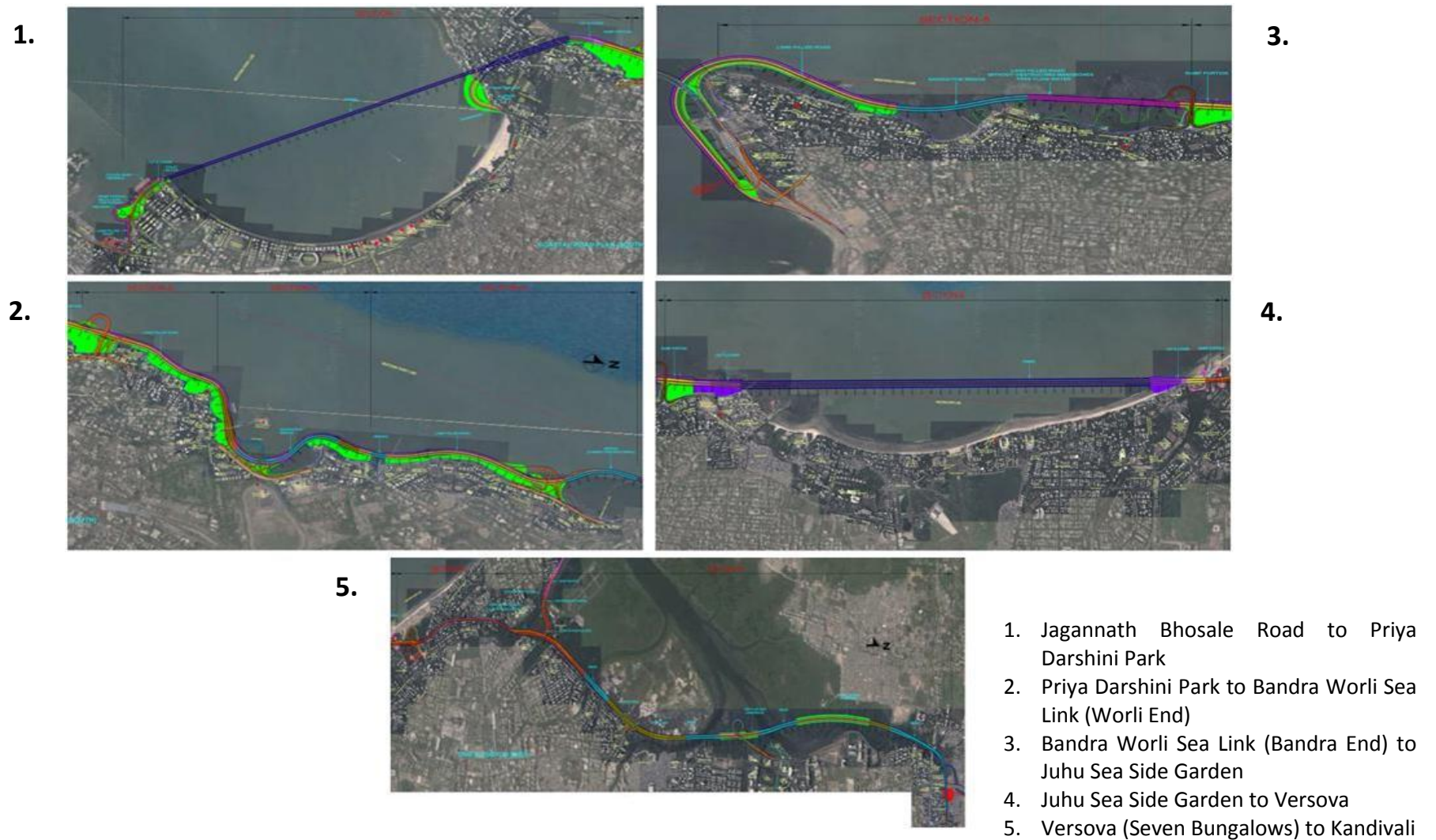


Figure 3-1 Project Alignment

The various project sections as shown in figure above are listed as below:

Part A : South (Jagannath Bhosale Road to Worli end of Sea Link)

Section 1 : Jagannath Bhosale Road to Priya Darshini Park

Section 2 : Priya Darshini Park to Mahalaxmi

Section 3 : Mahalaxmi to Baroda Palace

Section 4 : Baroda Palace to Worli End of Sea Link

Part B : North (Bandra end of Sea Link to Kandivali Junction)

Section 5 : Bandra End of Sea Link to Juhu Sea Side Garden

Section 6 : Juhu Sea Side Garden to Versova

Section 7 : Versova (Seven Bungalows) to Central Institute of Fisheries (Madh Island Interchange) and
Central Institute of Fisheries (Madh Island Interchange to Kandivali

The sections falling in Phase-I have been covered in Phase-I report submitted in February 2016.

The sections falling in Phase - II & III have been discussed below and accordingly observations and recommendations are given therein.

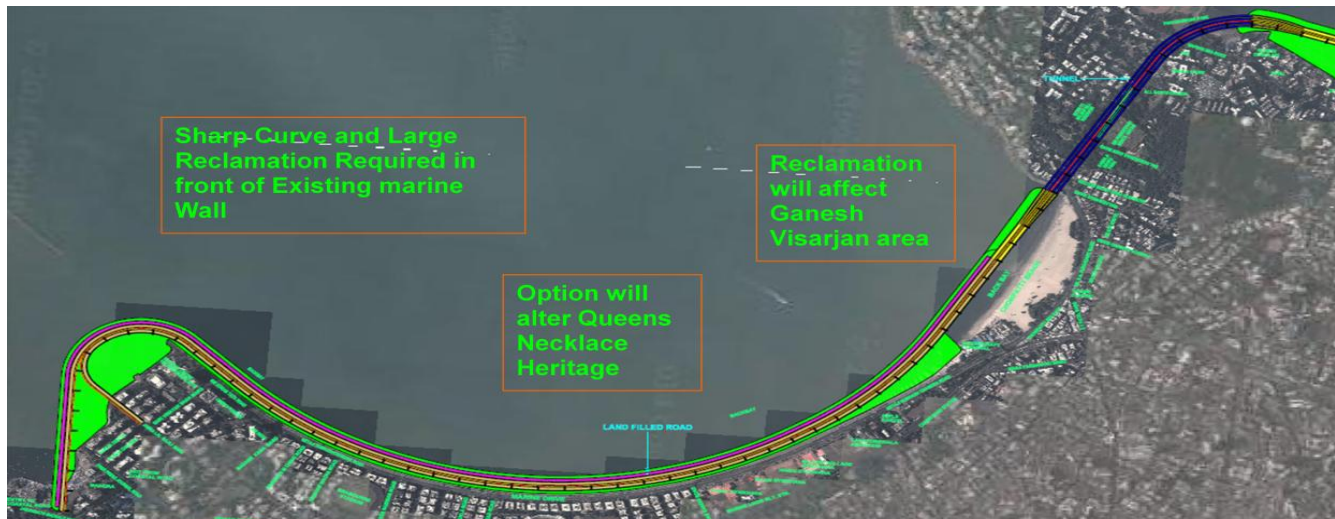
3.6.1 Section 1 : Jagannath Bhosale Road to Priya Darshini Park

The Alignment Options in Section 1 as proposed by JTC and DPR Consultants have been presented as below:



The proposed alignment in the initial section of road from Jagannath Bhosale Marg to NCPA has been proposed on land filled area. The alignment traverses along the existing Marine Drive with construction of tunnel for rest of the section.

Figure 3-2 Section 1- Option 1 & 2



The proposed alignment is an improved geometry over option 1 & 2. The alignment traverses parallel to existing Marin drive with proposed reclamation and construction of new promenade up to Chowpaty beach.

Figure 3-3 Section 1 - Option 3



The proposed alignment in this section is similar to option 3 with reclamation has been replaced by tunnel.

Figure 3-4 Section 1 - Option 4



In this option it is proposed to construct under sea tunnel from NCPA to Nepean Sea road. This provides geometry conforming to intended geometric standards.

Figure 3-5 Section 1 - Option 5



This is similar to option 5 with provision of 2 nos. of additional tunnels at Tambe Chowk.

Figure 3-6 Section 1 - Option 6

The summary of salient features of all the alignment options as provided by DPR consultant is presented below:

Option No.	Type of Road/ Structure	Start of Road/ Structure	End of Road / Structure	Length of Alignment (m)	Reclamation Area (Hectare)	No. of Heritage Structure
Option 1 & 2	Land Filled Road	Jagannath Bhosale Marg	NCPA	900	11.15	10
	Ramp portion Tunnel entry	NCPA	Oberoi Tower	300	1.80	
	Tunnel	Oberoi Tower	Nepean Sea Road	5200	8	
	Ramp portion Tunnel Exit	Nepean Sea Road	Priyadarshini park	200	1.20	
Option 3	Land Filled Road	Jagannath Bhosale Marg	Chowpati Beach	5000	57.29	10
	Ramp portion Tunnel entry	Chowpati Beach	Walkeshwar	400	2.40	

Option No.	Type of Road/ Structure	Start of Road/ Structure	End of Road / Structure	Length of Alignment (m)	Reclamation Area (Hectare)	No. of Heritage Structure
	Tunnel	Walkeshwar	Russian Consulate	1200		
	Ramp portion Tunnel Exit	Russian Consulate	Clinical Diagnostic Center	400	2.40	
Option 4	Bridge on Sea	Jagannath Bhosale Marg	NCPA	1200	3.10	10
	Ramp portion Tunnel entry	NCPA	Oberoi Tower	400	2.40	
	Tunnel	Oberoi Tower	Russian Consulate	5000		
	Ramp portion Tunnel Exit	Russian Consulate	Clinical Diagnostic Center	400	2.40	
Option 5	Land Filled Road	Jagannath Bhosale Marg	Raheja Center	410	7.94	10
	Ramp portion Tunnel entry	Raheja Center	NCPA	400		
	Tunnel	NCPA	Nepean Sea Road	4400		
	Ramp portion Tunnel Exit	Nepean Sea Road	Clinical Diagnostic Center	600		
Option 6	Land Filled Road	Jagannath Bhosale Marg	Raheja Center	410	7.94	10
	Ramp portion Tunnel entry	Raheja Center	NCPA	400		
	Tunnel	NCPA	Nepean Sea Road	4400	8	

Option No.	Type of Road/ Structure	Start of Road/ Structure	End of Road / Structure	Length of Alignment (m)	Reclamation Area (Hectare)	No. of Heritage Structure
	Tunnel entry and Exit near Walkeshwar	Nepean Sea Road	Walkeshwar junction	960	6.28	
	Ramp portion Tunnel Exit	Nepean Sea Road	Clinical Diagnostic Center	600		

DPR consultant has recommended Alignment Option no. 6 as preferred Option.

Conclusions and Recommendations:

The alignment of this section starts from Jagannath Bhosale Marg near MLA Hostel and runs up to Priya Darshini Park. The key features of alignment options identified by DPR consultant have been mentioned on the figures itself.

The alignment proposed in DPR is 2+2 lane from Jagannath Bhosale Marg till Priyadarshini Park with additional 2+2 lane joining from Tambe Chowk Interchange. The lane capacity required based on the fresh traffic survey and analysis is for 4+4 lane within this section. The DPR consultant shall take this into account. However, the observations provided within this report are based on the proposals presented in DPR.

In DPR option 1 & 2, the initial section of road from Jagannath Bhosale Marg to NCPA has been proposed on land filled area. The construction of tunnel has been proposed in the remaining section. The alignment traverses along existing Marine drive. This alignment option provides substandard geometry for the intended design speed at few locations. As referred in DPR this option is not feasible since it

will require precise traffic management during construction. It will also warrant utility relocations and lead to disruption of storm water drainage. Further, it will impact the aesthetics of existing promenade.

In DPR Option 3, the road is proposed on land filled area in the initial section up to Chowpaty beach. The remaining section of alignment is proposed through tunnel at Malabar hill. The tunnels further ends at Clinical Diagnostic center. The alignment traverses parallel to existing Marine drive with proposal of new promenade up to Chowpaty beach. Though this option is relatively low in cost, DPR points out that reclamation in front of Girgaon Chowpaty is not recommended as it impacts the religious importance of Chowpaty.

DPR Option 4 has been developed by keeping the alignment same as that of Option 3. However, this option involves construction of bridge in the initial section till NCPA. The construction of tunnel has been proposed for remaining section from NCPA till Priyadarshini Park. Since construction of tunnel is proposed outside existing shore protection wall, the option does not require traffic management and utility relocation. The existing marine drive and promenade has been retained in this option and provision of ventilation and emergency exit is possible. In accordance with DPR demerit of this option is the higher cost involved in the construction.

The DPR option no. 5 is proposed with straight alignment from NCPA to Napean Sea road with construction of undersea tunnel. This option provides a geometry conforming to intended geometric standards. The option does not impact the existing Marine drive and Girgaon Chowpaty beach. It involves minimum traffic management during the construction. In accordance with DPR the major demerit of this option is that it involves higher cost of construction. Also, the provision of ventilation, emergency exit, safety and security are challenging task.

DPR Option 6 is similar to option 5 with provision of 2 nos. of additional tunnels for connectivity at Tambe Chowk.

Having studied all the above options, it is suggested to explore the new Alternative which is a combination of option 3 & 6.

3.6.2 Suggested Alternative – Marine Drive

Description

This Alternative has been developed by further refining the DPR Option 3 & 6. In this Alternative Figure 3-7, it is suggested to construct the 4+4 road parallel to existing Marine Drive with new promenade on sea side. This option involves construction of road on land filled area till the start of Girgaon Chowpaty beach. Thereafter, construction of tunnel is suggested till Clinical Diagnostic center. Thus, aesthetics and religious importance of Chowpaty is not impacted. This alternative provides savings in the cost to great extent. The construction of land filled road is easy and faster compared to other options. Minimum traffic management is required in this option. However, Marine Drive is a place of heritage importance and is also called as Queen's Necklace. The alternative suggested here may invite public resistance, heritage and other clearances. These are the areas of concerns which need to be addressed if this alternative is chosen.

The entry and exit to Tambe Chowk may be retained same as that of Option no. 6.



Figure 3-7 Section 1 - Alternative

Alternatively, if construction of 4+4 lane road parallel to existing Marine drive is not feasible, then this alternative can be phased with initial construction of 2+2 lane along the existing Marine Drive and future augmentation of additional 2+2 undersea tunnel as per option 5.

If suggested alternative is chosen for further study, the land take in terms of working areas, lay-down areas, material logistics and required surveys/ investigations, and implementation program needs to be addressed and finalized accordingly by the DPR consultant.

The summary of salient features of Suggested Alternative is presented below:

Option No.	Type of Road/ Structure	Start of Road/ Structure	End of Road/ Structure	Length of Alignment (m) (approx)	Reclamation Area (Hectare) (approx)	No. of Heritage Structure
Suggested Alternative	Land Filled Road	Jagannath Bhosale Marg	Girls Hostel	4000	45.84	10
	Ramp portion Tunnel entry	Girls Hostel	Start of Chowpati Beach	400	2.40	
	Tunnel	Start of Chowpaty Beach	Russian Consulate	2200		
	Ramp portion Tunnel Exit	Russian Consulate	Clinical Diagnostic Center	400	2.40	

The comparative cost of DPR option and suggested alternative is given below.

Sr. No.	Parameters	DPR option 6 (Tunnel)	Suggested Alternative	Remarks
1	Design Speed (Kph)	80	80	Relaxation from Standard
2	Geometry	Complied to Design Speed	Complied to Design Speed	
3	Lane Capacity (Nos.)	2+2	4+4	4+4 lane is based on fresh traffic survey and analysis.
4	Land Filled road (m)	410	4000	
5	Tunnel (including ramp) (m)	5600	3000	

Sr. No.	Parameters	DPR option 6 (Tunnel)	Suggested Alternative	Remarks
6	*Block Cost (approx) in Crores	1025	863	The estimated block cost of suggested alternative for 4+4 lane capacity will be approx 1730 crores. However, for comparison, like to like provisions are considered.
7	Ranking	2	1	Based on above features, suggested alternative has been recommended for further studies

*Estimated using unit cost given in DPR.

It is also understood during course of study and field visits that DPR consultant is exploring few more options for this section; however the details are not yet made available for peer review. Therefore available report has been reviewed and comments are offered.

3.6.3 Section 6 : Juhu Sea Side Garden to Versova

The Alignment Options in Section 6 as proposed by JTC and DPR Consultants have been presented as below:



The proposed alignment in this option traverses through tunnel under ground from Juhu Sea side Garden till Ritumbhara College. The geometry is very tight.

Figure 3-8 Section 6 - Option 1 & 2



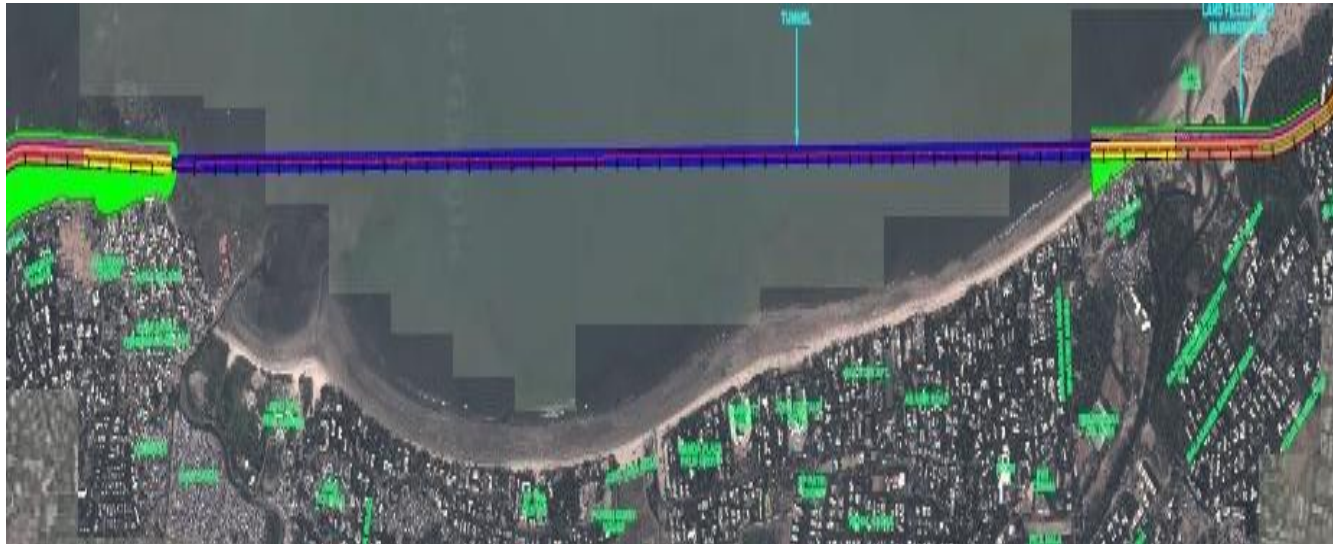
The entire alignment is proposed on reclamation. The alignment geometric is improved over option 1 & 2.

Figure 3-9 Section 6 - Option 3



This alignment is similar to option 3, with construction of tunnel along the existing beach.

Figure 3-10 Section 6 - Option 4



To overcome various constraints the alignment in this option is proposed as straight alignment with construction of tunnel from Khardanda to Ritumbhara College.

Figure 3-11 Section 6 - Option 5 & 6

The summary of salient features of all the alignment options including the JTC report and as provided by DPR consultant is presented below:

Option No.	Type of Road /Structure	Start of Road/ Structure	End of Road/ Structure	Length of Alignment (m)	Reclamation Area (Hectare)	No. of Heritage Structure
Option 1&2	Ramp portion Tunnel Entry	Juhu sea side Garden	Juhu Koliwada	200	1.20	1
	Tunnel	Juhu Koliwada	Ritumbhara College	3900		
	Ramp portion Tunnel Exit	Ritumbhara College	RGIT	300	1.80	
Option3	Land Filled Road	Khar Danda	Ritumbhara College	4700	62.14	1
Option 4	Ramp portion Tunnel Entry	Khar Danda	Juhu sea side Garden	500	9.40	1
	Tunnel	Juhu sea side Garden	Ritumbhara College	3800		

Option No.	Type of Road /Structure	Start of Road/ Structure	End of Road/ Structure	Length of Alignment (m)	Reclamation Area (Hectare)	No. of Heritage Structure
	Ramp portion Tunnel Exit	Ritumbhara College	RGIT	400		
Option 5 & 6	Ramp portion Tunnel Entry	Dandekar chowk	Khar Danda	400	4.00	2
	Tunnel	Khar Danda	Ritumbhara College	4350		
	Ramp portion Tunnel Exit	Ritumbhara College	RGIT	400	4.00	

DPR consultant has recommended Alignment Option no. 5 & 6 as preferred Option.

Conclusions and Recommendations:

The alignment in this section continues from the Juhu Sea side Garden and extends up to proposed Versova interchange near Nana nani park, Seven Bungalows. There are several slum areas along the alignment section near Leela Bungalow, Indra Nagar, Juhu Koliwada, Moragaon, Juhu. Mangroves exist near Versova, Juhu, Rajiv Gandhi Institute of Technology, Bharat Nagar.

The alignment in DPR Option 1 & 2 is same as proposed by Technical Committee which traverses through tunnel under ground from Juhu Sea Side Garden till Ritumbhara College as shown in Figure 3-11 above. This option retains the existing beach line in this section. However, this option has substandard geometry. The construction of this road will need rigorous traffic management during the construction and therefore is extremely challenging task. It will involve cumbersome task of utility shifting etc. Besides, the cost of construction is very high as noted in DPR.

In DPR Option 3, the entire alignment is proposed on reclamation. The alignment proposed under this option conforms to geometric standards. The demerits of this option as noted in DPR include impact to the existing beach available at sea front.

In DPR option 4, it is suggested to construct the tunnel along the existing beach by keeping the alignment same as proposed under option 3. The construction of tunnel will affect the usage of Juhu beach during the execution of works, which is a major recreational spot for public at present. It is observed that alignment options 5 & 6 have been proposed to overcome the constraints as faced in options 1 to 4. The construction of tunnel with straight alignment from Khardanda to Ritumbhara College has been proposed under DPR Option 5 & 6. The length of the alignment is shorter in this option. The tunnel construction nullifies the obstruction for view from the beach. Since tunnel alignment is away from existing beach, the construction activities will not cause major hindrances to the beach line.

After the review of all above options considered, few more options are suggested as alternative which are discussed below:

3.6.4 Suggested Alternatives

Alternative - I

The Alternative I is presented in Figure 3-12.

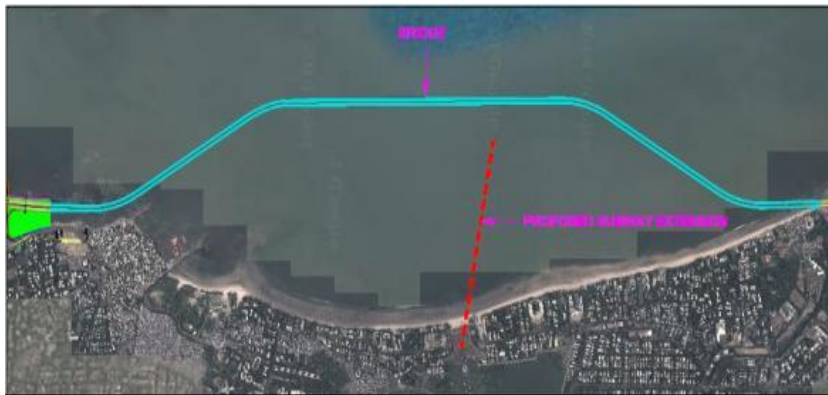


Figure 3-12 Section 6 - Alternative I

In this Alternative I the alignment of road remains same as that of DPR Option 5 and 6 with modification to overcome the constraint of expansion of Juhu runway as shown in Figure 3-12. Further it is suggested to explore the possibility of construction of bridge in place of tunnel. This is similar to the alignment previously studied by MSRDC as a sea link option. However the proposed alignment is comparatively closer to the shore than proposed by MSRDC. This proposed alignment is about 1.5 km from the shore line providing almost a 200m clearance to the end of proposed Juhu runway extension. This option will minimise the construction cost as compared to tunnel construction. Also, the difficulty of providing emergency exits and ventilation shafts in case of tunnel construction in option 5 & 6 can be overcome with the construction of bridge. This option will not disturb the existing beach. The bridge may be designed with the best aesthetics as in case of Bandra Worli Sea Link,

which has become prominent tourist attraction and land mark over the period.

However, as noted above there is a proposal of extension of Juhu runway into the sea for a length of about 1 to 1.20 Km by Airport Authority of India (as shown in dotted red line in figure). Therefore, feasibility of this option depends on the clearance required within the takeoff or landing flight path. This is still a manageable option if clearances required from AAI are obtained for the bridge option.

Alternative - II

The Alternative II is presented in Figure 3-13.



Figure 3-13 Section 6 - Alternative II

Alternative II is a refinement of DPR option 3. The alignment is proposed to pass as close as to the shore line as possible. The road is proposed on the reclaimed land. The existing beach shall be restored on the sea side reclaimed land. The pedestrian underpasses shall be provided for accessing the relocated beach. It is anticipated that this option might invite large objections from public, public representatives, hoteliers, residents etc. as the present available beach sea view will be disturbed and may have impact on business.

There will also be an impact on the existing beach which is a large recreational space attracting huge crowds at present. However, in the larger interest and likely future benefits by way of creation of more recreational space, the objections can be overcome substantially. The construction can be phased in such manner that sufficient length of beach is maintained for public use at all the times during construction. This alignment will avoid tunnel or a sea link.

However, it is also learnt that there is a proposal of extension of Juhu runway into the sea for a length of about 1 to 1.20 Km by Airport Authority of India. The extension of the Juhu runway can be done by construction of underpass for the coastal road alignment whenever it comes through.

Alternative - III

The Alternative III is presented in Figure 3-14.



Figure 3-14 Section 6 - Alternative III

The proposed Alternative III is the same as Alternative II with only change of reclaimed land is replaced by cut and cover tunnel. The alignment is proposed to pass as close as possible to the shore line.

The existing beach shall be restored at the same place. There will be impact on the existing beach which is a large recreational space attracting huge crowds at present. It is perceived that the objections with this proposal might not be as severe as that of Alternative-II. However in the larger interest and likely future benefits by way of creation of more recreational space, the objections can be overcome substantially. The construction can be phased out in such manner that sufficient length of beach is maintained for public use at all the times during construction. This alignment will avoid undersea tunnel and a sea link. The Interchange layout as proposed in DPR can still be retained with minor modifications.

If any of the suggested alternatives as discussed above is chosen for further study, the land take in terms of working areas and required surveys & investigations, lay-down areas, material logistics, and implementation program needs to be addressed and finalized accordingly by the DPR consultant.

Comparison of Alternatives:

The comparative cost of DPR option and suggested options is given below.

Sr. No.	Parameters	DPR recommended Option 5 & 6 (Tunnel)	Suggested Alternative I	Suggested Alternative II	Suggested Alternative III
1	Design Speed (Kph)	100	100	100	100
2	Geometry	Complied to Design Speed	Complied to Design Speed	Complied to Design Speed	Complied to Design Speed
3	Lane Capacity (Nos.)	4+4	4+4	4+4	4+4
4	Land Filled road (m)	NIL	NIL	5670	NIL
5	Tunnel (including ramp) (m)	5150	NIL	NIL	NIL
6	Bridge in Sea / Road on Stilt / Elevated Road	NIL	5300	NIL	NIL
7	Cut and Cover	NIL	NIL	NIL	5670
8	*Block Cost (approx) in Crores	2400	2385	726	1786
9	Ranking	4	3	1	2

*Based on unit cost given in DPR.

3.6.5 Section 7 : Versova to Kandivali Junction

The alignment Options in Section 7 as proposed by JTC and DPR Consultant have been presented as below:



The alignment in this section traverse from Versova to Kandivali and pass through Nana Nani Park, mangroves at Central Institute of Fisheries outskirts of Millat Nagar and further to Kandivali Junction. A geometry proposed is tight at certain locations. A connection to Madh Island is proposed by surface Interchange.

Figure 3-15 Section 7 - Option 1 & 2



The alignment in this section traverse from Versova to Kandivali and pass through Nana Nani Park, mangroves at Central Institute of Fisheries outskirts of Millat Nagar and further to Kandivali Junction. This is an improved geometry over previous option 1 & 2. The connection to Madh Island is proposed with grade separated interchange.

Figure 3-16 Section 7 - Option 3 to 6

The Summary of salient features of all the alignment options as provided by DPR consultant is presented below.

Option No.	Type of Road / Structure	Start of Road/ Structure	End of Road/ Structure	Length of Alignment (m)	Reclamation Area (Hectare)
Option 1 to 6	Land filled Road on Mangroves	RGIT	Seven Bungalows	1100	6.60
	Elevated Road	Seven Bungalows	Central Institute of Fisheries Education	1100	-
	Land filled Road on Mangroves	Central Institute of Fisheries Education	Millat Nagar	4545	27.27
	Land filled Road	Millat Nagar	Prakash Nagar	800	4.80
	Land filled Road on Mangroves	Prakash Nagar	Morgan Stanley	1800	10.80
	Land filled Road	Morgan Stanley	Ram Nagar	480	2.88
	Land filled Road on Mangroves	Ram Nagar	Rajan Pada	300	1.80
	Road on stilt	Rajan Pada	Kandivali junction	2450	-

DPR consultant has recommended Alignment Option no. 3 to 6 as preferred Option.

Conclusions and Recommendations:

The alignment under section 7, i.e. from Versova to Kandivali junction starts near Bharat Nagar and traverses through, Nana Nani park, mangroves at Central Institute of Fisheries, outskirts of Millat Nagar, Prakash Nagar, mangroves at Morgan Stanley and further to Kandivali junction. The geometry as proposed under DPR option 1 & 2 has been smoothened in DPR options 3 to 6. Also, the interchange scheme for traffic dispersal point towards Madh Island as proposed in DPR option 1 & 2 has been altered in DPR option 3 to 6. The alignment also proposes another 2 nos. of interchanges at Oshiwara and Malad. It is learnt that objections are received from public for passing the alignment through Nana Nani Park which is at present their recreational space.

The section of alignment from Rajiv Gandhi Institute of Technology to Central Institute of Fisheries Education, passes through habitation (see Figure 3-17 & Figure 3-18) and hence proposed as two level elevated section. The rehabilitation is required to some extent in this section. The rest of the alignment is proposed on the outskirts of habitation and does not require any rehabilitation of people and properties.

In view of the objections received from the public to pass the alignment through Nana Nani Park, it is suggested to develop alignment as shown in Figure 3-19. The alignment in this stretch is challenging one. The option of alignment in this stretch has been developed with the concept of two lane two level elevated roads but avoiding major portion of Nana Nani Park by following the existing roads on either side of the Nana Nani Park (Figure 3-20 and Figure 3-21). The proposed cross section is shown in Figure 3-22. The geometry of the alignment may have to be compromised to facilitate

minimal impact on the Nana Nani Park. With this almost 75% area of the Nana Nani Park remains unaffected. The construction can be phased in such a manner that some portion of park is available for use at all times. The Departure from standards will be required and needs to be agreed by the authority. The proposed structure will be uni-directional with one arm above the other separating out at the approach to Nana Nani Park at Seven Bungalow end. The existing road shall be followed along either side of the Nana Nani Park before finally merging into the alignment at the other end of the Park which constitutes as a 4+4 lane two level elevated structures.

It is also observed that Draft DP 2034 have planned to develop a 36.3m DP road and spaces have been reserved as Recreational ground, College, School, Public open spaces and Higher Education Institute. This route is going to be a prominent route in near future till the end of Central Fisheries Institute.



Figure 3-17 Location of Two Level Elevated section passing through Habitation & Properties



Figure 3-18 Nana Nani Park Northbound



Figure 3-19 Alternative option for 2 lane multilevel arm



Figure 3-20 Location of Two Level Elevated Section Near Fisheries Institute



Figure 3-21 Nana Nani Park Southbound

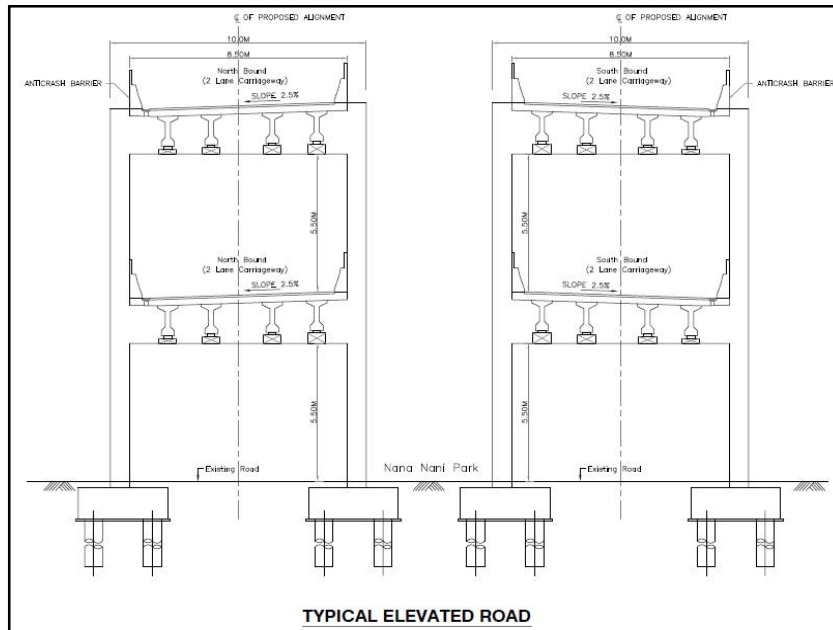


Figure 3-22 Typical Cross section of Two lane elevated Road

3.7 DPR Overall Preferred Option - Option 7

DPR Consultants have proposed various alignment options for each of the sections as described above. Also, they have indicated the preferred alignment option for each of the alignment sections. Accordingly, Option no. 7 has been developed for overall alignment by adopting preferred alignment in each section with fine tuning in the geometric element of the alignment.

After review of all alignment options and describing suitability/feasibility of each option in aforementioned sections, it is

recommended to undertake the feasibility of options suggested in the aforementioned sections.

However, our observations on the DPR preferred option 7 have been presented in table below. The complete Alignment plan for DPR preferred alignment Option 7 is presented below:

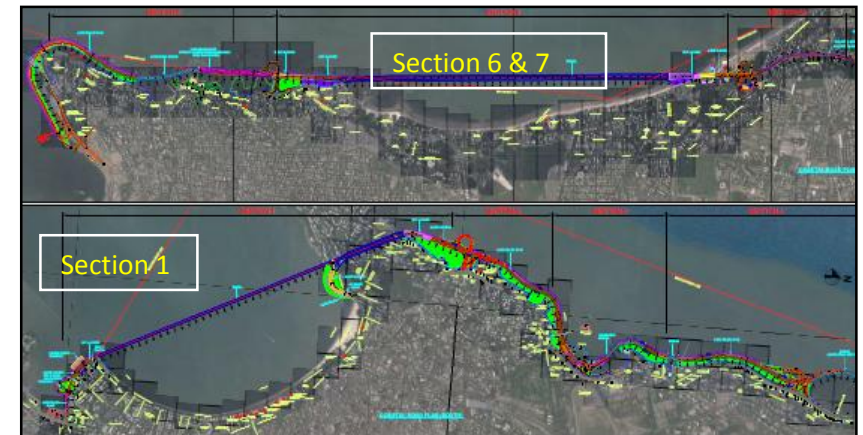


Figure 3-23 Preferred Alignment - Option 7 (Section 1 and Section 6 to Section 7)

Review of Plan / Alignment Drawings of Preferred Alignment

We have reviewed Typical Cross section drawings, Plan and Profile drawings as received from DPR Consultants under Volume VII: Drawings dated February 2015. It is noted that these drawings are developed for preferred Alignment Option, i.e. Option no. 7. This review is limited to Alignment in Phase II & III - Section 1 and Section 6 to 7, i.e. Jagannath Bhosale Marg to Priyadarshini Park, Khar Danda to Kandivali. In addition to the comments and observations made under conclusion and recommendation in of the each alignment above, following comments shall be taken into account for the preferred alignment.

Sr. No.	Report/ Drawing Reference	Element	Observation / Comments	Recommendation
1	8098/E/DD-407 (R1)	Typical Cross Section at Tunnel	Emergency lay by or cross passage is required in case of any emergency arising in tunnel	Provide emergency lay by or cross passage to other tunnel and include emergency exit / disaster management plan.
2	-	Road Capacity	Presently under phase II & III, four lane dual carriageway has been proposed by DPR Consultant	- As described in chapter 2, the minimum lane capacity for Phase II & III is as below, - Carter Road to Seven Bungalows (Versova) (Tunnel) – 4+4 lane - Seven Bungalows (Versova) to Madh Island Interchange(Elevated) – 4+4 lane - Madh Island Interchange to Kandivali Interchange - 4+4 Lanes (Elevated). The desirable is 5+5 lanes.
3	All drawings	SSD/DSD	SSD Visibility report and envelops considering all hazards as application to the design section, e. g. kerbs, safety barrier, parapets etc. to be developed to ensure correctness of geometry. Separate report on Decision sight Distance (DSD) to be developed for review for all Interchanges/ Toll Plaza and Change of cross section in accordance with IRC SP:99 Cl.2.9.3.2	Recommended for compliance.

Sr. No.	Report/ Drawing Reference	Element	Observation / Comments	Recommendation
4	All Profile Drawings	L Section (all)	Show the Sea Level (HTL or HRT) considered in design as minimum. The Proposed road level shall be in accordance with the requirement of shore protection and reclamation with due consideration to climate change. The present proposed level of +8.5m CD or +6.0m above MSL is likely to be on the lower side with respect to the design water level. The proposed structures like culverts, Bridges, Foot Over Bridges, and Interchange arms are not shown along profile. Show the crossing of Western Ferry Line in Profile.	The vertical alignment of the highway should ensure that there is sufficient construction depth to accommodate drainage infrastructure. Please indicate the details for better understanding, correctness, sufficiency and clarity. The design of storm water drainage, median drainage shall be taken in to account to decide on outfall connections into the existing / proposed structures. The storm water outfall shall be designed such as to avoid flooding of road during monsoon.
5	8098/E/DD-554 (R0) 8098/E/DD-555 (R0)	FOB	Length of FOB not indicated	Please indicate length of FOB for better understanding. Further consider comments given in Chapter 2.
6	8098/E/DD-556 A (R0) 8098/E/DD-560 A	Horizontal geometry and Superelevation	Camber indicated is 0.65% however the normal camber required is 2.5%	Consider revising Camber
7	8098/E/DD-561 C	Horizontal geometry and Superelevation	Transition length provided to radius 650m is more than required	Consider revising Transition length
8	8098/E/DD-562 A (R0) 8098/E/DD-562 C (R0) 8098/E/DD-570 A (R0)	Horizontal geometry and Superelevation	Speed should be limited to 80 kmph for 260m radius. Superelevation of 7% should be provided	Consider revising Speed and Superelevation.

3.8 Interchanges

DPR consultant has proposed seven number of interchange along coastal road under Phase II and Phase III.

The proposed Seven Interchanges in Phase II and Phase III are listed below:

Phase II

- Jagannath Bhosale Marg Interchange
- Tambe Chowk Interchange

Phase III

- Versova (Seven bungalows) Interchange
- Madh Island Interchange
- Oshiwara Interchange
- Malad Interchange
- Kandivali Interchange

3.8.1 Jagannath Bhosale Marg Interchange

The Interchange layout proposed by DPR consultant is shown below:



Figure 3-24 Jagannath Bhosale Marg Interchange

Our observation and finding on the above interchange are tabulated below:

JAGANNATH BHOSALE MARG INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides only turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange.
3	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes. Exit/ Entry of bus Terminal are not safe. Exit through arm 1 taper has potential to cause accident. Geometric details of bus exit loop & ramp not available.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.

JAGANNATH BHOSALE MARG INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
5	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints.
6	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e.g. kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.

JAGANNATH BHOSALE MARG INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
9	8098/E/DD- 1101 (R0) to 1104 Note: 8098/E/DN-7	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.

3.8.2 Tambe Chowk Interchange

The Interchange layout proposed by DPR consultant is shown below:



Figure 3-25 Tambe Chowk Interchange

Our observation and finding on the above interchange are tabulated below:

TAMBE CHOWK INTERCHANGE (WALKESHWAR ROAD)				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD-008 R4	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD-008 R4	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange.
3	8098/E/DD-008 R4	Design Speed	Design Speed and other Geometric details not available	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD-008 R4	Acceleration and Deceleration Lane	Details unavailable	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.
5	8098/E/DD-008 R4	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints.

TAMBE CHOWK INTERCHANGE (WALKESHWAR ROAD)				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
6	8098/E/DD-008 R4	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD-008 R4	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e.g. kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD-008 R4	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.
9	8098/E/DD-008 R4	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.

3.8.3 Alternative Alignment at Tambe Chowk

Alternative - I

During the course of the discussion with the authority it is learnt that MCGM is keen to start the project from Tambe Chowk Junction in the first phase. Though the traffic warrants for 4+4 lane between Nariman Point and Priyadarshini Park, the alternative has been conceptualized to start the coastal road from Tambe chowk using the existing Marine Drive.

The proposed layout has been shown in Figure 3-26. The alignment is proposed to use the existing road named 1st Lane beside the Kilachand Garden which directly leads to the foothills of Malabar hill. Figure 3-27 & Figure 3-28 shows two options that can provide direct entry into the face of the hill by way of tunnel. This may require constructing an aerial cover as a safety / noise measure. This side would be difficult as TBM option but fine as a D&B or road header. Though, this will require acquisition of single or few buildings, this will facilitate direct entry to the tunnel by utilising the best usage of topography. The existing Junction will need some major improvements (reclamation towards sea side) to provide the proper access to the tunnel. Since this junction is prominently used by VVIPs a strategic planning and traffic management is the essence during execution. It is also anticipated that acquisition at this place may be major social issue inviting resistance from the people and public representatives. However, savings in terms of construction cost will be much higher than the cost that will be incurred for rehabilitation and resettlement.

Further, the facility can be augmented in near future by construction of undersea tunnel as originally planned in DPR.

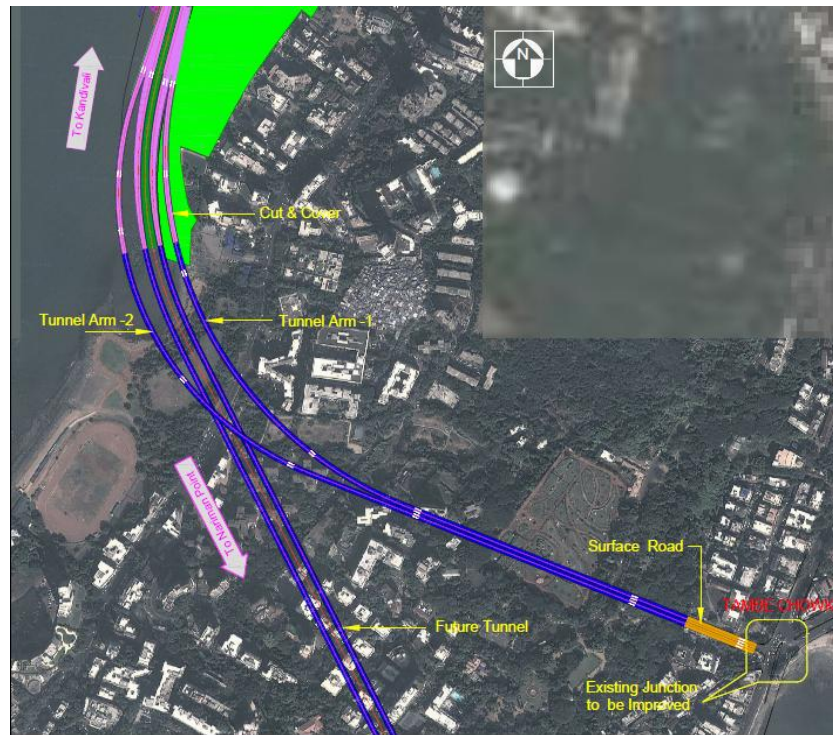


Figure 3-26 Alternative Layout at Tambe Chowk



Figure 3-27 Proposed Face of the Tunnel Option - 1



Figure 3-28 Proposed Face of the Tunnel Option - 2

3.8.4 Versova Interchange

The Interchange layout proposed by DPR consultant is shown below:

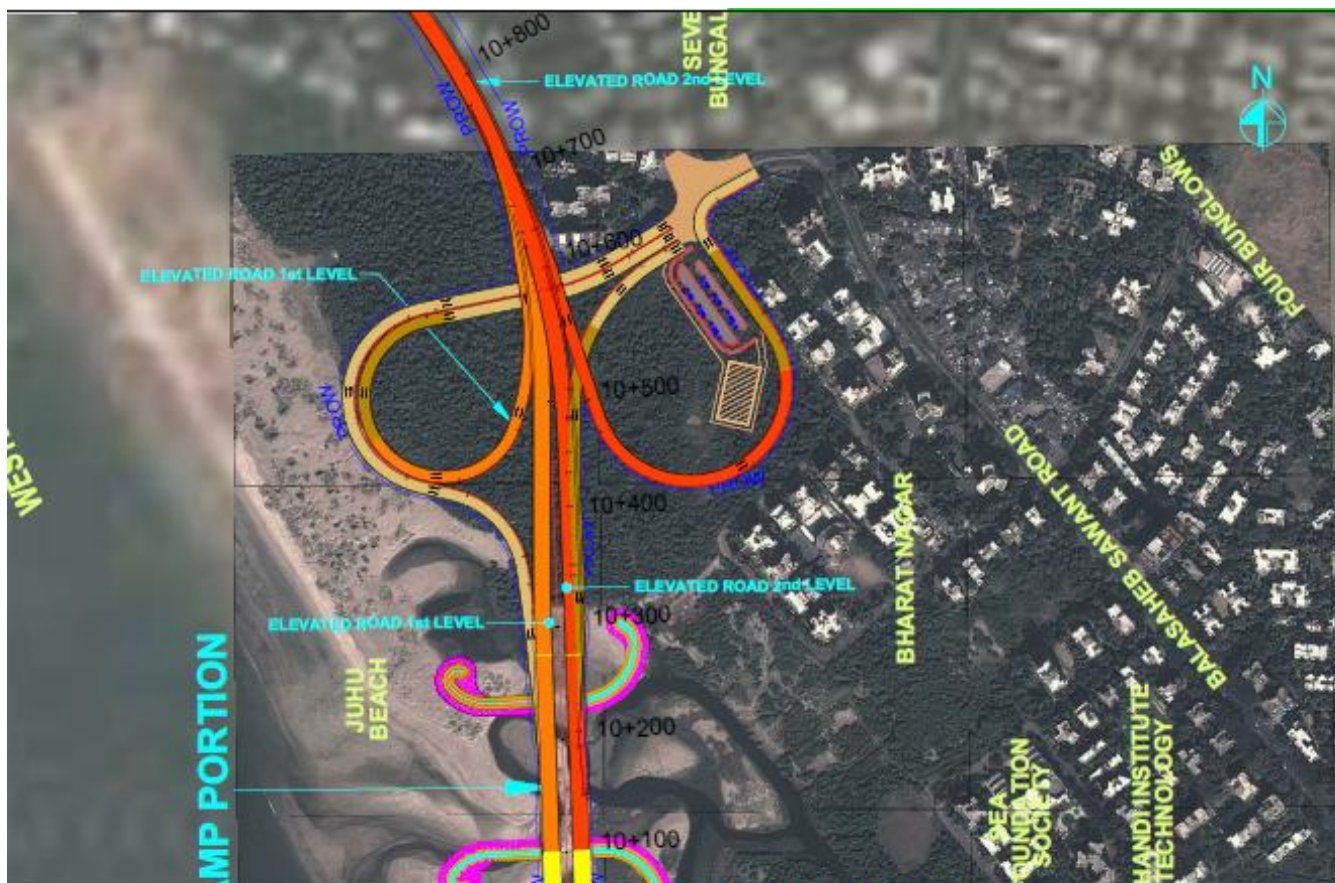


Figure 3-29 Versova Interchange

Our observation and finding on the above interchange are tabulated below:

VERSOVA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange
3	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.

VERSOVA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
5	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road. There appears to be a conflict of traffic entering coastal road and exiting coastal road at Seven Bungalows between Arm 4 and Arm 5. The Arm 5 provides exit from the coastal road to Seven Bungalows, however it is observed that the arm is merged on the wrong side of the existing road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints. Conflict of Arm 4 and Arm 5 should be resolved. Road user safety and priorities shall be taken into account while improving this junction.
6	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e. g. kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.

VERSOVA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
8	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.
9	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Crossfall/ Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.

3.8.5 Madh Island Interchange

The Interchange layout proposed by DPR consultant is shown below:



Figure 3-30 Madh Island Interchange

Our observation and finding on the above interchange are tabulated below

MADH ISLAND INTERCHANGE (INSTITUTE OF FISHERIES EDUCATION)				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1171 (R0) to 1175 and 8098/E/DD-1171A(R0) to 1175A Note: 8098/E/DN-7	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange.
3	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.

MADH ISLAND INTERCHANGE (INSTITUTE OF FISHERIES EDUCATION)				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
5	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints.
6	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e. g. kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Turning movement	Width of ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.

MADH ISLAND INTERCHANGE (INSTITUTE OF FISHERIES EDUCATION)				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
9	8098/E/DD- 1161 (R0) to 1164,1163A and 1164A Note: 8098/E/DN-7	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.

3.8.6 Oshiwara Interchange

The Interchange layout proposed by DPR consultant is shown below:

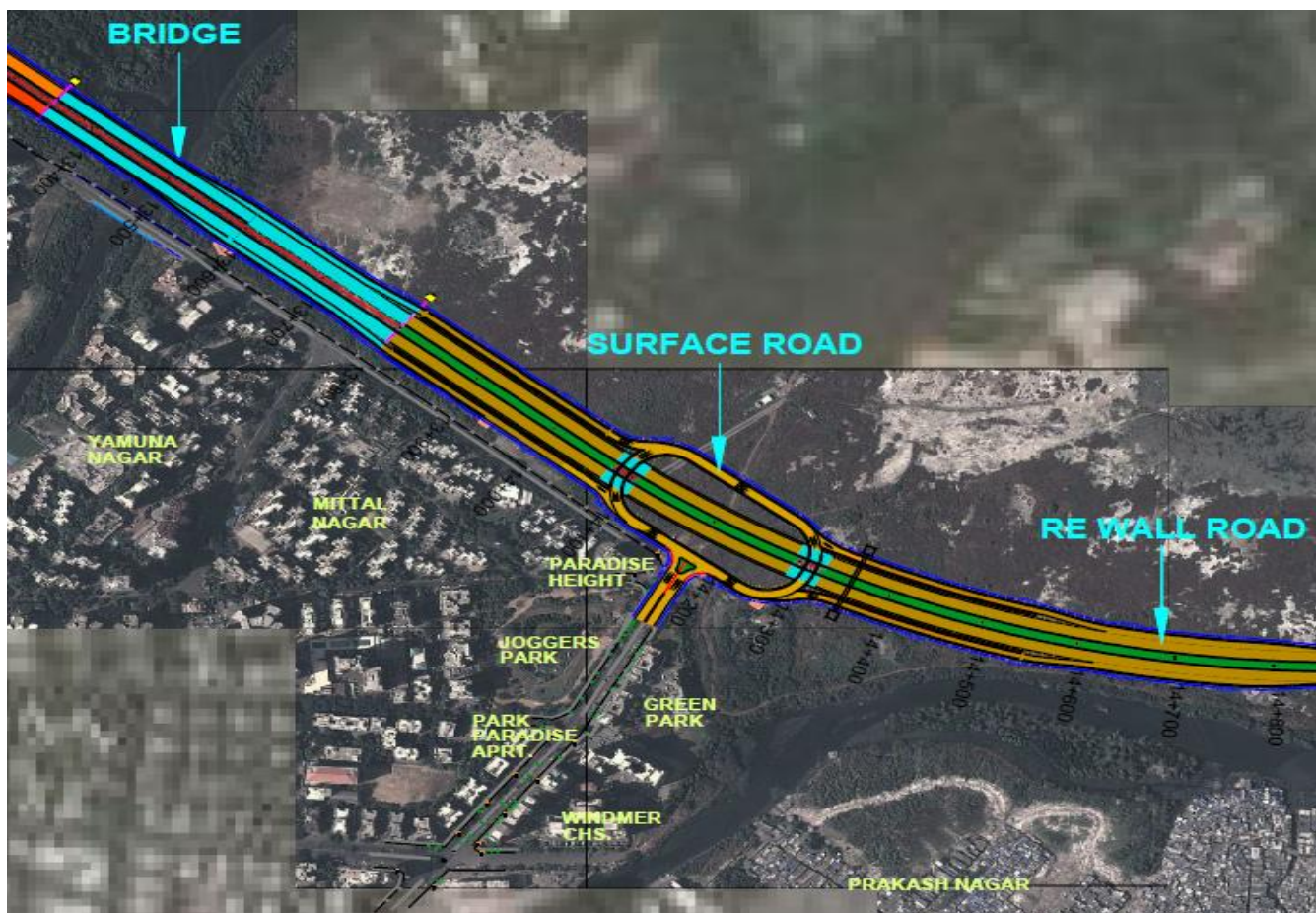


Figure 3-31 Oshiwara Interchange

Our observation and finding on the above interchange are tabulated below

OSHIWARA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7 Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange.
3	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.

OSHIWARA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
5	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints.
6	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e. G. kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.

OSHIWARA INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
9	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.
10	8089/E/DD-008 R4	FOB / Metro / HT Line Conflict	Foot over bridge is proposed at this Interchange. The present proposal envisage coastal road to pass at first level while the roundabout arms are proposed at surface level. At site it is observed that HT line is passing in this area. It is also learnt that the Pahadi Goregaon area is also identified for proposed Metro Depot and Metro Line is suppose to pass over the coastal road to access depot.	As coastal road is planned at level 1, the proposed FOB will have to be over the coastal road at level 2. It is highly unlikely that public will use this FOB to cross over due to its height. Relocation of this FOB or a subway arrangement, lift, escalators or ramps shall be looked at. Also in view of the Metro Depot and Metro line passing over coastal road, the vertical profile of metro should be designed in accordance with the vertical profile of coastal road to ensure requisite vertical clearance. This needs to be communicated to Metro authority for necessary action.

3.8.7 Malad Interchange

The Interchange layout proposed by DPR consultant is shown below:



Figure 3-32 Malad Interchange

Our observation and finding on the above interchange are tabulated below

Malad Interchange				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1191 (R0) to 1194 and 8098/E/DD -1191A(R0) to 1194A Note: 8098/E/DN-7	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7 Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal to and fro from Coastal road. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange.
3	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.
4	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.

Malad Interchange				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
5	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints.
6	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.
7	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Visibility	Visibility report / envelopes not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e.g kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.

Malad Interchange				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
9	8098/E/DD- 1220 (R0) to 1226 and 8098/E/DD -1220A(R0) to 1226A Note: 8098/E/DN-7	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.
10	-	HT Line	It is observed at site that HT line is crossing at the location of Interchange loop.	The vertical clearance below HT line should be confirmed.

3.8.8 Kandivali Interchange

The Interchange layout proposed by DPR consultant is shown below:



Figure 3-33 Kandivali Interchange

Our observation and finding on the above interchange are tabulated below:

KANDIVALI INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
1	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A Note: 8098/E/DN-7 8098/E/DD-008 R4	Location	The location of this interchange is in order in view of the traffic dispersal.	
2	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Traffic Dispersal	The provision has been made for traffic dispersal back and forth from Coastal road except the exit from coastal road to Mith Chowky junction. The DPR report provides turning ADT.	Peak hour turning movement should be used to arrive at the requirement of different arms and their capacities at Interchange. The requirement of arm for exit from Coastal road to Mith Chowky needs to be ascertained based on turning pattern.
3	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Design Speed	The Design speed adopted for interchange ramp and loop is 40 kmph which is not as per Table 3.1 of IRC SP 99.	The main road design speed is 80 kmph. The recommended design speed as given in table 3.1 of IRC SP 99 shall be followed. The geometry should be designed with respect to the design speed.

KANDIVALI INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
4	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Acceleration and Deceleration Lane	Insufficient lengths are provided for acceleration and Deceleration lanes.	In the interest of road safety, sufficient acceleration and deceleration length shall be provided along with appropriate nose lengths. Taper length shall be indicated on drawings for better clarity.
5	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A Note: 8098/E/DN-7 8098/E/DD-008 R4	Tie-in with existing Road	It is not clear from layout if the interchange ramps are properly tie-in to existing Road. There also appears to be conflict for arm entering onto coastal road from Malad Marve Marg (from existing Bridge) and two way access road just at the edge of bridge for Ryan International School.	DPR consultant to clarify if sufficient space is available for tie-in. Provide 2-3 cross section at critical locations showing existing road and other feature or constraints. Alternate for avoiding conflict mentioned in observation may be explored.
6	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	All Tie-ins	Tie-in shall be matched properly. The tie-in shall be in same design plane as per main carriageway sufficiently covering the acceleration and deceleration lengths. Design contours shall be made available for further review.	DPR consultant to confirm.

KANDIVALI INTERCHANGE				
Sr. No.	Report / Drawing Reference	Element	Observation / Comments	Recommendation / Suggestion
7	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Visibility	Visibility report/ envelops not available for review. SSD and Decision sight distance (DSD) (as per table 2.7 and 2.8 of IRC SP 99) shall be available.	DPR consultant to provide visibility report and confirm availability of SSD/DSD considering all the hazards e.g kerb, parapets etc. Widening shall be incorporated wherever necessary or appropriate mitigation measures shall be suggested and incorporated in design.
8	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Turning movement	Width of loops and ramps on curves needs to be checked for manoeuvring of large vehicles.	DPR consultant shall confirm conflict free manoeuvring based on Auto Turn layout considering the highest possible rigid vehicle length likely to use the interchange. Deficient bends shall be widened appropriately.
9	8098/E/DD- 1201 (R0) to 1204 and 8098/E/DD - 1201A(R0) to 1204A 8098/E/DD-008 R4 Note: 8098/E/DN-7	Crossfall / Superelevation	The location of tie-in and application of super elevation are likely to cause flat spot issues which are undesirable as they have potential to cause accidents.	Flat spot shall be avoided. DPR consultant shall provide flat spot report and confirm there are no flat spot when checked for desirable gradient of 0.5%.
10	-	Interchange Layout	The Interchange Layout at Kandivali is still under discussion and options are being worked out by DPR Consultant	Few conceptual design alternatives have been suggested and are discussed in subsequent section below. The feasibility shall be explored by DPR consultant.

3.8.9 Suggested Alternatives

Alternative I

The proposed arrangement is shown in Figure 3-34.



Figure 3-34 Kandivali Interchange - Alternative I

The Alternative- I is almost similar to what has been proposed by DPR consultant in drawing no. 8098/E/DD-008 R4 with minor change in traffic dispersal. Based on the fresh traffic survey and analysis a minimum of 4+4 lanes are required with desirable provision of 5+5. Considering minimum 4+4 lane requirement the Interchange layout is proposed. The exit has been proposed at two locations – the first one at the Link Road and the second one on to planned DP 2034 road with onward connection to Shankar Lane and S V Road. At present, encroachments are observed at this location which needs to be removed in view of DP 2034. Accordingly a two lane exit onto Link road and two lane exit connecting to Shankar Lane is proposed. The coastal road alignment is proposed to cross the Link Road at level 1. It is also acknowledged that Metro Line is planned on to Link road. Figure 3-35 represents the proposed cross section showing the

crossing of coastal road and Metro line. The requisite clearance needs to be maintained and vertical profile of Metro shall be designed/ amended accordingly if necessary.

It is also learnt that the land on north-west of coastal road is identified as proposed Metro Depot. However, there doesn't appear to be any conflict with metro if requisite clearances are maintained and co-ordinated. The entry on to Link Road is planned at surface and therefore the entry of Metro to depot is conflict free. The only hurdle at this stage is removal of encroachment on the north-eastern side of the Link road.

The entry onto coastal road is planned from three points, first one as two lane entry from Shankar Lane, second one as two lane entry from Link road and third one as two lane entry from Malad Marve Marg through flyover. The flyover entry from Malad Marve Marg will eliminate the local conflict between coastal road user and access road to Ryan International School. The access road will pass beneath the flyover by maintaining necessary vertical clearance.

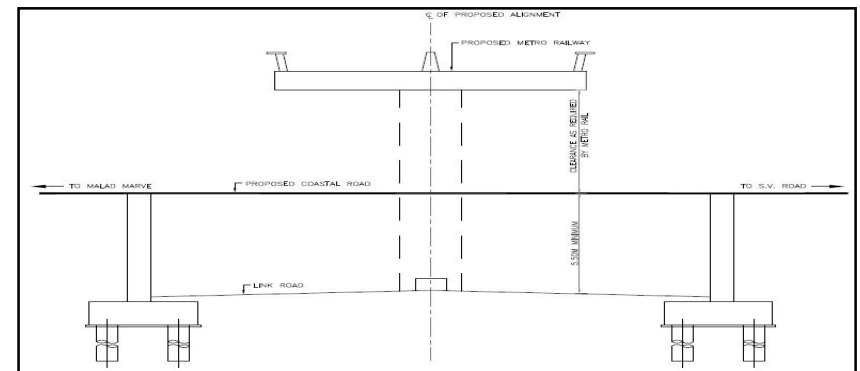


Figure 3-35 Proposed Arrangement at Kandivali Interchange on Link Road

Alternative II

The proposed arrangement is shown in Figure 3-36.



Figure 3-36 Kandivali Interchange - Alternative II

The Alternative II is with slight modification over Alternative I with change in traffic dispersal points. The exit in this option have been proposed at three locations - the first one being the Malad Marve Road through single lane loop, the second one as two lane on Link road and third one as two lane onto planned DP 2034 road with onward connection to Shankar Lane and S V Road. At present, encroachments are observed at this location which needs to be removed in view of DP 2034. The coastal road alignment is proposed to cross the Link Road at level 1. It is also acknowledged that Metro Line is planned on to Link road. Figure 3-35 represents the proposed cross section showing the crossing of coastal road and Metro line.

The requisite clearance needs to be maintained and vertical profile of Metro shall be designed/ amended accordingly if necessary.

It is also learnt that the land on north-west of coastal road is identified as proposed Metro Depot. However, there doesn't appear to be any conflict with metro if requisite clearances are maintained and co-ordinated. It is also acknowledged that there could be a conflict of Metro with the Interchange loop and therefore needs careful planning and coordination with Metro. This area though identified for Metro depot there appears to be development / encroachment that needs to be taken care of in acquisition / rehabilitation etc.

The entry onto coastal road is planned from two points, two lane entry from Shankar Lane and two lane entry from Malad Marve road (as flyover). The flyover entry from Malad Marve Marg will eliminate the local conflict between coastal road user and access road to Ryan International School. The access road will pass beneath the flyover by maintaining necessary vertical clearance.

3.9 Pavement Design

The DPR consultant has presented the pavement design chapter in Volume II: Design Report (Part-1). The same has been reviewed in accordance with the latest codes. Our observations and comments are already submitted in Phase - I report.

3.10 Land acquisition plans

The land acquisition plans are not made available for review at this stage. The same will be reviewed once the data is made available to us.

3.11 Structural Design

3.11.1 Interchanges

- The codes used, IRC6:2000, IRC 21-2000 have been superseded. Latest prevailing codes to be used.
- Working stress method is used. Limit state method should be adopted in the detailed design.
- Wind pressure to be checked with IS 875.
- No calculations have been given for curved girders. Pier design and foundation design for curved girders will also be required.
- Effect of continuous girders not considered in design
- Seismic arrestors to be added
- In design of superstructure, last page, calculation shows section is unsafe in ultimate shear.
- Wave pressure not considered in design of substructure and foundations. Wave pressure forces are also to be applied to the substructure and the foundations.
- Scouring effect not considered in design
- Spherical bearings to be adopted, as they have longer life and are more resistant to corrosion.
- Reinforcement bars with galvanising, to be used as project is located in a highly corrosive environment.
- Corrosion protection is required for saline environment.
- Sea Wall calculations are also required.

3.11.2 Bridges

- The points mentioned for Interchanges, also apply for the design of Bridges
- Considering the spans are not less than 30m neoprene bearings are to be avoided. Spherical bearings should be used.

3.11.3 Foot Over Bridges

- A more contemporary design should be adopted, considering the importance of the project and the city.
- For calculating wind loads, effect of hoardings to be considered.
- Wind loads to be as per IS 875.
- Working stress method has been used. This may be acceptable in preliminary design, in the final design, limit state method should be adopted.

Further for effective use of FOB by Commuter see section 2.4.3, Table 2-3.

3.12 Material Survey and Investigation

The DPR consultant has carried out material investigation for the project road and the report reference Note 8098/E/DN-07 titled "Material Investigation Report" is made available for review.

The search for bulk raw materials need to identify type, quality and quantity. Careful study of project requirements and the careful measurement of existing resources will be needed. Further special investigations may be needed in some cases.

Provisions must be made to search for existing resources and potential new sites and identify:

- Existing quarries and pits
- Potential new sites (land)
- Potential marine sites (dredging potential)
- Consideration of appropriate access routes to main sites
- Intermediate logistical corridors outside and within site area
- Studies for design options concerning lightweight fills, reinforced earth, and other design changes might be investigated.

Source of Material

The DPR consultant has identified the source of various materials and the same is presented in Volume III - Material Investigation Report.

The identified sources appears to be nearest to the project site. The availability of earth fill quantity required shall be verified at source and confirmed by the DPR Consultant.

Similarly the material report is silent on quality of reclamation fill available at various identified sources. It is also understood during discussion that the excavated muck from proposed tunnel as well as muck from metro line tunnel will be used for reclamation fill. At this stage this is very optimistic scenario. The execution of metro as well as coastal road needs to be planned accordingly to ensure fill material is available in time. Moreover the suitability of the material and logistics needs careful planning to avoid delays and cost overruns.

Alternative source shall be identified in case the work of both the project cannot be taken up simultaneously. This risk needs attention and monitoring to avoid cost overruns and project delay.

Observations

Our observations on the Material Investigation report are already submitted in Phase - I report.

3.13 Road Safety

The safety of road user is paramount while designing the road facility. Any fault in design and subsequent execution, if not properly mitigated may lead to serious potential accidents. The various hazards that may pose serious risk to road user needs to be identified and appropriately mitigated to minimise and control the risk.

The mitigation measures can be in the form of:

- a) Crash Barriers
- b) Road Signs
- c) Road Markings
- d) Highway Traffic Management System (HTMS)
- e) Education

Observations

Based on the available information from the DPR consultant and in the interest of safe traffic movement along the coastal road following suggestion / recommendation shall be taken into account along the coastal road and/or at all critical locations e.g. Interchanges etc.

1. HTMS Control System and continual monitoring with user information system (Variable Message Signs)
2. Traffic Safety Aid (Ambulance and Patrol Vehicle)

Pedestrian Circulation

The coastal road scheme will generate recreational spaces along the project road which is currently under threat. These open spaces shall attract public to enjoy the nature's beauty using the promenade facility provided along sea front.

The DPR consultant has proposed Bus bay/ Bus stops at Intermediate interval with Pedestrian bridges. However, the pedestrian circulation and segregation from the high speed facility is not provided in detail. The same shall be provided in the interest of ensuring safe movement of the pedestrian.

Road Signs and Marking

The proposed road sign and marking are reviewed based on the alignment scheme, traffic dispersal and safety of the road user. Our observations are already covered in Phase - I report submitted earlier.

3.14 Security

The DPR provided is silent on the security of the coastal road.

The security of the coastal road facility needs to be given top most priority. The facility needs to be properly secured in curbing any untoward incident that may happen in future. The plans and related documents of the same need to be provided so that the review can be made. These may comprise of the following but not limited to:

1. Variable Message Sign boards (VMS)
2. Ramp Metering systems, replete with Vehicle Detectors and linked to VMS system
3. Incident Detection and Management Systems

4. Communication System along with plan to deal with breakdown/ Disaster Management
5. Traffic Dispersal Management

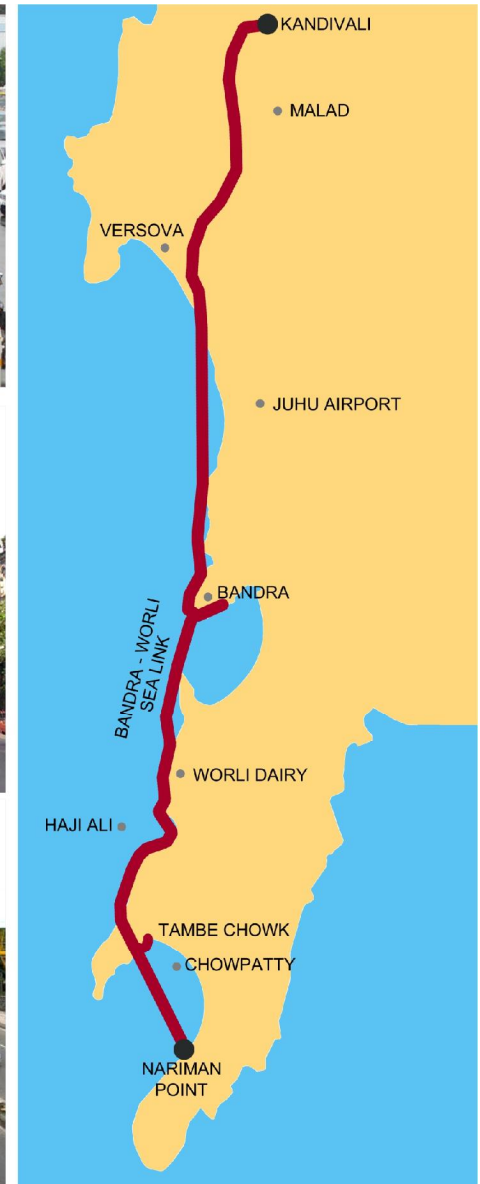
3.15 Summary of Key Issues - Alignment Studies

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
1	Topographic Surveys	Topo survey information is limited	Key features required at important locations are missed out (e.g. Sea bed levels, existing roads etc.).	The deficiency shall be covered by capturing the key features at all such locations
2	Typical Cross-section	Limited details shown	The provision of space for utility ducts / services, cross passage for tunnels required	The details shall be included.
3	Road Alignment	Section- 1, 6 and 7	There is scope for more Options of alignment in these sections.	The Options are suggested, which should be further explored and finalised accordingly.
4	Interchanges	Various arms considered	At some of the interchanges, arms for particular turning movement are not provided	Recommendations given at respective sections shall be considered.
5	Relaxation or Departure from Standards	Very limited or no information available	Relaxation or Departure are essential prior to freezing the alignment and need to be approved by Client	Approved List of relaxation / Departure from standard shall be produced and included in tender document.
6	Geometric Parameters (Main Alignment and Interchange)	Geometric details provided.	At few locations the geometric features do not conform to adopted standards. There is opportunity for improvement in geometry.	The geometry shall be improved to the extent possible.
7	Visibility (Main Alignment and Interchange)	No information on available/ achieved visibility	The facility is designed as high speed road and Visibility is of utmost importance for safe travel.	The achieved visibility shall be confirmed in view of safety of the road user

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
8	Traffic Dispersal	Substantial evaluation of Traffic movement not detailed out.	The requirement and capacity of the interchange ramps should be arrived at based on peak hour traffic. The DPR provides ADT information.	The DPR consultant shall substantiate the lane capacity and requirement based on peak hour flows
9	Tie-ins with existing network	Limited or no information provided.	Sufficient details are required at all tie-in locations with existing roads to ensure enough space is available for construction and dispersal.	Detailed cross sections shall be produced by DPR consultant at all such critical locations to ensure there are no constraint and congestion.
10	Road Signs and Markings	Typical details available	The signs are designed using IRC 67-2010. Detailed layout plans not available	Latest Sign code IRC 67-2012 shall be followed. Detailed layout plans shall be developed
11	Road Safety	Not identified in detail	Traffic Safety aid or HTMS needs to be provided. The pedestrian circulation and segregation from the high speed facility is not provided in detail.	The safety plan and document shall be provided in the interest of ensuring safe movement of the vehicles and pedestrians.
12	Security	No information provided	Security of the coastal road is an important element and needs effective planning	Incident information and management systems/ plans, communication plans and disaster management system shall be developed
13	Material Transportation	Sources are identified within transportation	Very limited information on transportation/ logistics. Both marine material and Road transportation networks identified but the impact of road and marine transportation on	A detailed logistic master plan is needed with careful planning at micro level to avoid delays and

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
		plan	existing Mumbai network is not evaluated in detail. This is an essential element to plan precisely the programme, logistics, delays, risks and cost.	cost overruns.
14	Conflict with Metro and Utilities	Not discussed in sufficient details	Site visits envisaged possible conflict with HT lines at Oshiwara and Malad Interchange. Similarly, access to Metro depot over Oshiwara Interchange (Pahadi Goregaon) and Kandivali Interchange needs to be coordinated with concerned authorities.	Proactive Coordination with relevant authorities is required to avoid execution delays.

RECLAMATION



4 RECLAMATION

4.1 Introduction

The Mumbai Coastal Road project lies directly adjacent to the Indian Ocean and is exposed to wind and waves emanating from the west between Nariman Point in the south and Versova beach in the north. To the north of Versova Beach the road moves inland passing through a tidal creek finishing in Link Road. Within the tidal creek the major influences are tidal and fluvial flows together with the presence of soft estuarine soils and mangroves. The coastal road runs through this area with much of the construction within the tidal creek and through mangroves.

STUP Consultants Pvt. Ltd. has prepared a Detailed Project Report (DPR) for the project and the objective of this section of the report is to summarise the findings of the Peer Review for the reclamation and coastal protection elements of the project. The activities within the peer review have included:

- Review of the DPR documents
- Site visits along the length of the project
- A gap analysis on the information supplied with the DPR
- Assessment of the technical options presented in the DPR
- Identification of potential risks to cost and programme
- Recommendations to mitigate the principal risks
- Assessment of the overall technical feasibility

4.2 General Definitions

Throughout this report, the term “Platform level” has been used to describe the final constructed level of land filled roads and the reclamation. The “Platform level” will be the surface on which road will be constructed. The term “crest level” refers to the top of the

bund protecting the periphery of the island. Both of these definitions are shown in Figure 4-1 .

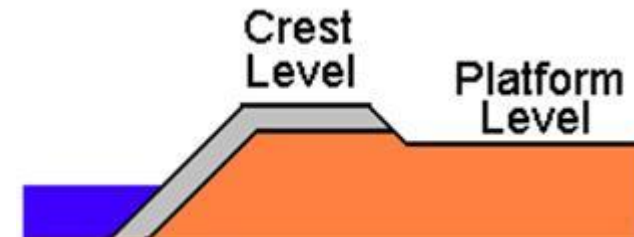


Figure 4-1 Definition of Levels



Figure 4-2 Malad Creek Adjacent to the Location of the Land Filled Road



Figure 4-3 Malad Creek

4.3 Contract Definitions

For the purposes of this report the following definitions have been used in this report:

- **Contract Data** – Information supplied with the Contract Package for the use of the Tenderer to prepare his tender. For example, this would include: bathymetric survey data; site investigation information and data on sources of materials. It should be noted that the Contract Data should be issued on the basis that it is the responsibility of the Tenderer/ Contractor to undertake his own investigations and that the Employer is not responsible for the accuracy or the interpretation of the information by the Contractor.
- **Design Requirements** – Information supplied with the Contract Package which specify the overall design requirements as a

Design and Build Contract. For example, this would include: geometrical requirements such as: the vertical and horizontal alignment of the roads; horizontal alignment and minimum crest levels for the shore protection. The Design Requirements should also include details associated with appropriate codes of practice, wave heights, design water levels, design return periods etc.

- **Performance Specification** – Specification defining the performance of the works. For example, this could include density requirements for the reclamation.
- **Materials Specification** – Specification of materials used within the works to ensure that materials incorporated within the works are durable and fit for purpose.
- **Employer's Requirements** - The Contract Package which includes: Contract Data, Design Requirements, Performance and Materials Specifications.

4.4 Reclamation sections in Phase II & Phase III

Reclamation works for phase II and III as per the draft DPR are as follows:

Table 4-1 Phase II & Phase III reclamation works in the draft DPR

Sr. No.	Reclamation Sections	Area (Ha)
	Phase II	
1	Jagannath Bhosale Marg Interchange(Tunnel entry)	7.94
2	Tambe Chowk (Tunnel entry)	6.28
3	Khar Danda Interchange(Tunnel entry)	4.0
4	Versova Interchange (Tunnel exit and land filled road up to RGIT)	4.0
	Phase III	
5.	Versova Interchange(land filled road in mangroves RGIT to Seven Bungalows)	6.6
6.	Land filled road in Malad Creek (Central Institute of Fisheries Education to Rajanpada)	47.55

In the peer review, alternative alignments involving reclamation are suggested. These are described in detail under section 3.6.2 and 3.6.4 and summarized below:

Table 4-2 Phase II- reclamation works in Peer Review Alternatives

Sr. No.	Location of Reclamation	Area (Ha)
1.	Jagannath Bhosale Road to Priyadarshini Park	
i	Nariman Point Post Office to Savitri Phule Girls Hostel (Landfilled Road-4000m length)	45.84
ii	Savitri Phule Girls Hostel to Start of Chowpati Beach (Tunnel entry/exit)	2.4
iii	Russian Consulate to Clinical Diagnostic Center (Tunnel exit/ entry)	2.4
2	Khar Danda to Versova (Landfilled Road -5670 m length)	88.63

The general comments and suggestions presented in Peer Review Phase I report are applicable for the reclamation works suggested above. These are discussed in ensuing sections with reference to Phase II & Phase III. Also, specific observations such as impact on existing beaches near reclamation/tunnels and flood risk due to reclamation in the Malad creek are discussed.

4.5 Marine and Fluvial Environment

4.5.1 General

Water level, flow and wave climate are critical factors in the design of the land filled roads and other structures within the Malad Creek. During periods where there are exceptionally high water levels and under high flows the coastal road must remain secure and stable at all times. Accordingly, the land filled roads must be designed to accommodate high tidal/ fluvial currents and locally generated waves; mitigate the risk of erosion and ensure that settlement/ consolidation does not adversely affect the road.

The five components associated with the design of the land filled roads are:

- * Astronomical tides
- * Storm surge
- * Fluvial flows within the Malad Creek
- * Climate change (sea level rise and increased fluvial flows)
- * Locally generated waves within the creek

4.5.2 Tides, Storm Surge, Fluvial Flows and Climate Change

Section 4.4.2 of the Phase 1 Peer Review report contains an assessment of the information presented in the DPR Report relating to astronomical tides, storm surge and climate change. It was concluded that the analysis presented by the DPR consultant was inconsistent and incorrect and this conclusion is equally applicable to the Phase 3 works within Malad Creek.

The construction of the road is within the floodplain of the tidal creek and it is anticipated that the mangroves on the flood plain are periodically inundated from tidal and / or fluvial flows. The Volume 1

Main Report (February 2015) contains no information on the influence of urban run-off and fluvial flows on the design of the works. Figure 4-4 has been extracted from Drawing 8098/E/DD-008 (R5) and this shows that width of the floodplain at the upstream end of the creek will be significantly reduced by the proposals. The presence of the embankment will reduce the capacity of the channel to convey fluvial flood water and this will increase water levels upstream during extreme events. This could lead to flooding of adjacent properties. This eventuality has not been considered in the DPR.

It is considered that a hydrological analysis in conjunction with hydraulic modelling would have provided design criteria (peak water levels, peak current velocities) for the design of land filled roads embankments, bridges and other structures within the creek. It would have also facilitated the assessment of scour (at abutments) and flooding. Aerial photography also indicates that the land filled road will cross a number of small tidal tributaries / creeks as highlighted in Figure 4-4. It is assumed that these smaller creeks will be culverted under the road.

An example of tidal inundation modelling is presented in Figure 4-5.

4.5.3 Wave Climate

The Volume 1 Main Report (February 2015) gives no information on the wave climate within Malad Creek. In this respect it should be recognised that locally generated waves within the creek could influence the platform levels for the road and the design of protection to the embankments. Wave fetches of over 1 km are feasible within the creek and it is expected that this could generate waves of sufficient height to require consideration of armouring.

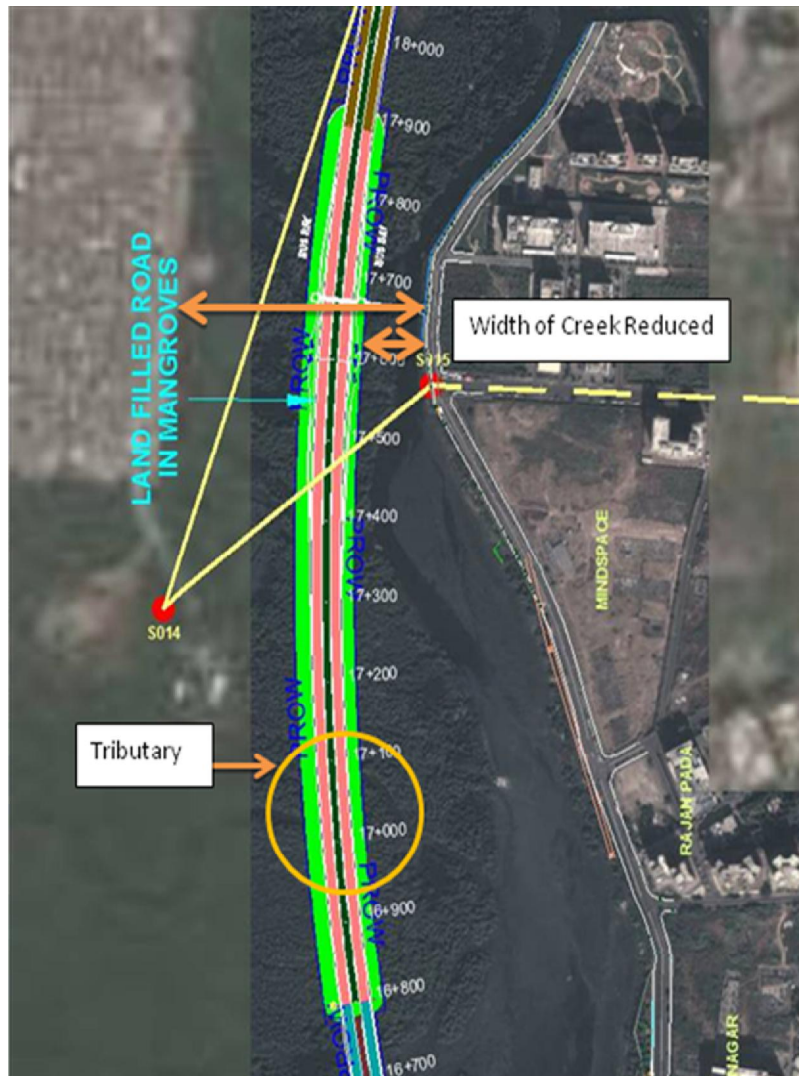


Figure 4-4 Malad Creek - Location

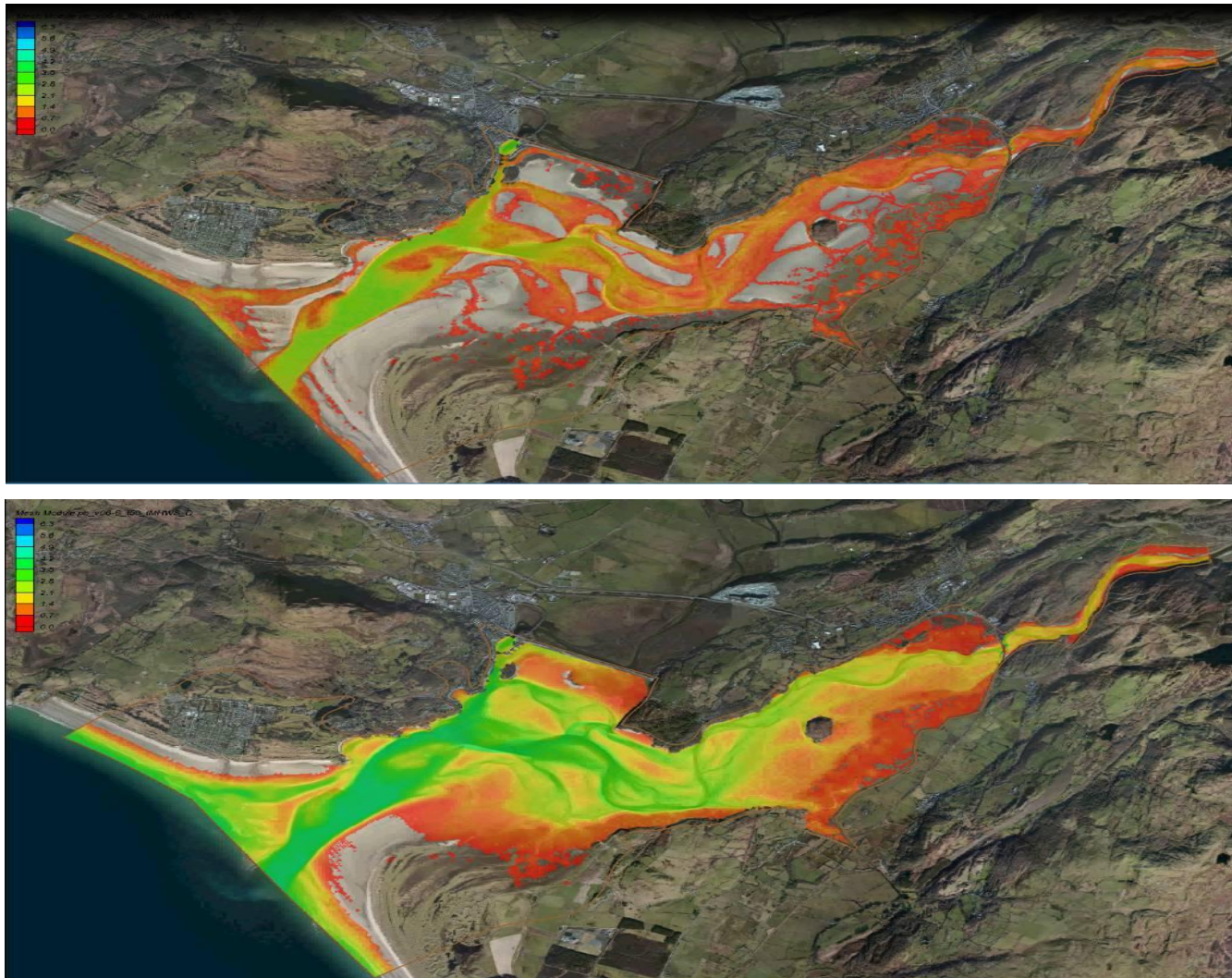


Figure 4-5 Tidal inundation modelling of the Dwryd Estuary in North Wales

Conclusions and Recommendations

The analysis presented in the Volume 1 - Main Report of Draft DPR and Appendix 5 is silent on matters relating to tidal, storm surge, wave climate and fluvial flows within Malad Creek. A formal Flood Risk Assessment supported by hydrological analysis and hydraulic modelling has not been prepared and there no specific information or analysis within the DPR to facilitate the design of the embankments and other structures within the document.

It is considered that these issues must be rectified and details included with the contract package. The maximum still water level (tides surge climate change and fluvial), peak velocities, significant wave height and wave period are key design parameters. Accordingly, it is recommended that:

- An extreme water level analysis of Maximum Annual Still Water Levels should be undertaken using available tide gauge data and fluvial modelling. Again this should be presented for a range of return periods including 1:5, 1:25, 1:50 and 1:100 year return periods and must incorporate climate change.
- The impact of the construction of the highway on fluvial flood levels should be investigated through hydrological analysis and hydraulic modeling.
- The locally generated wave climate within the creek should be evaluated to determine an up-to-date estimate of the significant wave height (Hs). This shall be presented for a range of return periods including 1:5, 1:25, 1:50 1:100 year return periods
- Minimum road level should be derived from the above analyses.
- This wave and fluvial analysis should be included in the contract package as Contract Data.
- The minimum crest and road levels derived from the analysis should be included within the Employer's Requirements as Design Requirements.

In relation to accommodating existing surface water infrastructure, tidal creeks, it is recommended that the Employer's Requirements incorporates the following:-

- The location of all existing outfalls, drainage ditches, tidal creeks and rivers which discharge into the sea. (Contract Data)
- The width, invert and soffit levels required for all of the above features so that flood water can be safely discharged in a 1 in 100 year or other agreed return period event. (Design Requirements)
- The vertical alignment of the highway to ensure that there is sufficient construction depth to accommodate drainage infrastructure and the highway. (Design Requirements)

The above work should be undertaken by a competent organisation and individuals who have suitable experience in the above techniques. The benefits of implementing these recommendations would include:

- Removal of uncertainty associated with the design requirements for shoreline protection
- Significant reduction in uncertainty at tender stage allowing Contractors to prepare accurate pre-tender designs
- More competitive tendering with all tenderers using the same baseline information
- Identification of all structures required to convey flood water through the reclamation and better identification of the scope of construction works
- Removal of uncertainty associated with the design requirements for shoreline protection
- Significant reduction in uncertainty at tender stage allowing Contractors to prepare accurate pre-tender designs

4.6 Bathymetric and Topographic Survey Data

The DPR consultant has supplied details of the bathymetric survey within the channels of the Malad Creek. This is understood to be subject to confidentiality agreements with the Indian Navy and it is not clear whether this information can be used within the tender package. A comparison between the survey and historical aerial photography (Google) indicates that there has been significant geomorphological change within the creek since the survey was undertaken in 2008. This includes movement in the position and size of channels. This is to be expected within a tidal creek over the period of seven years but this does mean that the bed levels shown on the chart may not be reliable. It should also be recognised that ongoing geomorphological change within the creek could have an impact on the design of the works.

The bathymetric survey does not include the survey levels on mangrove areas where the land filled roads will be constructed. Accordingly, there will be uncertainty in the volume of fill material required to construct the works. This will have an impact on the tender prices. Based on these observations it is recommended that the DPR consultant should procure a topographic or LiDAR survey at low tide which should include the mangrove areas. It is also considered that an up-to-date aerial photographic survey should be procured before construction commences.

4.7 Geotechnical Data

There is limited geotechnical information associated with the geotechnical conditions in Malad Creek. A number of boreholes have been sunk adjacent to the tidal creek and the borehole logs indicate that there is between 3.0m and 7.5m of silty clay overlying the basalt horizon. It is understood that none of the boreholes were undertaken over water or in the mangroves and it is expected that

soils within the tidal creek and under the mangroves will be less dense, weaker and more compressible. It is recommended that

- Geotechnical site investigation should be undertaken along the line of the road. An average frequency at one borehole per 300m has been recommended and this is not considered unreasonable for a project of this size. The site investigation should include in-situ and laboratory testing to determine the strength and compressibility of the silts and clays under the road alignment. Consideration should be given to the use of Cone Penetrometer Testing (CPT).
- The site investigation should be designed to be flexible so that borehole locations can be changed to allow particular locations to be explored in greater detail if required (e.g. soft spots).
- Results of the geotechnical site investigation should be included in the Employer's Requirements as Contract Data.

4.8 Materials

Sections 4.8 and 4.9 of the Phase 1 Peer Review Report contain an assessment of the information contained in the DPR Volume 1 Main Report and Appendix 5. The peer review includes discussions on the key materials which would be used to construct the works. This includes:

- Reclamation Fill / Fill for Land Filled Roads
- Rock Core Materials
- Rock Armour

The conclusions contained in Sections 4.8 and 4.9 and the recommendations made in the document are equally applicable to the Phase 3 work within the Malad Creek.

4.9 Logistics

Section 4.10 of the Phase 1 Peer Review Report contains an assessment on the constraints associated with the construction of the works. This includes:

- Marine delivery
- Overland Delivery
- Transfer of Materials within the site
- Plant
- Concrete Fabrication

The conclusions contained in Section 4.10 and the recommendations made in the document are equally applicable to the Phase 3 work within the Malad Creek.

4.10 Land Filled Road / Embankment Design

4.10.1 Introduction

The configuration and design of the works will ultimately be the responsibility of the Design and Build Contractor who will take a range of factors into account including:

- Mobilisation of marine plant
- Availability of plant and materials
- Access to the site for marine and land based plant
- The cost of transporting and placing bulk fill materials

4.10.2 Land Filled Road

The complexity of an embankment design increases substantially when the underlying materials contain: loose cohesionless soils; cohesive soils or soils with a high content of clay / silt. Settlement / consolidation of these soil types frequently require pre-loading or

the introduction of band / wick drains to accelerate consolidation / settlement.

These soil groups can require the use of more complex and expensive improvement techniques (e.g. pre-loading or band / wick drains) and these techniques can have a negative impact on programme due to the time required for consolidation. Based on the limited information given in on the borehole logs this is likely to be the case within the Malad Creek.

The DPR Main Report Appendix 5 makes reference to a number of improvement techniques including the use of wick / band drains, vibro-compaction, dynamic compaction and stone columns. The use of dynamic compaction methods should be excluded due to potential impacts on adjacent buildings. It is unlikely that vibro-compaction techniques will be possible due to the presence of silts and clays.

The Main Report and Appendix 5 of the DPR makes no reference to specification requirements associated with density, settlement and consolidation and this will be an important factor in the design. Accordingly, the development of a comprehensive Performance Specification taking into account the use of the reclamation as a highway is crucial. This should specify:

- Density requirements for fill above and below MHWS tidal levels
- Settlement/ consolidation requirements to ensure that settlements of the road are acceptable
- Monitoring requirements for density, settlement / consolidation

4.10.3 Conclusions and Recommendations

As noted in the introduction the Design and Build Contractor will be responsible for the design of the Land Filled Roads including the embankments. However, it is the duty of the DPR Consultant to prepare the Employer's Requirements which should include sufficient

information to allow the design to be developed and the works to be built. As noted previously this includes the: Contract Data; Design Requirements; Performance and Materials Specifications. It is recommended that the DPR Consultant should include the following information into the Employer's Requirements:

Contract Data

- Bathymetric and topographic survey including the mangrove areas
- Geotechnical site investigation within the tidal creek
- This extreme wave and water level analysis including consideration of potential increases in fluvial flood risk as a result of the constriction of the channel. This should be undertaken by a competent organization.
- The location of all existing outfalls, drainage ditches, tidal creeks and rivers which discharge into the sea.

Design Requirements

- The vertical and horizontal alignment of the highway to ensure that there is sufficient construction depth to accommodate drainage infrastructure and the highway
- The minimum road levels derived from the extreme wave and water level analysis taking into account tidal fluctuation, surge, climate change, fluvial flows, waves, and freeboard.
- The width, invert and soffit levels required for all existing outfall Malad creek tributaries.

Performance Specification

- Density requirements for fill material placed above and below MHWS tidal levels
- Settlement/ consolidation requirements to ensure that settlements of the embankments in relation to the design of the road are acceptable

- Monitoring requirements for density settlement / consolidation

Materials Specifications

- Materials Specification for the materials which are likely to be included in the Contractor's design to ensure that materials used in the embankments are durable and fit for purpose. This includes rock for armour / core and embankment fill.

It should be noted that this list is not exhaustive and should be carefully reviewed by the DPR Consultant. In addition, it is considered that there the Employer and DPR Consultant should design and implement monitoring systems to:

- Independently check and verify the designs to ensure that they meet international standards and are in accordance with the Employer's Requirements
- Validates that the construction work conforms to the design and the Employer's Requirements

4.11 Construction Methodology

4.11.1 General

The sections on Materials (Section 4.8), Logistics (Section 4.9) and Design of Land Filled Road / Embankment (Section 4.10) has included discussion on the construction of the works primarily because the construction methodology cannot be separated from the availability of suitable materials, the logistical constraints which will also dictate the design of the works. In addition, it must also be recognised that the Design and Build Contractor will dictate the construction methodology based upon the particular skills of the Contractor and the availability of plant at the Contractor's disposal.

Construction Methodology

The presence of soft clays and sands within the estuary will dictate the construction methodology and as noted previously it is likely that ground improvement works will be required to address settlement and consolidation of the underlying silts and clays. It is likely that this will include pre-loading or the installation of wick / band drains to accelerate the rate of settlement/ consolidation. Particular care should be taken to ensure that the methodology used to improve the silts and clays does not displace weaker materials laterally which would result in the formation of hard and soft areas along the road.

Conclusions and Recommendations

The construction of the land filled roads and embankments are feasible and within the capability of a local Contractor but it should be noted that the design and construction cannot be separated from the availability of suitable materials, the logistical constraints. In addition, it must also be recognised that the Design and Build Contractor will dictate the design and construction of the works based upon the particular skills of the Contractor and the availability of plant at the Contractor's disposal.

In addition it is recommended that:

- A water monitoring strategy is developed to ensure that pollution due to the discharge of fines into the sea is controlled during construction. This should include thresholds above which action should be taken to mitigate pollution events.

4.12 Impact on Existing Beaches**4.12.1 Chowpatty Beach**

In the DPR, reclamation is proposed adjacent to Chowpatty beach for development of Tambe Chowk interchange. Also a

suggested/alternative option in peer review study proposes a land filled road adjacent to marine drive and a tunnel under the beach.

The DPR report contains no reference to the sustainability of Chowpatty Beach or the impact of the reclamation and adjacent construction works on the beach. An inspection of historical mapping indicates that there has been a beach within Back Bay at Chowpatty since at least 1926. Back Bay is comparatively shallow and enclosed by the Malabar Hills to the north and rock outcrops / reclamation to the south. However, it is not known whether any nourishment has been carried out which has supplemented the beach in the past 100 years.

Nevertheless, it is highly likely that the beach and bay has been geomorphologically stable for many decades. In this respect "stable" means that there has been comparatively little net movement of beach sediments out of the bay either through cross-shore (offshore) or alongshore (littoral drift). Accordingly, the design and construction of reclamation works adjacent must be undertaken to mitigate adverse impacts to Chowpatty beach. Potentially this could include:-

1. Nourishment of the existing beach
2. Incorporation of non-reflective shore protection works to minimise changes to the wave energy within Back Bay which could result in erosion and alterations in plan form of the beach.

As noted above the DPR is silent on these matters and the Employer's Requirements will need to address these issues in detail. Failure to do so could result in adverse impacts to Chowpatty Beach.

4.12.2 Versova and Juhu beaches

The draft DPR proposes reclamation works as part of tunnel entries and interchange ramps adjacent to Versova and Juhu beaches.

Suggested/ alternate options in peer review propose tunnelling/ landfilled road adjacent to Juhu beach.

The draft DPR contains no reference to the sustainability of Versova and Juhu Beach or the impact of the adjacent construction works on the beach. An inspection of historical mapping indicates that there has been a beach within at Juhu since at least 1889 which is exposed to easterly waves from the Arabian Sea. The beach is bounded by Madh Island in the north and Danda Village Jetty to the south which forms the limits of the beach deposits.



Figure 4-6 Versova Beach

The Malad Creek provides a source of sediment to the northern end of the Versova beach but annual volume of recharge material provided through the creek is not known and may have reduced as a result of development of the hinterland. Versova and Juhu Beaches are divided by Kapas Wadi and aerial photography at the entrance to the Wadi implies that there is a slight dominance in littoral drift to the north and this is also reflected on the historical mapping for 1889. It is not known whether any beach nourishment has been

carried out to supplement either the Versova or Juhu beaches in the past 100 years. However, it is highly probable that development to the rear of Juhu Beach has encroached on the beach reducing the overall width.

The bathymetric survey indicates that the beach shoals at approximately 1 in 400 adjacent to the entrance to Malad Creek and 1 in 100 at the Novotel. Accordingly waves will break further offshore in the north on Versova Beach and Juhu Beach will be subject to more wave energy. Samples taken from the beach during the site inspection indicates that the beach is composed of calcareous shelly fragments, basalt and weathered breccia (see Figure 4-7). The grain size of the sample gives a D50 of approximately 0.3mm implying that the sediment is “potentially” highly mobile in most wave conditions.

Nevertheless, the historical mapping indicates that beach and bay has been relatively stable for decades. In this respect "stable" means that there has been comparatively little net movement of beach sediments out of the bay either through cross-shore (offshore) or alongshore (littoral drift).

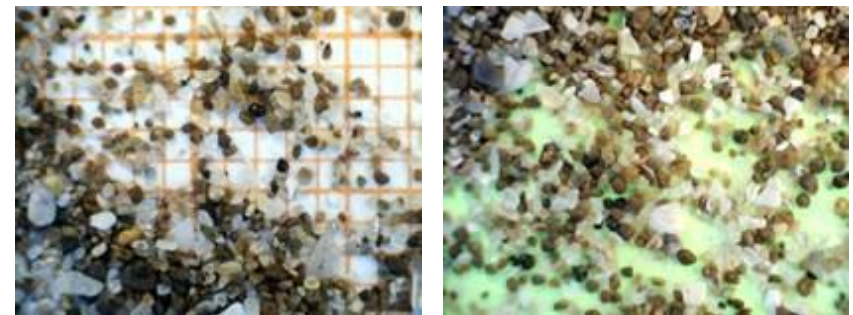


Figure 4-7 Beach Sediments Versova Beach

If alternative suggested in section 3.6.4 is selected by client, the construction of the tunnel along the periphery of the bay on the sea side of the beach will mean that a new beach will have to be created

in front of the road or the beach is lost and replaced by reclamation and shore protection. In relation to reclamation and shore protection reference should be made to the Phase 1 discussions in the report. The feasibility of creating a sustainable beach on the sea side of the beach will depend on a range of factors including:-

- Changes to existing geomorphological patterns of littoral drift associated with moving the beach into deeper water.
- Potential provision of groynes to control littoral drift
- Transition in beach cross section between the Versova and a realigned Juhu beach
- Availability of suitable beach sediment material with appropriate grading

It is recommended that a geomorphological / littoral drift modelling study is undertaken to assess the feasibility of moving the beach further offshore and to give an indication of beach slope and volumes. This will require the development of an inshore wave model which could be based on the existing wave modelling undertaken by the National Institute of Oceanography. The objective should be to demonstrate that the beach is sustainable in the long term.

As noted above the DPR is silent on these matters and the Employer's Requirements will need to address these issues in detail. Failure to do so could result in adverse impacts to Versova and Juhu Beaches.

4.13 Summary of Key Issues - Reclamation

The project is feasible but with many opportunities to significantly reduce the risks associated with large project. The key issues are tabulated below.

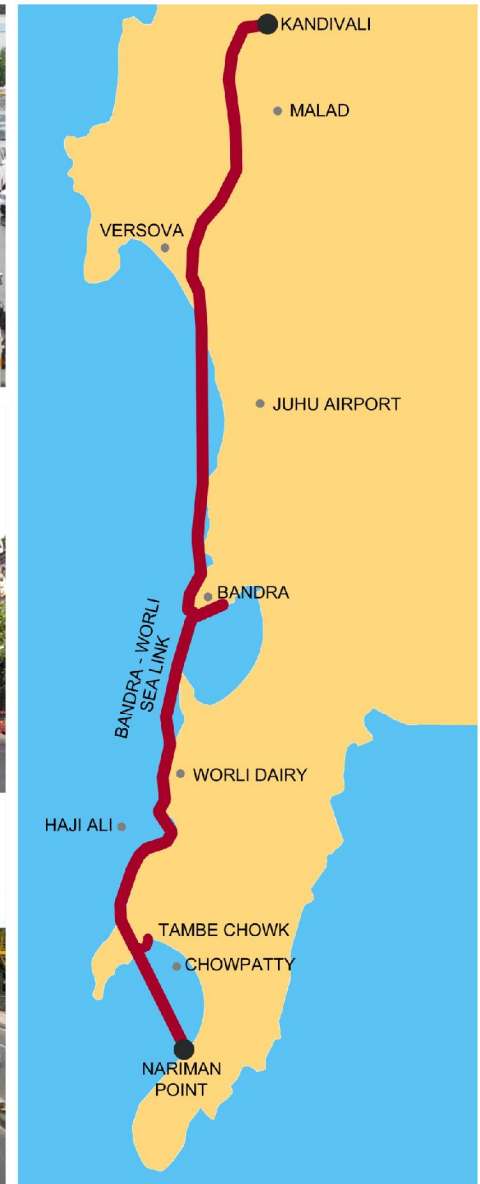
Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ suggestions
1	Marine and Fluvial Environment Water Level Fluctuation Wave Climate	The analysis relating to astronomical tides, storm surge and climate change are, in places, incorrect and inconsistent. No information on the influence of urban run-off and fluvial flows on the design of the works The Volume 1 Main Report (February 2015) gives no information on the wave climate within Malad Creek.	These deficiencies could potentially lead to a serious under design of the reclamation Width of the floodplain at the upstream end of the Malad creek will be significantly reduced by the embankment proposed. Capacity of the channel to convey fluvial flood water is reduced and may lead to flooding of adjacent properties. Locally generated waves within the creek could influence the platform levels for the road and the design of protection to the embankments.	It is recommended that the assessment of wave climate and water level fluctuation should be undertaken. Hydrological analysis in conjunction with hydraulic modelling is suggested in order to determine design criteria (peak water levels, peak current velocities) for the design of land filled roads, embankments, bridges and other structures within the creek. The same will also facilitate the assessment of scour (at abutments) and flooding. The locally generated wave climate within the creek should be evaluated to determine an up-to-date estimate of the significant wave height (Hs). Minimum road level should be derived from the above analyses - This wave and fluvial analysis should be included in the contract package as Contract Data - The minimum crest and road levels derived from the analysis should be included within the Employer's Requirements as Design Requirements.

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ suggestions
2	Adequacy of Bathymetric, Topographic Surveys Geotechnical Data	The DPR consultant has supplied details of the bathymetric survey within the channels of the Malad Creek. There is limited geotechnical information associated with the geotechnical conditions in Malad Creek. Boreholes indicate that there is between 3.0m and 7.5m of silty clay overlying the basalt horizon	A comparison between the survey and historical aerial photography (Google) indicates that there has been significant geomorphological change within the creek since the survey was undertaken in 2008. The bathymetric survey does not include the survey levels on mangrove areas where the land filled roads will be constructed. Accordingly, there will be uncertainty in the volume of fill material required to construct the works. This will have an impact on the tender prices. None of the boreholes were undertaken over water or in the mangroves which are expected to be less dense, weaker and more compressible	The DPR consultant should procure a topographic or LiDAR survey at low tide which should include the mangrove areas. An up-to-date aerial photographic survey should be procured before construction commences. Geotechnical site investigation should be undertaken along the line of the road with an average frequency of one borehole per 300m. Insitu and Laboratory tests should be carried out to determine strength and compressibility of soil samples. Consideration should be given to the use of Cone Penetrometer Testing (CPT). Results of the geotechnical site investigation should be included in the Employer's Requirements as Contract Data.
3	Materials Investigation Bulk Fill Material	Investigations are very limited. The Materials Investigation Report does not include information on the	There are significant shortfalls in material volumes identified in excess of any other use of spoil arising from MML3 and/or CR	As a matter of urgency, identify suitable resources conforming to appropriate material specifications and develop materials and performance specifications to remove

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ suggestions
	- Rock Products - Concrete	source or specification of rock materials.	Tunnelling etc. The availability of suitable reclamation materials within the immediate vicinity of Mumbai has not been conclusively proven within the Materials Investigation Report	uncertainty and ensure quality and durability of different materials to be used in the project.
4	Logistics - Overland Delivery - Marine Delivery - Transfer of materials within the site - Concrete Fabrication	Not identified as a significant constraint.	Logistics is a highly significant constraint given restrictions of land transportation and difficulties of marine operations keeping in mind the operational tidal window, approvals required. The DPR currently envisages that the reclamation works contracts are split linearly along the length of the project with the contracts including shore protection, reclamation, road and bridge construction but this may not be the most efficient contract strategy.	Logistics is highly influential factor on the construction methodology and the logistical constraints/limitations need to be investigated as soon as possible by a Project Master Plan. It is considered that there could be opportunities to improve the Project Master Plan to benefit the wider aims of the scheme and have a positive impact on cost and programme. This could include revising the contract strategy, to include enabling works and concrete fabrication.
5	Choice of type of design for Reclamation and related structures	The DPR is proposing specific methodologies and techniques which in some cases are inappropriate. The DPR makes no reference to the information and data to be supplied to the Contractor through the Employer's Requirements.	The Design and Build Contractor will be responsible for the design of the Shore Protection Works and the Reclamation. The Design and Build Contractor will take a range of factors into account including: Mobilisation of marine plant	In order to be able to prepare a competitive tender The Employer's Requirements should include sufficient information to allow the design to be developed and the works to be built. This includes: - Contract Data; - Design Requirements - Performance Specifications

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ suggestions
			• Availability of plant / materials • Access for marine and land based plant • The cost of transportation • The cost of fabrication	• Materials Specifications. It is considered that there the Employer implement monitoring systems to: • Independently check and verify the designs to ensure the requirements specified. • Validate the construction work
6	Construction • Shore Protection Works • Reclamation	There is very little information in the DPR in relation to possible construction methodologies. There is no information on the controls to be placed on the Contractor during construction. This includes: noise, water and air quality requirements.	The construction of the reclamation is feasible and within the capability of a large International Dredging Contractor but it should be noted that the design and construction cannot be separated from the availability of suitable materials and the logistical constraints. It must be recognised that the Design and Build Contractor will dictate the design and construction of the reclamation based upon the particular skills of the Contractor and the availability of plant at the Contractor's disposal.	it is recommended that the Project Master Plan is reviewed to consider the advantages and disadvantages of: • Splitting the contract both horizontally and vertically to separate the reclamation from the bridgeworks, tunnel and road contractors. • Creating a Pre-Cast Concrete Fabrication Yard to provide concrete products to the whole of the works • The construction of a materials handling jetty/ causeway for the delivery of bulk products to the works. Water, air and noise pollution strategies should be developed for the works.
7	Programme/ Critical Path	Not discussed in sufficient detail	Need to consider overall contract programme (irrespective of different construction packages)	Consider optimum selection of single or multiple package options and identify critical path

TUNNEL DESIGN



5 TUNNEL DESIGN

5.1 Introduction

The Peer Review Report - Phase I submitted on 17th February 2016 examined the adequacy of studies carried out and tunneling methodology suggested by the DPR consultant.

The complexity of the project was pointed out as well as the fact that geotechnical and logistical considerations are the major drivers for the project. Issues which must be addressed were highlighted in the report. There were no tunnel sections in Phase I. Comments on Tunnel sections for Phase II & III are presented in this chapter.

5.2 Tunnel Sections in Phase II & III

5.2.1 Tunnel Sections in Phase II

The tunnel sections for phase II are as follows for the alignment from Jagannath Bhosale Road to Priya Darshini Park:

Table 5-1 Tunnel Sections for Phase II

Sr. No.	Alignment Option	Tunnel section	Length (m)
1	Option 1&2	Oberoi Tower to Nepean Sea road	5200
2	Option 3	Walkeshwar to Russian Consulate	1200
3	Option 4	Oberoi Tower to Russian Consulate	5000
4.	Option 5 & 6	NCPA to Nepean Sea Road	4400

Sr. No.	Alignment Option	Tunnel section	Length (m)
5.	Suggested New Option	Chowpatty Beach to Russian Consulate	2200

The suggested option is explained in 3.6.2 (Figure 5-1)



Figure 5-1 Suggested Alignment Option for Jagannath Bhosale Road to Priya Darshini Park

Tambe Chowk Connectivity

The alternatives to connect Tambe Chowk to the Coastal road at Priyadarshini Park are explained in 3.8.3. The alignment proposed using the existing road named 1st Lane beside the Kilachand Garden which directly leads to the foot of Malabar hill. Tunnelling through Malabar hill and coming out at the reclamation near Amarson garden

interchange is suggested. Though, this will require acquisition of single or few buildings the alignment makes the best usage of current topography. The existing Junction will need some major improvements to provide the proper access to the tunnel. Since this junction is prominently used by VVIPs a strategic planning and traffic management is the essence during execution. It is also acknowledged that acquisition at this place can be major social issue inviting resistance from the people and public representatives. However, savings in terms of cost will be much higher than the cost that will be incurred for rehabilitation and resettlement.



Figure 5-2 Tambe Chowk connectivity- Road leading to Malabar Hill

5.2.2 Tunnel Sections in Phase III

Various tunnel options were explored by JTC and the DPR consultant for the section between Juhu Sea Side Garden and Versova in Phase III. Details of these may be referred at 3.6.3. The selected option in the draft DPR is a marine tunnel from Khar Danda to Versova. The peer review explored three alternatives for this as explained in section 3.6.4:

Alternative I – Sea bridge (elevated)

Alternative II – Reclamation along beach line

Alternative III – Cut and Cover Tunnel

Alternative III is a cut and cover tunnel from Khar Danda to Versova (Length- 5670m) passing close to the beach line (Figure 5-3). The existing beach shall be restored at the same place. The alternative is ranked no 2 among the three.

It is perceived that the public objections to this proposal owing to impact on the existing beach might not be as severe as that of Alternative-II. The construction can be phased in such manner that sufficient length of beach is maintained for public use at all the times during construction.

This alignment will avoid undersea tunnel and a sea bridge. The Interchange layout as proposed in DPR can still be retained with minor modifications.



Figure 5-3 Suggested Alignment Option (Alternative III) for Juhu sea side to Versova

The merits and demerits of these alignments are detailed in the chapter on alignment options. However, it is imperative that the risks and concerns brought out in the earlier report are addressed before decisions on tunnel options and design are taken. A brief summary of the issues is presented herein.

5.3 Adequacy of Tunnelling Surveys

Various Surveys have been identified in the DPR. Limited number of surveys have been carried out to date

Additional surveys will be required to ensure that the contract is devised and executed with the minimum of uncertainties and the minimum of programme and cost impacts.

5.3.1 Bathymetric and Topographic Survey Data including geophysical investigations

Need for establishing survey controls, methodology and tools for bathymetric & topographic survey were explained.

5.3.2 Land and Marine Geotechnical Data

Need for a common base plan and survey controls for land and marine geotechnical data was highlighted. Type and extent (location, spacing and depth) of Ground investigation and rock study required to be carried out for roads, structures and tunnels were prescribed. Need for hydrological and pumping tests were highlighted.

Comments on Ground investigation are as follows:

- **Ground Investigations for Roads:** As per international standards boreholes are to be taken to a depth till rock head which is generally up to 3m depth (below rock). A number of specific issues must be addressed in specifications.
- **Ground Investigations for Structures:** Structures require investigation at every principal point of ground loading. Spacing at 200m is likely to be insufficient. Furthermore, they must be investigated and studied not less than 3D depth below (D being a principal dimension, usually footing width) and generally 3m into, to prove, rock head, whichever is greatest. The spacing may be relaxed in cases where adjacent bore holes show the anticipated geology.
- **Ground Investigations for Tunnels:** Both rock (and soil) materials and masses must be assessed in rigorous and internationally accepted logging schemes supplemented by necessary laboratory and field tests and further by characterizations for rock mass assessments and for tunnel design schemes. In all cases, as qualitative and semi-quantifiable systems, it is common practice to apply multiple schemes and then to compare and contrast the results of each one. Considerable boring and coring to provide samples for inspection and testing will be required both from land and overwater locations.

- Spacing of holes should be as close as possible since the least risk (cost) is associated with knowledge; and underwater the knowledge is essential. However practical limits may allow engineers to widen separations in areas where the geology is seen to be regular and known. Again, on the basis that confidence is high for good geological interpretation the spacing may be relaxed so long as adjacent holes do show the anticipated geology.

These investigations too should follow the basic parameters of scale, namely a reach of several diameters away from the structures; above, below and sideways. These stated guides will influence survey control needs.

Lacking at this stage from the DPR is a thorough assessment of the materials to be excavated and how these might perform in various schemes of excavation. a range of material classes can already be studied, e.g. Basalt, Tuff, Breccia as three principle material. Such tables of information will provide a better picture of potential works and may influence alignment choices as well as excavation system.

5.4 Tunnelling Methodology & type of design

The DPR is proposing specific methodologies, techniques without geotechnical basis. Alternative methodologies should not be excluded by the tender process. Execute detailed geotechnical investigations to ensure selection of optimal methodology. Methodologies/ techniques need to be rigorously justified based on available evidence, clearly stated preferences, or based on facts obtained in the study to date.

A number of options may be applied to tunnel excavation selection. The choice is largely one of preference and a convincing argument

from contractors to excavate as required. The Table 5-2 below describes a series of options for construction. These challenges are entirely optional. A good deal depends upon the choice of the contractor and preferences of the client. The following tunnelling methodologies compared:

- 1 Tunnel Boring Machine (TBM)
- 2 Road Header (RH)
- 3 Drill and Blast(D&B)
- 4 Combination of Road Header (RH+D&B)

The main criteria for selection refer to flexibility of use, the impact on design, the scale of essential working areas (which will have to be provided in advance) and the nature of construction process (segmental / non segmental lining).

Although efficient, a TBM has huge demands on space and materials supply in the form of lining segments. Other systems have much reduced land take and lining is generally pumped (i.e. cast in situ shutters) or sprayed (i.e. shotcrete) alongside other flexible systems of rock support. This flexibility might allow, for instance, entrance portals to be placed between existing properties, a few hundred meters from the coast and hence a shorter route and less obtrusive to existing infrastructure. Although some properties may be affected, such a scheme would be cheaper and shorter.

Table 5-2 Challenge Issues relating to Chosen Tunnelling Technique

Site Specific issue/ Technical Aspect	TBM (Tunnel Boring Machine)	RH (Road-Header)	D&B (Drill and Blast)	Combined RH & DB	Associated techniques, Notes, Warnings
Coastal, inter-tidal Marine environment risk	VL complex track access and train configuration	L Portal protection 'gates'	L Portal protection 'gates'	L Portal protection 'gates'	± for all techniques Water levels (MHWL) anticipated at or close to invert level
Scale of Work Site Areas (outside of tunnel portal)	VL As long as TBM train; very long; erection (cavern) area; reduce after starting	S Sufficient for Road-Header, Haulers/ Loaders	S Sufficient for Jumbo, Haulers/ Loaders	S Sufficient for wheeled equipment	TBM train typically very long and requires all train systems of marshaling and loading, unloading. RH and D&B typically wheeled systems and mobile and flexible support and loading
Construction supplies; Rock Support; emergency systems; Power supplies	VL pre-cast segment requires construction yards; storage areas; Concrete supply areas; high power supply	M small yards; small maintenance areas; Concrete-shotcrete supply areas; diesel / electric	M small yards; small maintenance areas; Concrete-shotcrete supply areas explosive stores (offshore?) diesel / electric	M small yards; small maintenance areas; Concrete-shotcrete supply areas explosive stores (offshore?) diesel / electric	Large and aligned sites are required for TBM systems. Small and dispersed sites can be utilized in RH and D&B systems, flexible and pumped into casts or sprayed shotcrete

Site Specific issue/ Technical Aspect	TBM (Tunnel Boring Machine)	RH (Road-Header)	D&B (Drill and Blast)	Combined RH & DB	Associated techniques, Notes, Warnings
excavation related stress; support demands	M Low stress due to circular cut; some over-space	S Optimized stress; no over-space	S Optimized stress; no over-space	S Can be Optimized no over-space	TBM yields circular opening; good for stress distribution but may involve considerable over cut for need. Others can cut to optimum for stress or need as required.
Spoil handling and disposal	L	M	S	S	TBM is semi continuous system of spoil delivery requires secondary handling or continuous disposal to dump. Other systems are cyclic
Excavation, probing and support risks	VL	M	S	S	Experience and likelihood of ground failure, or, inability to probe or handle surprise conditions
Construction contractor experience	VL	M	VL	VL	Good experiences in civil infrastructure for TBM and D&B RH is typically more mining related experiences

Site Specific issue/ Technical Aspect	TBM (Tunnel Boring Machine)	RH (Road-Header)	D&B (Drill and Blast)	Combined RH & DB	Associated techniques, Notes, Warnings
Recovery Risk	VL	M	M	S	Ability to handle unforeseen conditions. Because of flexibility of systems all eventualities of emergency support or treatments are possible or can be handled
Emergency access risks	VL	M	VS	S	TBM provides closed and tight machinery; others have open spaces and relatively free access
Pre-construction surveys, and, vibration monitoring	M	M	VL	L	Pre-construction surveys needed in all options not under sea

NOTES:

*D&B likely required for portals and cross-tunnels

*Explosives require special permissions

VL – Very Large; Very High

L– Large; High

M– medium; moderate

S– Small; Low

VS– Very Small; Very Low

5.5 Materials Investigation

A full scale materials investigation was recommended considering the huge scale of filling requirement from Marine sources transported through marine transport routes.

Provisions must be made to search for existing resources and potential new sites and identify:

- Existing quarries and pits
- Potential new sites (land)
- Potential marine sites (dredging potential)
- Consideration of appropriate access routes to main sites
- Intermediate logistical corridors outside and within site area
- Studies for design options concerning lightweight fills, reinforced earth, and other design changes might be investigated.

5.6 Logistics

The project is only feasible when the logistics can solve the movement of materials for reclamation filling; shoreline protection construction; road construction; and, tunnel disposal. Given the crowded streets of Mumbai already at capacity, road access is not considered a feasible option except in emergency situations when traffic may have to be disrupted.

The entire design of the project will come from marine operations and will therefore require associated priming works. Jetties, harbour and quay walls may be necessary to facilitate the contractors operational plans and for the execution options of other road parts.

The possibility of making use of tunnel spoil (muck) as reclamation fill is unlikely. The production rate and reliability of tunnel spoil is unlikely to be high enough for major filling operations.

5.7 Marine Environment and Tunnelling

There is a greater perceived risk from flooding due to storm water and ground water surge in marine tunneling which may lead to stability issues and other difficulties. Protection measures must be prepared, practiced and available at all times.

A further difference in land and marine sites may arise from the possible use of ancillary systems reaching from surface such as probing, investigation boreholes, grouting holes and ventilation shafts. These items may be costlier in the marine environment. The consequences of these limitations are various and many but they must not be ignored or avoided.

The marine or coastal environment can also provide opportunities for material supply and for spoil disposal should a tunnel heading be close to the sea.

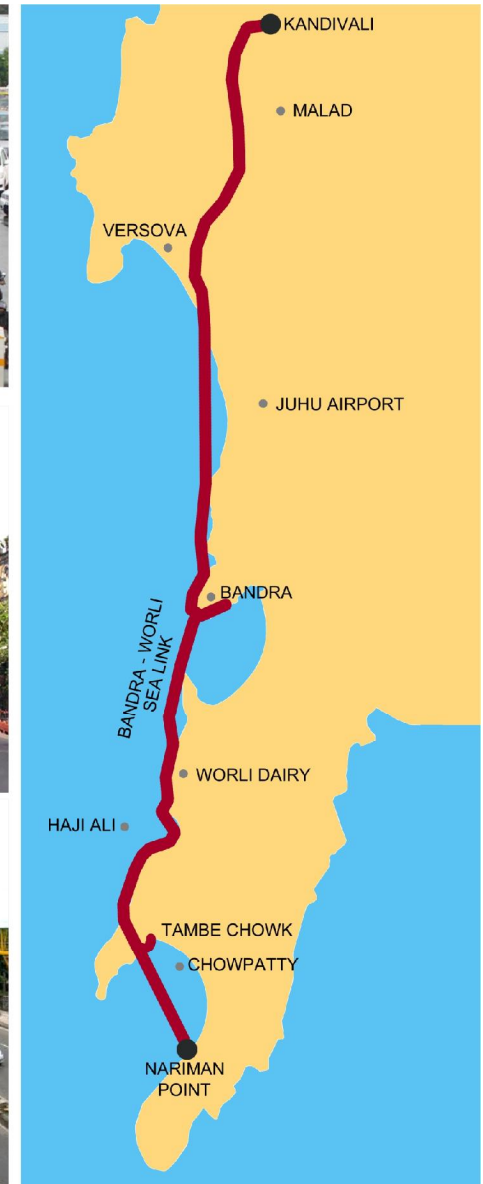
Given the precise details of project which will involve considerable reclamation, a secondary use may be made of berthing and/or off-loading facilities in relation to tunneling works. Furthermore, opportunities might arise to export spoil as fill, reuse locally, or, to use it in some constructive marine endeavor.

5.8 Summary of Key issues - Tunnelling

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
1	Adequacy of Tunnelling Surveys	Various Surveys have been identified in the DPR.	Limited number of surveys carried out to date	Additional surveys will be required to ensure that the contract is devised and executed with the minimum of uncertainties and the minimum of programme and cost impacts.
2	Choice of type of design for each section-Tunnel	The DPR is proposing specific methodologies, techniques	The tunnelling methods are prescriptive.	Methodologies/techniques need to be rigorously justified based on available evidence, clearly stated preferences, or based on facts obtained in the study to date.
3	Materials Investigation	Investigations are very limited.	There are significant shortfall in material volumes identified in excess of any other use of spoil arising from MML3 and/or CR Tunnelling etc.	As a matter of urgency, identify suitable resources conforming to appropriate specifications
4	Logistics	Not identified as a significant constraint	Logistic will define this project. Logistics is a highly significant constraint given restrictions of land transportation and tunnel disposals.	Logistics is highly influential factor on the construction methodology and the logistical constraints/limitations need to be investigated as soon as possible by a Project Master Plan Consideration of an enabling contracts to front load the works
5	Tunnelling Methodology	Prescriptive Methodology without geotechnical basis	Alternative methodologies should not be excluded by the tender process	Execute detailed geotechnical investigations to ensure selection of optimal methodology

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
6	Programme/Critical Path	Not discussed in sufficient detail	Need to consider overall contract programme (irrespective of different construction packages). Lack of sufficient information for bidding purpose.	Consider optimum selection of single or multiple package options and identify critical path Sufficient details for designer and contractor shall be included to warrant competitive pricings.
7	Safety and Security	Not discussed in sufficient detail	The safety and security of the coastal road including tunnel facility is paramount.	Safety and security related documents and plans required.

ENVIRONMENTAL IMPACT ASSESSMENT



6 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Introduction

The Mumbai Coastal Road project is proposed to be constructed on a combination of road based on reclamation, bridges, elevated roads and tunnels on western side of Mumbai and has largely been debated because of its impact on the cultural heritage in the project area, along with environmental impacts due to the reclamation of land along the coast.

This section is divided in seven main areas:

- Methodology adopted for review of EIA and SIA Reports
- Adequacy of reported Baseline Environmental data
- Sufficiency of Regulatory and Institutional Regime
- Identification of Impacts
- Impact mitigation and enhancement measures
- Adequacy of Environmental Management Action Plan
- Continuous public consultation and participation

Each area is discussed in the following sub-headings:

6.2 Methodology Adopted for Review of EIA and SIA Reports

6.2.1 Environmental Impact Assessment

The Environmental review verifies the natural setting of the project zone, the appropriateness of the collected baseline data, proper identification of the anticipated environmental impact and adequacy of mitigation measures to minimize the adverse impacts. The prevailing institutional and legislative setup of the Government of

India (GOI) has been followed. The review also takes into account the mechanism for ensuring effective implementation of the environmental safeguard measures at different stages of the project.

Institutional responsibilities for the implementation of the suggested management plan have also been identified as part of this task.

The EIA Notification 2006 and its subsequent amendments issued in 2009, 2011 and 2013, IRC: 104-1988, "Guidelines for Environmental Impact Assessment of Highway projects, MoEF & CC publication 2010 "Environmental Impact Assessment Guidance Manual for Highways and Guidelines on preparation and implementation of Environment Management plan (IRC:SP:108-2015) had been referred.

6.2.2 Social Impact Assessment

The Social Impact assessment will be reviewed in the light of RFCTLARRA. The Government of India has brought in to force a new Act viz., the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013" (RFCTLARRA) with effect from 1-1-2014. Section 103 of the said Act provides that it shall be in addition to and not in derogation of any other law for time being in force and that Section 107 provides that the Act shall not prevent any State from enacting any law to enhance or add to the entitlements enumerated under the said Act which confers higher compensation than payable: and made provisions for R&R which is more beneficial than benefits under the RFCTLARRA Act-2013.

It will be also review that through the public consultation the project ensures that the affected population and other stakeholders are Informed, consulted, and allowed to participate actively in the development process. Consultation has been carried out in ways appropriate for gender-based and other differences among the stakeholders. The findings of consultations have been incorporated

in the design of the proposed alignment of the project section and were included in the mitigation measures suggested.

That during implementation and monitoring stage, information will be disseminated to project affected persons and other key stakeholders in appropriate ways. This information will be prepared in Hindi and Marathi/local languages as required, describing the main project features including the entitlement framework. It will ensure the following:

- a. That the vulnerable groups, (disabled, elderly persons, women and children, indigenous peoples) have been identified and shall be given additional support and assistance under the project;
- b. All common property resources (CPR) lost due to the project will be reconstructed or compensated by the project;
- c. Information related to the preparation and implementation of resettlement plan will be disclosed to all stakeholders and people's participation will be ensured in planning and implementation;
- d. Appropriate grievance Redressal mechanism will be established at project and state levels to ensure speedy resolution of disputes;
- e. An effective monitoring and evaluation mechanism will be established to ensure consistent implementation of resettlement activities planned under the project including third party monitoring.

6.3 Adequacy of Reported Baseline Environmental and Social Data

The base line description/ data collection should take into account the existing and proposed developments in the area so that cumulative impacts can be assessed.

A Land use map of the study area drawn to a scale of 1: 25,000 based on recent satellite imagery delineating the crop lands (both single and double crop), agricultural plantations, fallow lands, waste lands, water bodies, built-up areas, forest area and other surface features such as railway tracks, ports, airports, roads, and major industries etc. have not been incorporated in the report(also a requirement of EIA report as per Standard TOR issued by ministry in April-2015), followed by ground truthing and also through secondary data sources.

A detailed ground surveyed map on 1:2000 scale showing the existing features falling within the right of way namely trees, structures including archeological & religious, monuments etc. if any should be attached in the EIA Report along with the NOC from the Archeological Department (if the structure falls between 100m to 300m from the edge of the road).

The nearest IMD meteorological station from which climatological data have been obtained has not been mentioned.

Water resources discussed under climatic conditions needs to be discussed elsewhere.

For EIA studies the monitoring period is generally for a season in this report monitoring has been conducted for a month only. As per TOR air quality monitoring should be carried out as per the new notification issued on 16th November, 2009.

The Social demography has other components like, scheduled castes, scheduled tribes, religion, literacy rate, languages spoken etc., which has not been mentioned in the report.

6.4 Sufficiency of Regulatory and Institutional Regime

The proposed project does not completely fulfill either of the criteria described for Category A or B, i.e. the proposed alignment is a coastal road which is 34.56 km (less than 100km) and it is not a national/state highway (As per the EIA Notification of MoEF & CC issued on 14th September, 2006, and its subsequent amendments (2009, 2013) a National or State highway development or expansion projects fall in either Category A or B of the schedule of the notification). Hence, there is no need of obtaining Environment Clearance from Ministry of Environment and Forests (MoEF) for which an EIA/EMP study is a primary requirement. However, the proposed alignment passes through coastal regulation zone (CRZ) as per the Coastal Zone Management Plans (hereafter referred to as the CZMPs) of Mumbai and Navi Mumbai. Hence application for approval from Maharashtra Coastal Regulation Zone Management Authority (MCZMA) and MoEF was put with a request for amendment to Coastal Regulation Zone (CRZ) notification, 2011.

The Union Ministry of Environment and Forests (MoEF) issued a final notification to allow reclamation for a coastal road. On 30th December 2015 the project has been granted clearance for constructing coastal road on 150 ha of reclaimed land and also diversifying the mangroves forest for non-forestry purposes.

6.4.1 Additional Applicable Regulations

Some of the Environmental Legislation Applicable and not mentioned in the EIA document of DPR consultant are mentioned below:

- a. Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013;
- b. Central Motor Vehicle Act, 1988;

- c. The Right to Information Act, 2005;
- d. The Flyash Notification, 2008 as Trombay Tata Power plant is 12km away from project site;
- e. Hazardous Wastes (Management and Handling) Rules, 1989;
- f. Public liability and Insurance Act, 1991;
- g. Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996;
- h. Mines and minerals (Regulation and Development) Act 1957 as amended in 1972;
- i. The Building and Other Construction Workers (Regulation of Employment and conditions of Service) Act 1996;

During the construction stage, some of the key statutory requirements that need to be obtained by the Contractor as part of mobilization (pre-construction) have been listed in the table given below, needs to be mentioned in the EIA Report.

Table 6-1 Statutory Clearances to be obtained by the Contractor

Sr. No.	Clearance Required for	Statute under which clearance is required	Statutory Authority
1	Hot mix plants, Crushers and Batch Mix Plants	Air (Prevention and Control of Pollution) Act, 1981 and Noise Pollution (Regulation and Control) Rules, 2000	State Pollution Control Board
2	Storage, handling and transport of hazardous materials	Hazardous Waste (Management and Handling) Rules, 1989 and Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989	State Pollution Control Board
3	Location/ layout of workers camp, equipment and storage yards	Environment Protection Act, 1986 and Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989	State Pollution Control Board
4	Quarries (in case of opening of new quarries)	Environment Protection Act, 1986	Dept. of Mining; Concerned District Administration
5	Discharges from Labor Camp	Water (Prevention and Control of Pollution) Act, 1974	State Pollution Control Board
6	Permission for withdrawal of groundwater for construction	Environment Protection Act, 1986	State Ground Water Board
7	Permission for sand mining from river bed	Environment Protection Act, 1986	Irrigation Department; Concerned District Administration
8	Disposal of bituminous wastes	Hazardous Waste (Management and Handling) Rules, 1989	As per state norm/Local Civic Body
9	Tree felling permission	Indian Forest (Conservation) Act, 1980	Maharashtra State Forest Department, MoEF & CC
10	Permission to store Hazardous Materials	Waste Management and Handling Act 1989	State Pollution Control Board

Sr. No.	Clearance Required for	Statute under which clearance is required	Statutory Authority
11	Storage of Explosive Materials	The Explosive Act (& Rules) 1884, 1983	Chief Controller of explosives, Petroleum & Explosive Safety Organization

6.4.2 Other Applicable Laws

Environmental issues during road construction stage generally involve equity, safety and public health issues. The road construction agencies require complying with laws of the land, which include inter alia, the following:

- a. Workmen's Compensation Act 1923: The Act provides for compensation in case of injury by accident arising out of and during the course of employment;
- b. Contract Labour (Regulation and Abolition) Act, 1970: The Act provides for certain welfare measures to be provided by the contractor to contract labour;
- c. Minimum Wages Act, 1948: The employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act;
- d. Payment of Wages Act, 1936: It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers;
- e. Equal Remuneration Act, 1979: The Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees;
- f. Child Labour (Prohibition and Regulation) Act, 1986: The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labour is prohibited in Building and Construction Industry;
- g. Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979: The inter-state migrant workers, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home to the establishment and back, etc.;
- h. The Factories Act, 1948: The Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours and rendering information-regarding accidents or dangerous occurrences to designated authorities;
- i. Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996: The Rules provide for mandatory preparation of On-Site Emergency Plans by the industry and Off-Site Plans by the district collector and the constitution of four tier crisis groups at the centre, district, and local levels for the management of chemical disaster.

In addition, the methods of measuring air pollution should be in conformance with IS: 5182-1977 and in case of noise pollution, IS: 3028-1980 for measurement of noise emitted by moving road vehicles; IS: 4758-1968 for measurement of noise emitted by machines; IS: 10399-1982 for measurement of noise emitted by stationary road vehicles are to be followed. As regards Highway aesthetics, use of provisions made in IRC: SP: 21-1979 - Manual on Landscaping of roads and its subsequent revised versions are to be followed. Some other references include the Indian Roads Congress (IRC) Guidance note on Highways, May 2011 and Guidelines on preparation and implementation of Environment management plan (IRC:SP:108-2015) are to be referred.

6.5 Identification of Similar Stretches

For the sake of convenience and similarity of the sections the Environmental and social impacts due to the development activities are considered in two phases, namely:

Phase II Consists of:

1. Jagannath Bhosale Road to Priya Darshini Park including Tambe Chowk connectivity(Southern Tunnel)
2. Khar Danda (Carter Road) to Versova(Northern Tunnel)

Phase III Consists of:

1. Versova (Seven Bungalows) to Institute of Fisheries(Areas not requiring forest clearance) (Madh Island interchange)
2. Institute of Fisheries to Kandivali Junction(areas requiring forest clearance)

6.6 Identification of Impacts

6.6.1 Impact on Biodiversity

The impacts due to the construction of Southern and Northern Tunnels (Phase II) will be most significant during construction phase of the project.

- Construction activities will disturb and diminish the surface and sub surface flora and fauna
- Impacts on Flamingo
- Impacts on Benthos in Mudflat area
- The ecological imbalance of the microorganism will also affect the other lifecycles associated with them
- Restoration of the same will take a long time

In Phase III major impact of construction will be on humans and on community resources as (in non-Forest areas) they will be displaced and will require relocation. 15 species of Mangrove will be affected and 3.0 ha of reserve forest land will be diverted for non-forestry purposes. The project proponent has applied for Forest clearance, and has obtained the Permission for the same. Adequate management plan are to be imposed to mitigate the adverse impact of the same.

6.6.2 Impact on Coast Line

The coast line will be impacted significantly at the entry and exit of the Southern and Northern tunnel (Phase II) and this will be a permanent change indirectly impacting the biodiversity of the local area. Phase III will not impact on coast line however due to

reclamation of land of the forest area the hydro-dynamics of the area will be changed.

6.6.3 Impact on Physical Environment

Details of sand quarry, borrow area and their rehabilitation is not included in the EIA report prepared by DPR consultant.

In Phase II, Prediction of noise levels should be done by using mathematical modeling at different representative locations and especially within the two tunnels. Points of resonance and heightened vibrations should be studied for underground tunnels so that adequate mitigation can be done of the same.

Prediction of impact on ambient air quality within the tunnel shall be carried out using appropriate mathematical model, description of model, input requirement and reference of derivation, distribution of major pollutants and presentation in tabular form for easy interpretation.

Details of water quantity required and source of water including water requirement during the construction stage with supporting data and also categorization of ground water based on the CGWB classification is not given in the report.

Construction activities & deforestation of mangrove (Phase III) for land reclamation will generate greenhouse gases such as CO₂. At the same time, operation of construction machines and construction activities generate the CO₂. Post construction greenhouse gas may increase by the increase in traffic. Hence all the components participating in climatic change need stringent mitigative measures.

6.6.4 Impact on Social Environment

The Social Impact assessment for Phase II and Phase III is missing in the report.

The final alignment has been frozen based on technical and environmental feasibility only, social impact assessment report on different alternatives and its comparative cost benefit analysis (based upon number of persons displaced, affected, Community property relocated) is lacking. In Phase III especially in non-forest areas a detailed social impact assessment is required along with suitable rehabilitation and resettlement implementation plans.

6.7 Impact Mitigation and Enhancement Measures

Separate Environmental and rehabilitation enhancement plans are to be developed for Phase II and Phase III. The environmental enhancement measures are intended to provide value addition to the proposed project.

6.8 Adequacy of Environmental Management Action Plan

Management plan for (Phase III) reclamation area, coastal protection and soil erosion and sediment management should be formulated along with suitable enhancement measures.

Risk analysis and contingency planning for Phase II shall be included.

Management plan for follow-up environmental monitoring, environmental recovery plan for closedown or abandonment shall be prepared.

6.9 Continuous Public Consultation and Participation

The public consultation shall be conducted for both the phases and included in the report. The social impact assessment due to the proposed construction of road, tunnels, details of the properties, houses, businesses religious and social places etc. activities likely to be affected by land acquisition and their financial losses annually, are not given(Phase III non forest areas).

Detailed R&R plan with data on the existing socio-economic status of the population in the study area and broad plan for resettlement of the displaced population, site for the resettlement colony, alternative livelihood concerns/employment and rehabilitation of the displaced people, civil and housing amenities being offered, etc and the schedule of the implementation of the project specific R&R plan are not given.

The EMP implementation cost is not included in the report.

6.10 Conclusions and Recommendations

The developmental activities will significantly impact during the construction period of the project on both the Phases i.e. Phase II and III. The recovery of the same will take time.

In phase II, Air, water and noise environment during construction of tunnel and during operation has to be critically studied with the help of mathematical modelling and suitable mitigation measures are to be suggested and monitored for implementation as per the prevailing regulatory regime of the state and of nation.

In Phase III in non-forest areas, project will displace and impact large number of families, who are to be continuously consulted, resettled and rehabilitated by their consent. A suitable R&R plan is to be devised for them and common property resources are to be

relocated with the consent of the local authorities. Plan for Social forestry is also to be designed and implemented. For the diverted forest areas and plantation, compensatory afforestation has to be done as per the forest department norms. Mangrove rehabilitation and enhancement plan is to be devised to minimize the adverse impact of deforestation.

Detailed R&R plan and the EMP implementation cost shall be included in the report.

Guidelines on preparation and implementation of Environment management plan (IRC:SP:108-2015) should be referred for a fool proof EMP.

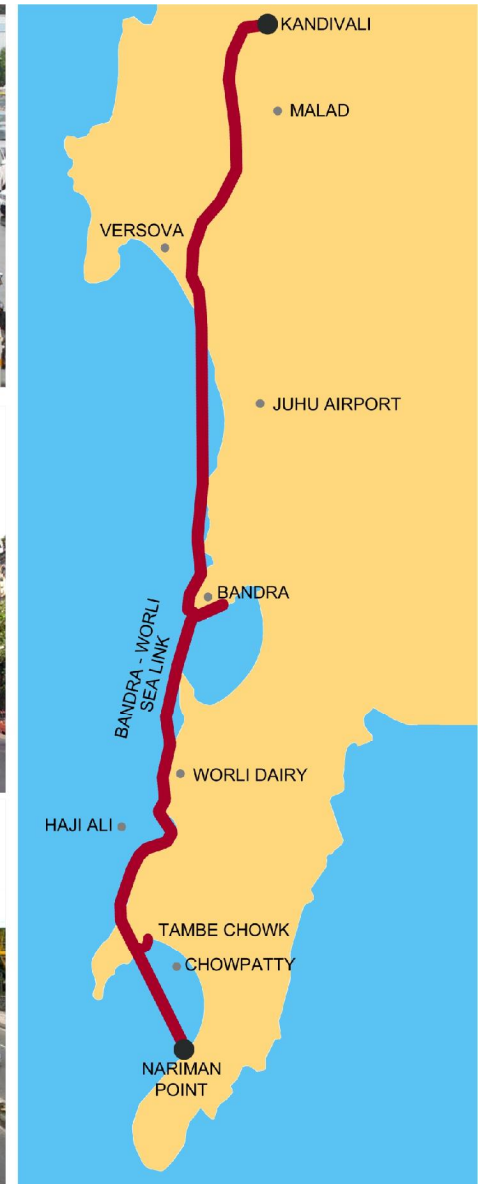
Table 6-2 Key Issues of EIA & SIA

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
1	Erosion and Sedimentation	Very little is discussed in DPR	Land Reclamation may increase erosion and sedimentation	Mitigation and enhancement measures are to be incorporated for both aspects
2	Topography Flood plains/ coastal belt	Not discussed	Topography near the entry and exit of tunnels will change (Phase II) Land use pattern in Phase III will also change for both the forest and non-Forest areas	Mitigation and enhancement measures for minimizing the adverse Impacts and enhancement measures are to be incorporated in the report
3	Vulnerability to subsidence, in Reclaimed zone	Not discussed	Information based on secondary source may be furnished	Mitigation and enhancement measures are to be incorporated
4	Materials Availability	Inadequate	Quantity of Natural resources required for the project should be detailed out	Carbon Foot prints are to be calculated from the same for Phase II and III
Climate, Air Quality and Noise				
1	Micro-climate Change, Global Warming, accelerated sea level rise (due to potential global warming climate effects), seawater intrusion, flooding, lithoral transport	Not discussed	Mitigation and enhancement measures are to be suggested for the same	Impacts of construction on climate change need to be incorporated especially for Phase III for diverting the forest area of 3.0 Ha
2	Air Dispersion Model, Noise Impact from Traffic	Not discussed	Ground level Contours of CO, HC and PM ₁₀ and PM _{2.5} are to be studied	Mathematical modelling is Suggested especially for Phase II

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
Coastal Hydrodynamics				
1	Hydrodynamic simulations, Impacts on current flow trends and velocities	Not discussed	Observations on requirement of related studies are given in Chapter 4	Mitigation and enhancement measures are to be suggested for construction period, especially for Phase III
2	Impacts on current flow trends and velocities	Not discussed	Observations on requirement of related studies are given in Chapter 4	Mitigation and enhancement measures are to be suggested for the same for Phase II, near entry and exit of the tunnels
3	Impact on long term shoreline changes	Not discussed	Observations on requirement of related studies are given in Chapter 4	Mitigation and enhancement measures are to be suggested for the same
Hydrology				
1	River sediment spreading and settlement	Not discussed	Observations on requirement of related studies are given in Chapter 4	Mitigation and enhancement measures are to be suggested for the same for Phase III in location of forest diversion and also for Phase II, near entry and exit of the tunnels
2	Tidal Flushing	Not discussed	Observations on requirement of related studies are given in Chapter 4	Mitigation and enhancement measures are to be suggested for the same especially for Phase II
Biological System				
1	Habitat Damage	Not discussed	The same can be included in biodiversity report for Phase II and III	Mitigation and enhancement measures are to be suggested for the same

Sr. No.	Issue	DPR	Peer Review observation	Recommendations/ Suggestions
2	Drainage interceptor (Drainage and streams for biological communities)	Not discussed	The same can be included in biodiversity report for Phase II and III	Mitigation and enhancement measures are to be suggested for the same
3	Migratory route/crossing of wild animals and birds (outside designated protected areas)	Not discussed	The same can be reviewed from secondary sources and addressed for Phase III in mangrove area	Mitigation and enhancement measures are to be suggested for the same
Socio- Economic Systems				
1	Land use Change/ Settlements	Not discussed	The same can be reviewed from secondary sources for Phase II and III	Mitigation and enhancement measures are to be suggested for the same
2	Drinking water sources	Not discussed	The same can be reviewed from secondary sources for Phase III for non-forest areas	Mitigation and enhancement measures are to be suggested for the same
3	Demographic change	Not discussed	The same can be reviewed from secondary sources for Phase III for non-forest areas	Mitigation and enhancement measures are to be suggested for the same
4	Livelihood of those who are dependent on the sea resources (fishermen and tourism operators)	Not discussed	The same can be reviewed from secondary sources for Phase II and III	Mitigation and enhancement measures are to be suggested for the same

CONSTRUCTION COST ESTIMATES



7 CONSTRUCTION COST ESTIMATES

The DPR consultant has submitted Draft Project Report Volume-V, Cost Estimate & Rate Analysis (South & North) Note No. 8098/E/DN-09 Rev. No. (R1) dated 24/02/2015 for Mumbai Coastal Road Project. The document has been reviewed and the comments are already submitted under Phase I report.