मुंबई महानगर प्रदेश विकास प्राधिकरण
MUMBAI METROPOLITAN REGION
DEVELOPMENT AUTHORITY

No. ED/MTHL/CRZ/MCZMA/2015

Engineering Division
Dt. 06-11-2015

To
The Chairman
Maharashtra Coastal Zone Management Authority,
Environment Department, Room No. 217 (Annex)
Mantralaya, Mumbai - 400 032

Sub : Mumbai Trans Harbour Link (MTHL) project -
- Submission of Rapid EIA report & CZMPs

Madam,

The Mumbai Trans Harbour Link (MTHL) project has been granted CRZ clearance by the MoEF&CC, Govt. of India on 19th July 2013.

An appeal (Appeal No. 4/2013) was filed in the National Green Tribunal (West Zonal Bench) challenging the CRZ clearance granted to the project. The National Green Tribunal (West Zonal Bench) has recently passed an order (Dt. 15th Oct. 2015) in this matter (copy is enclosed)

In the order, the NGT has directed the MoEF&CC to consider the CRZ clearance application afresh as per the CRZ notification, particularly in view of issues related to applicability of Environmental Clearance (EC) Regulations 2006 for various issues raised in the appeal within 8 weeks from the passing of the above order.

Accordingly, the CZMPs (1:4000 scale) prepared by the Institute of Remote Sensing, Chennai and the EIA report prepared earlier has been updated with respect to the revised CZMPs.

The Coastal Zone Management Plans (CZMPs) (1:4000 scale) and the rapid EIA report revised based on the CZMPs are enclosed herewith. It is requested to consider the proposal for in the meeting of the MCZMA.

As the MoEF&CC has to respond to the NGT's orders in 8 weeks from the date of the order, it is requested to scrutinize the submission and expeditiously forward the proposal with recommendation to the MoEF&CC for approval.

Thanking you,

Yours faithfully

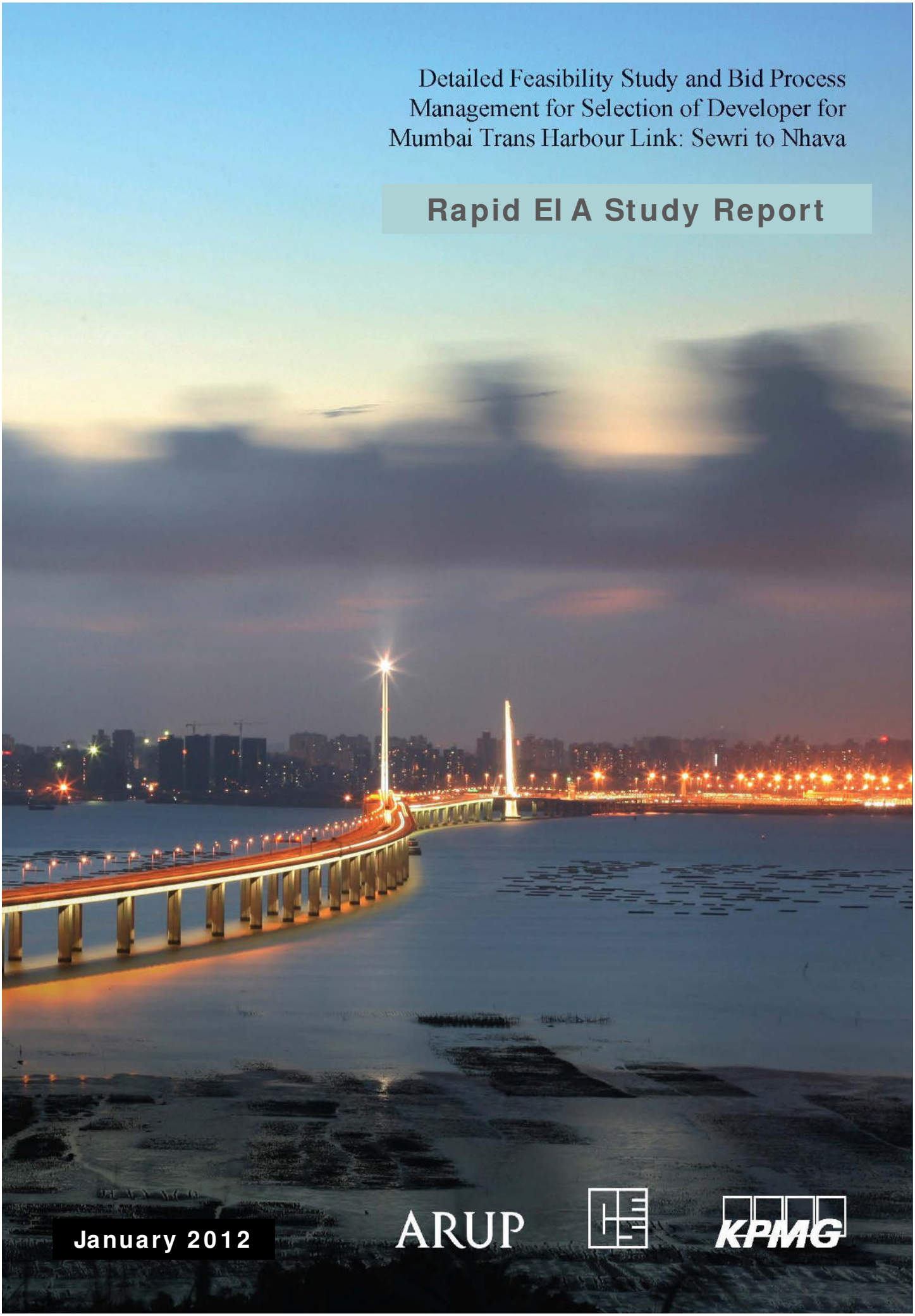
Encl : 1. Copy of NGT order
2. Rapid EIA report including form 1 & Executive summary
3. CZMPs (1:4000 scale)
4. A note on MTHL project

(Sanjay Khandare, IAS)
Additional Metropolitan Commissioner-II

वांद्रे-कुर्ला संकुल, वांद्रे (पूर्व), मुंबई - ४०० ०५१. कार्यालय : २६५९ १२३४ • इपीएबीएक्स : २६५९ ०००१/४०००.
फॅक्स : २६५९ १११२ / २६५९ १२६४ • वेब साईट : http://www.mmrda.maharashtra.gov.in

Detailed Feasibility Study and Bid Process Management for Selection of Developer for Mumbai Trans Harbour Link: Sewri to Nhava

Rapid EIA Study Report



January 2012

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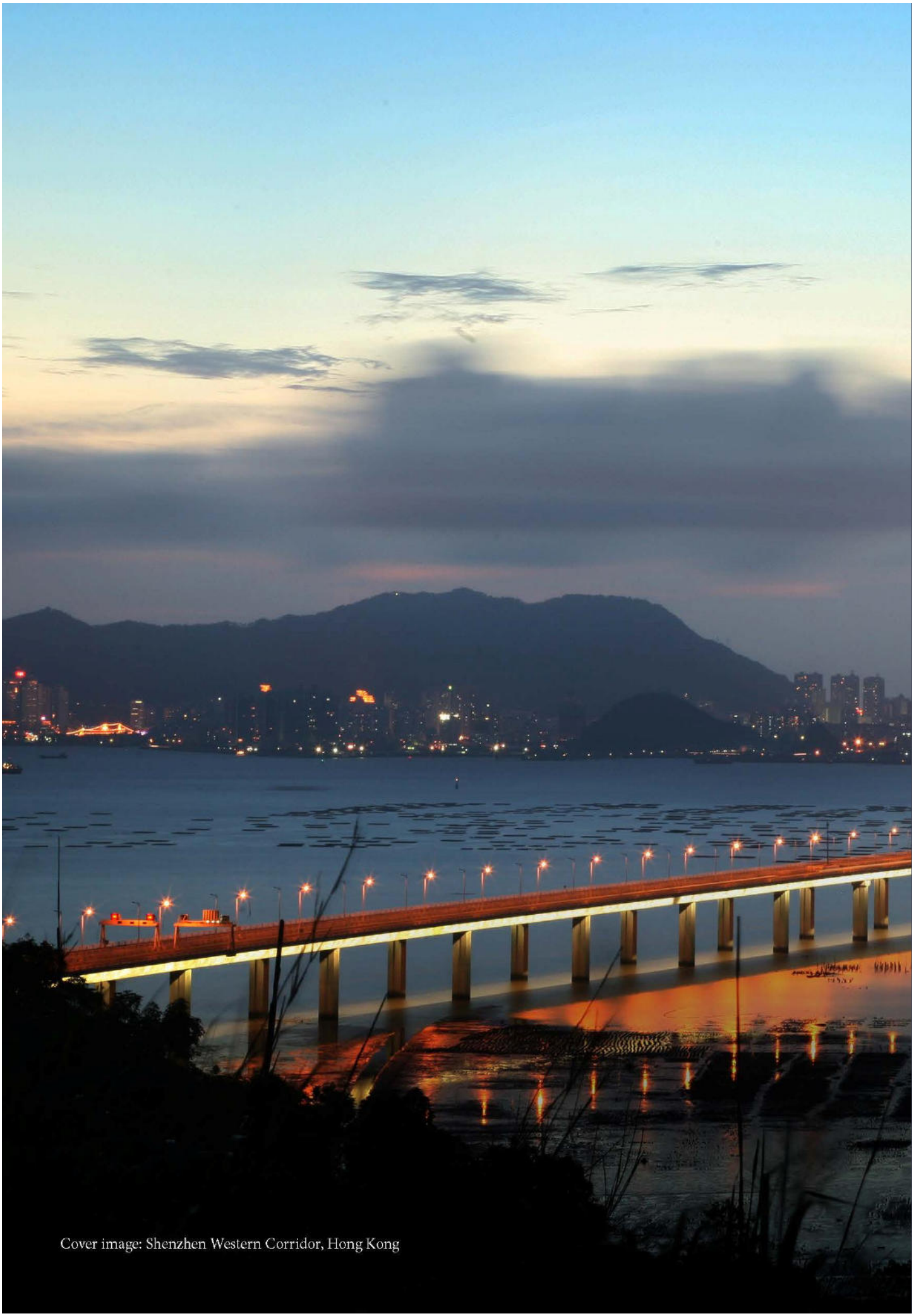

Cover image: Shenzhen Western Corridor, Hong Kong

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Annexure – I : CRZ clearance to the project 19th July 2015

Annexure I

Checklist for Submission of Application for prior CRZ Clearance under CRZ Notification, 2011
General Instructions for Submission of Application for CRZ Clearance to MCZMA:

(1) Please do not write on the checklist.
(2) PART-A of the application form is applicable for all projects. Project Proponent is required to fill submit the application to concerned planning authorities such as Municipal Corporation, Municipal Councils, District Collector through Town Planning for the rest of the rural area, MHADA / SRA/MMRDA / CIDCO etc. as per the details indicated in the checklist.
(3) PART-B of the application covering all the detailed information, maps indicated in the check-list should be completed/ developed by concerned planning authority and send to MCZMA for prior CRZ recommendation/clearance.
(4) Concerned planning authority should submit applications to MCZMA along with PART-A & PART-B with detailed information on the points covered in it along with its remarks on the proposed project/ activity.

PART-A
(To be submitted by Project proponent to Planning Authority)

			Particulars	Page No.
1			Executive Summary of the project	Enclosed
2			Duly filled Form I as per annexure IV of CRZ Notification 2011(Compulsory for all Projects)	Enclosed
3			Whether proposed project covered under EIA Notification 2006	No
	a		If yes, duly filled Form I & IA (As per provision 4(i)(d) and 4(ii)(a) of CRZ Notification, 2011)	NA
	b		CRZ maps indicating HTL & LTL demarcated by one of the authorized agency in 1:4000 scale (as per para (2) of CRZ Notification, 2011)/ on the approved CZMP of the area showing the site under consideration	Yes
4			**Introduction of the Project/ Background information indicating following:**	Chapter 1
		i	Identification of the project & project proponent , landownership indicating CTS No./ Survey Nos. etc.	Chapter 2
		ii	Brief description of nature of the project with details including, Layout Plan, Building Floor Plan etc.	Chapter 2
		iii	Need for the project & its importance	Chapter 1
		iv	Demand supply gap or information on similar projects in the region	Chapter 2
5		i	Location of the project showing general location, specific location, Project boundary, project site approved layout with coordinates from competent Authority	Chapter 2
		ii	Details of the alternative sites considered from environmental point of view	Chapter 2
6			**Site Analysis**	
		i	Area of the project site (in sq. m.)	Total length of the Sea Link=22km with 6 lane
		ii	Connectivity	Interchanges at Sewri in Mumbai and Shivaji Nagar & Chirle in Navi Mumbai
		iii	Land form, land use, Land ownership	Out of 22km, 16.5km is through the creek and remaining on the land on Mumbai and Navi Mumbai side
		iv	Topography (along with map)	Enclosed
		v	Existing land use pattern (agriculture, non- agriculture, forest, water bodies shortest distances from the periphery of the project to periphery of the forest, national park, wild life sanctuary, eco-sensitive area, water bodies (distance from the HFL of the river). In case of notified industrial area, a copy of the Gazette notification should be given	The proposed sea link passes through the CRZ areas in the creek between Mumbai & Navi Mumbai

			Particulars	Page No.
		vi	Social Infrastructure available	NA
7			**Planning Brief**	
		i	Planning concept (type of industries, facilities, transportation etc) Town & Country planning/ Development Authority Classification.	Road infrastructure project
		ii	Population projection	NA
		iii	Land use planning (breakup along with green belt etc)	NA
		iv	Assessment of Infrastructure Demand (Physical & Social)	NA
		v	Amenities/ Facilities (existing & proposed)	NA
		vi	Proposed use	NA
		vii	FSI proposed to be consumed	NA
		viii	Whether lift, lobby, staircase etc. are claimed free of FSI & if so whether they are permissible (if so mention the provision of DCR)	NA
8			**Proposed Infrastructure**	
		i	Industrial area (Processing Area)	NA
		ii	Residential Area (Non processing Area)	NA
		iii	Green Belt/ Afforestation details	NA
		iv	Social Infrastructure	NA
		v	Connectivity (Traffic &Transportation Road/ Rail/ Metro/Water ways etc)	Road transportation (Trans Harbour Link)
		vi	Drinking Water Management (Source & supply of Water)	NA
		vii	Sewerage System	NA
		viii	Industrial Waste Management	NA
		ix	Solid Waste Management	NA
		x	Power requirement & Supply/ Source	NA
9			**Rehabilitation & Resettlement (R& R) Plan**	
		i	Policy to be adopted (central/ state) in respect of the project affected persons including home oustees, land oustees & landless laborers (a brief outline to be given)	As per the applicable policy of the State Govt.
		ii	Proposed detailed action plan for mangroves re-plantation (if any)	As stipulated by the Forest Authorities
10			**Project Schedule & Cost Estimates**	
		i	Likely date of start of construction & likely date of completion (Time schedule for the project to be given)	Project likely to start by November 2016 Construction period about 5 years
		ii	Estimated project cost along with analysis in terms of economic viability of the project	Rs. 8,800 Crore (April 2012) Rs. 11,370 Crore (2016)
		iii	Share holding of the developer	
		iv	Share holding of the state government	
11			**Analysis of proposal (Final Recommendations)**	
		i	Environmental cost benefit analysis including financial & social benefits with special emphasis on the benefit to the local people including tribal population, if any, in the area	Chapter 6
12		i	Rapid EIA report including marine & terrestrial component except for construction projects listed under 4 (c), 4(d) of CRZ Notification, 2011. (Not applicable for building proposal)	Report Enclosed
		ii	Comprehensive EIA with cumulative studies for projects in the stretches classified as low & medium eroding by MoEF based on scientific studies & in consultation with the State Governments and Union Territory Administration (as per provision of 4.2 (c) of CRZ Notification, 2011) (Not applicable for building proposal)	NA
		iii	Disaster Management Report , Risk Assessment Report & Management Plan (As per provision of 4.2 (d) of CRZ Notification, 2011)	Chapter 6
		iv	Photographs & Google images of the site indicating existing status & location of the site	Enclosed in the report
		v	CRZ map indicating HTL and LTL and CRZ classification by one of the authorized agencies by MoEF in 1:4000 scales and project	Enclosed

			Particulars	Page No.
			layout superimposed on the above map of CZMP (As per provision 4.2 (e) and (f) of CRZ Notification, 2011)	
		vi	The CRZ map normally covering 7 km radius around the project (for ports, harbours, jetties, infrastructure projects) (as per provision 4.2 (g) of CRZ Notification, 2011)	Enclosed
		vii	NOC from MPCB for projects involving significant discharge of effluents, solid wastes, sewage and the like (As per provision 4.2 (i) of CRZ Notification, 2011)	Not required being a road project
13			**Attached following No Objection Certificates (if applicable)**	
		i	Heritage Conservation	Clearance given by Archeological Survey of India
		ii	State Ground Water Board	NA
		iii	Maharashtra Pollution Control Board	NA
		iv	High Court	NA
		v	Maritime board	Clearance given by MMB
		vi	Port Trust	NA
		vii	Civil Aviation	NA
		viii	High Rise Committee	NA
			Applicable for SRA/ Cessed/ Dilapidated/ Unsafe Building	
14			Undertaking of the Project proponent for the development through Slum Rehabilitation Scheme along with the state Government to ensure that all legally regularized tenants are provided houses in situ or as per norms laid down by the State Government in this regard (as per the provision of 8 (V) (2) (iii) of CRZ Notification, 2011)	NA
15			Undertaking of the Project proponent to agree to be covered under the Right to Information Act 2005 (as per the provision 8 (V) (c) (d) (v) of CRZ Notification, 2011)	NA
16			Public consultation Report (As per provision 8 (v) (4) of CRZ Notification, 2011)	NA
17			Stake of the State Govt. or its parastatal entities (which should not be less that 51%) in the project (As per provision 8(V)(1)(ii)(b)(2)(i) of CRZ Notification, 2011)	NA
18			Any other information relevant to the proposal	NA

Declaration

I hereby declare that the information mentioned above is true to the best of my knowledge. I fully understand that any information furnished above, if proved incorrect or false will render me liable for any penal action or other consequences as may be prescribed in law or otherwise warranted. Further I hereby state that I will also submit half yearly compliance report in soft & hard format, on 1st June & 31st December of each calendar year to the CZMA as per the rule 4.2 (v) of the CRZ Notification, 2011 issued under the Environment Protection Act, 1986. I will pay the requisite fees to MCZMA for processing the application placed before it.

Date: 05-11-2015

Signature of Applicant
Engineer-in-Chief (MMRDA)

Place: Mumbai

PART-B

(To be filled by Planning Authority for onward submission to MCZMA)

Note:

(1) Proposals other than Koliwada, Cessed, SRA, Dilapidated & unsafe Building in Mumbai area should be processed as per DCR 1967. For other areas proposals should be processed as per DCR existing & in forced as on 19.2.1991.

(2) CZMP of Maharashtra and Mumbai approved by Govt. of India (MoEF) will be valid for two years till the new CZMP is prepared and approved as per CRZ Notification, 2011. The planning authorities should process application on the basis of approved CZMP of the area. For rural areas CZMP prepared by Space Application Centre (SAC), Ahmedabad (in the scale of 1:25000) and approved by MoEF shall be used. Coastal land use maps prepared by MRSAC, Nagpur, prepared on the basis of CZMP of SAC, Ahmedabad shall be submitted with the application along with approved map for reference. This procedure will be applicable till the time new CZMP as per CRZ Notification, 2011 is approved by MoEF.

			Particulars	**Page No.**
1	a		Whether the project site falls in CRZ-I, II, III & IV	CRZ I, II & IV
	b		CRZ map indicating HTL & LTL demarcated by one of the authorized agency in 1:4000 scale (as per para (2) of CRZ Notification, 2011)/ on the approved CZMP of the area showing the site under consideration	Enclosed
	c		Project layout superimposed on the above map indicated at (b) above	Enclosed
	d		CRZ map covering 7 km radius around the project site & indicating CRZ-I, II, III & IV areas including other notified ecologically sensitive areas	Enclosed
	e		If Project Site falls in CRZ-I A/ CRZ-I B, then submit the following	
		i	Distance of the project site from mangroves/ HTL	Alignment of MTHL passes through the CRZ I & Mangroves
		ii	Density of mangroves & extent of 50 meter buffer zone from project site	As above
	f		If Project Site falls in CRZ-II	Alignment of MTHL passes through the CRZ II
		i	Whether project site is on seaward side of the existing road as on 19.2.1991	As above
		ii	Whether project site is on landward side of the existing road constructed prior to 19.2.1991	As above
		A	If yes, certificate from Competent Authority indicating approval of road on development plan & date of construction	It is part of Regional Plan of MMR
		B	width of road	28m
		Iii	Whether project site is on seaward/ landward side of the Hazard line	As above
	g		If Project Site falls in CRZ III, distance of project site from HTL & mangroves, if any	NA
2			**Zoning, Land use & Development Plan remarks from the**	

			Particulars	Page No.
			Competent Authority indicating the following details: (As per the provision 8(i)(I), (II) & (III) of CRZ Notification, 2011)	
		i	Identification of the project & project proponent, landownership indicating CTS No./ Survey Nos. etc.	Chapter 1 of EIA Report
		ii	Brief description of nature of the project with details including, Layout Plan, Building Floor Plan etc.	Refer Chapter 2 of EIA report
		iii	Information of the project site with respect to the CTS No., Survey No. total area etc.	Refer Chapter 2 of EIA report
		iv	Copy of approved CTS plan from Land Records Department/City Survey Office	part of Regional plan of MMR
		v	Status of land Freehold/ Leasehold	NA
		vi	Copy of Property Card/ 7/12 Extract	NA
		vii	Zoning remarks for the project site as per development plan existing & enforce as on 19.2.1991	It is as per Regional Plan of MMR
		viii	Zoning remarks for the project site as per current/ prevailing development plan as on today	NA
		ix	Permissible height as per DCR enforce as on 19.2.1991	NA
		x	Permissible height as per current prevailing DCR	NA
		xi	FSI calculations as permissible in DCR existing on 19.2.1991	NA
			indicating eligible FSI in the proposed project	
		a	Proposed use	NA
		b	FSI proposed to be consumed	NA
		c	Whether lift, lobby, staircase etc. are claimed free of FSI & if so whether they are permissible (if so mention the provision of DCR)	NA
		xii	Permissibility of proposed use as per development plan & DCR as on 19.2.1991	NA
		xiii	Development plan of the area indicating site under reference, zoning, reservation etc.	NA
		xiv	Land use change, if any, in the project	NA
		xv	Designated reservations, if any, as per development plan/ Regional plan as on 19.2.1991 and as per current prevailing development plan of the area	NA
		xvi	Specific powers of Authority enabling relaxation in height, use & another provisions of DC Regulations	NA
3			**Proposed project Detail including Layout Plan, Building Floor Plan etc.** (As per provision 8(II) & (III) of CRZ Notification, 2011)	NA
4			**Details of Existing structure/ Infrastructure on site from Competent Authority indicating following details** (As per provision 8(II) & (III) of CRZ Notification, 2011)	
		I	Occupation certificate	NA
		ii	Commencement certificate	NA
		iii	Authorized plinth map from land records/ city survey office	NA
		iv	FSI consumed & approved building plan of the existing structure from Planning Authority	NA
		v	Remarks indicating existing use of the structure	NA
		vi	Details of court cases/legal matters if any with respect to	NA
			proposed matter	NA

			Particulars	Page No.
		vii	Details of complaints, if any	NA
5			**Additional information for reconstruction of Houses in Koliwada** (As per provision 8(V)(4)(g) of CRZ Notification, 2011)	NA
		a	Details of notified fishing settlement areas/ Koliwadas as per development plan existing as on 19.2.1991 from competent Authority	NA
		b	Certificate from competent Authority indicating, traditional Fishermen communities/ other local coastal communities as per the Govt. records if proposal belongs to Koliwada	NA
6			**SRA/ CESS/ Dilapidated/ Unsafe Building** (As per provision 8(V) of CRZ Notification, 2011)	NA
		a	Slum area declaration Notification along with list of eligible tenants	NA
		b	Public consultation Report	NA
		c	CESS/Dilapidated/dangerous/Unsafe building certificate from Competent Authority.	NA
		d	Stake of the State Govt. or its parastatal entities (which should not be less that 51%) in the SRA scheme projects (As per provision 8(V)(1)(ii)(b)(2)(i) of CRZ Notification, 2011)	NA
7			**Detailed remarks of the Planning Authority on the proposed project**	

Signature
Engineer-in-Chief
MMRDA

Date:

Place: Mumbai

Form-I for seeking clearance for project attracting CRZ notification

Basic information:

Name of the Project: - Construction of Mumbai Trans Harbour Link from Sewri on Mumbai island to Chirle on mainland (22 km)

Sr. No.	Sections	Chainage	Length
1	Sewri Interchange for the Link which integrates MTHL with roads of Mumbai city.	0.0 to 1.0 km	1.0 km
2	Viaduct on Sea which includes 1.5 km and 0.6 km of mudflats on Sewri and Nhava sides respectively	Ch. 1.0 to 17.58 km	16.58 km
3	On rolling land on Nhava Side	Ch. 17.58 to 22.00 km	4.42 km
	TOTAL		22.00 km

Location or site alternatives under consideration: - The alignment of proposed MTHL starts at Sewri on Mumbai side and ends at Chirle on Navi Mumbai side. Various alignments of this link were studied by different committees/agencies and finally the alignment was approved by Prime Minister's Office (PMO) in 1984. The alignment satisfies the requirements of MbPT, BARC, and Archeological Survey of India etc.. This alignment is also as per the Regional plan of Mumbai Metropolitan Region**.**

Size of the project (in terms of total length):- Total length of Mumbai Trans Harbour Link from Sewri on Mumbai island to Chirle on mainland including Road/Viaduct/ROB/Creek Bridge = 22 Km

CRZ classification of the area: - CRZ I/CRZII/CRZ IV

Expected cost of the project: Rs. 8800 Crore (April 2012) updated to Rs 11,370 Crore (2016)

Contact Information:- Engineer In-Chief, Mumbai Metropolitan Region Development Authority, Bandra-Kurla Complex, Bandra (E), Mumbai

(II) Activity

1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, and the like)

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography	Yes	The proposed sea link consists of Viaduct/ROB /Creek Bridge across

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
	including increase in intensity of land use (with respect to local land use plan)		Thane Creek and is as per the regional plan of Mumbai – Metropolitan Region.
1.2	Details of CRZ classification as per the approved Coastal Zone Management Plan?	Yes	Proposed alignment passes through CRZ I, CRZ II & CRZ IV between Sewri and Shivaji Nagar side.
1.3	Whether located in CRZ-I area?	Yes	The proposed link crossed CRZ I on Sewri and Shivaji Nagar.
1.4	The distance from the CRZ-I areas.		Not Applicable
1.5	Whether located within the hazard zone as mapped by Ministry of Environment and Forests/National Disaster Management Authority?	No	Not Applicable
1.6	Whether the area is prone to cyclone, tsunami, tidal surge, subduction, earthquake etc.?	No	Not Applicable
1.7	Whether the area is prone for saltwater ingress?	Yes	
1.8	Clearance of existing land, vegetation and buildings?	Yes	Structures / slum dwellers are affected on Sewri side
1.9	Creation of new land uses?	No	Not applicable
1.10	Pre-construction investigations e.g. bore hole, soil testing?	Yes	Geotechnical Investigations, Bathymetric surveys, Seismic surveys and hydraulic modeling by CWPRS has been carried out for the Trans Harbour Link.
1.11	Construction works?	Yes	The project comprises of construction of approaches, land & marine viaducts along the alignment.
1.12	Demolition works?	Yes	There are about 318 number of structures affected within ROW. Also, there are plots allotted to lessees and the structures affected at Sewri.
1.13	Temporary sites used for construction works or housing of construction workers?	Yes	Temporary sites like casting yard, jetty will be used for construction works. Housing of construction works will be provided outside/away from the construction site

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.14	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations	Yes	MTHL is proposed to be a viaduct structure with interchanges at Shivaji Nagar & Chirle on land on Navi Mumbai side. The Sewri interchange would be on land on Mumbai side.
1.15	Underground works including mining or tunneling?	No	Not Applicable
1.16	Reclamation works?	No	No reclamation is envisaged in the bridge work. The casting yard area would be filled up, leveled / paved to make it fit for the intended use.
1.17	Dredging/reclamation/land filling/disposal of dredged material etc.?	NA	As mentioned above there will be no reclamation for bridge. The construction waste generated would be disposed at designated sites.
1.18	Offshore structures?	Yes	The project comprises of construction of land & marine viaducts along the alignment.
1.19	Production and manufacturing processes?	No	Not Applicable
1.20	Facilities for storage of goods or materials?	Yes	Labour establishment & Construction materials will be stored at the casting yard site on Sewri & Nhava side.
1.21	Facilities for treatment or disposal of solid waste or liquid effluents?	Yes	Solid waste will be handled as per Municipal Solid Waste management and handling Rules.
1.22	Facilities for long term housing of operational workers?	No	The proposed project does not envisage long term operational workers.
1.23	New road, rail or sea traffic during construction or operation?	Yes	During construction : Roads on the mainland (Nhava end) will be strengthened/ improved for accommodating the increased traffic due to conveyance of construction material to the site. Temporary jetties will be constructed on either side to facilitate the bridge work in intertidal zone & marine area. At operation :

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
			Traffic on the constructed link.
1.24	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?	Yes	Same as above
1.25	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?	NA	Diversion of existing transport routes is not contemplated.
1.26	New or diverted transmission lines or pipelines?	NA	There is no need of new or diversion of existing transmission or pipelines.
1.27	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?	NA	No such change in hydrology is envisaged.
1.28	Stream and river crossings?	Yes	The proposed link crosses the creek between Mumbai island city and the mainland with a bridge.
1.29	Abstraction or transfers of water from ground or surface waters?	NA	Not applicable.
1.30	Changes in water bodies or the land surface affecting drainage or run-off?	NA	No such change is expected.
1.31	Transport of personnel or materials for construction, operation or decommissioning?	Yes	The personnel required will be provided with settlement in nearby sparsely populated areas away from the settlements of original inhabitants. Construction material required for the purpose will be procured and transported to site.
1.32	Long-term dismantling or decommissioning or restoration works?	NA	No such activity is involved in the project.
1.33	Ongoing activity during decommissioning which could have an impact on the environment?	NA	Not applicable.
1.34	Influx of people to an area in either temporarily or permanently?	Yes	i. Construction of proposed bridge may involve labourers from local areas as well as from other regions is envisaged. ii. Apart from labourers, increase in population is expected on the

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
			Navi Mumbai side due to the various developmental projects coming up in the area.
1.35	Introduction of alien species?	No	Not applicable.
1.36	Loss of native species or genetic diversity?	No	Not applicable.
1.37	Any other actions?	No	Not applicable.

2. Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)	No	The land viaduct on the mainland side does not envisage requirement of agricultural land
2.2	Water (expected source & competing users) unit: KLD	Yes	Approximately 50,000 liters water per day would be required from CIDCO & MCGM for construction activity and for drinking for the construction labour.
2.3	Minerals (MT)	No	No minerals are proposed to be used in the project.
2.4	Construction material – stone, aggregates, sand/soil (expected source – MT) (source, competing users) Unit: fuel (MT), energy (MW)	Yes	All materials will be procured from the authorized quarries.
2.5	Forests and timber (source – MT)	No	No wood is proposed to be used in the project.
2.6	Energy including electricity and fuels	Yes	Electricity would be required for construction activities & for the temporary accommodation for the labour.
2.7	Any other natural resources (use appropriate standard units)		No requirement for other natural resources.

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

Sr. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)	No	Not expected in the project
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)	No	Not expected in the project
3.3	Affect the welfare of people e.g. by changing living conditions?	No	Not expected in the project
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,	No	Not expected due to the project
3.5	Any other causes	No	

4. Production of solid wastes during construction or operation or decommissioning (MT/month)

S. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.1	Spoil, overburden or mine wastes.	Yes	During construction of bridge foundation, excavated soil will be generated. It will be disposed off at the designated/approved dumping site.
4.2	Municipal waste (domestic and or commercial wastes)	Yes	Municipal solid waste will be handled as per the relevant rules of Municipal Solid Waste Management and handling.
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)	No	Not applicable
4.4	Other industrial process wastes.	No	Not applicable
4.5	Surplus product	No	Not applicable
4.6	Sewage sludge or other sludge from effluent treatment	No	Not applicable
4.7	Construction or demolition wastes	Yes	Please see 4.1 Above
4.8	Redundant machinery or equipment	No	Not applicable
4.9	Contaminated soils or other materials	No	Not applicable
4.10	Agricultural wastes	No	Not applicable

S. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.11	Other solid wastes	No	Not applicable

5. Release of pollutants or any hazardous, toxic or noxious substances to air (Kg/hr)

S. No.	Information/Checklist confirmation	Yes/ No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources	No	Not applicable
5.2	Emissions from production processes	No	Not applicable
5.3	Emissions from materials handling including storage or transport	Yes	Material handling during construction is expected to generate SPM and RSPM as well as gaseous emissions. Necessary care would be taken so that during construction as well as operational phases pollutants do not exceed CPCB Standards.
5.4	Emissions from construction activities including plant and equipment	Yes	As above
5.5	Dust or odors from handling of materials including construction materials, sewage and waste	No	Not applicable
5.6	Emissions from incineration of waste	No	Not applicable
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)	No	Any burning of waste in open air will not be allowed during construction. The contractor will be directed to handle waste as per the MPCB norms.
5.8	Emissions from any other sources	No	Not applicable

6. Generation of Noise and Vibration, and Emissions of Light and Heat:

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers	Yes	The machinery used for construction will conform to the national / international emission norms. The machinery would be properly maintained to have minimal effect on air and noise emission.
6.2	From industrial or similar processes	No	Not applicable.
6.3	From construction or demolition	Yes	Some noise is expected from loading and unloading operations of construction
6.4	From blasting or piling	Yes	

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
6.5	From construction or operational traffic	Yes	materials, equipments, piling operations, construction & operational traffic etc. However, those are not significant. Wherever required the workers will be provided with personal protective equipment. The machinery used will be properly maintained and will be installed with mufflers to minimize the noise pollution.
6.6	From lighting or cooling systems	No	Not applicable.
6.7	From any other sources	No	Not anticipated.

7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea:

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials	No	There is no use of hazardous material in the proposed project.
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)	No	Proper drainage arrangements will be provided to drain the sewage into the existing sewage network of Municipal corporation.
7.3	By deposition of pollutants emitted to air into the land or into water	No	The pollution levels are expected to come down on the existing road network due to the construction of MTHL.
7.4	From any other sources	No	Not expected
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?	No	The pollution levels are expected to come down on the existing road network due to the construction of MTHL.

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances	No	Not applicable
8.2	From any other causes	No	Not applicable
8.3	Could the project be affected by natural	Yes	The project will be designed by taking

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
	disasters causing environmental damage (e.g., floods, earthquakes, landslides, cloudburst etc)?		in to consideration these factors as per relevant codes and standards.

9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S. No.	Information/checklist confirmation	Yes/ No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
9.1	Lead to development of supporting. utilities, ancillary development or development stimulated by the project which could have impact on the environment e.g.:	Yes	The proposed project will support the development of : i. Navi Mumbai SEZ ii. Navi Mumbai International Airport iii. Connectivity of Mumbai island city to other states through Mumbai-Pune Expressway and NH 17. Above developments will take place as per the existing DC Rules & proper EMP will be implemented during Construction & operation phases.
	• Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.)	Yes	
	• housing development	Yes	
	• extractive industries supply industries	No	
	• other	Yes	
9.2	Lead to after-use of the site, which could have an impact on the environment	No	The traffic conditions will be improved the level of air pollutants are expected to come down which will be monitored during construction phase.
9.3	Set a precedent for later developments	Yes	-
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects	No	This is not envisaged at this stage

III. Environmental Sensitivity

S. No.	Areas	Name/ Identity	Aerial distance (within 15 km.) Proposed project location boundary
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value	Elephanta caves	3km
2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests	Coastal Zones – Sewri and Nhava mudflats (CRZ I)	The project alignment passes through the Sewri and Shivaji Nagar Mudflats.
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration	Coastal Zones – Sewri and Nhava mudflats (CRZ I)	The project alignment passes through the Sewri and Shivaji Nagar Mudflats.
4	Inland, coastal, marine or underground waters	Arabian Sea lies to the West	The project alignment passes through the Thane creek of the Arabian Sea
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas	Elephanta caves	3km
7	Defense installations	Navy	8 km
8	Densely populated or built-up area	Mumbai and Navi Mumbai	
9	Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)		NA
10	Areas containing important, high quality or scarce resources (ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)		NA
11	Areas already subjected to pollution or environmental damage. (those where existing legal environmental standards are exceeded)	Sewri mudflats, Arabian Sea between Mumbai island city and Mainland.	
12	Areas susceptible to natural hazard which could cause the project to present environmental problems (earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions)		NA

EXECUTIVE SUMMARY

Preamble

Mumbai's peculiar geographical spread imposes constraints on expansion; its great job potential has nevertheless attracted migrants from many parts of the country. The result has been severe housing shortages, lack of open spaces and civic amenities and transport bottlenecks. As per the 2011 census, the population of Mumbai is 12.25 Million.

The northern & north eastern parts of Greater Mumbai are likely to be saturated in the near future. In that event, the only location for expansion (apart from Navi Mumbai) will be in areas to the north of Greater Mumbai upto Virar at the northern limit of the Mumbai Metropolitan Region. This northwards expansion however is aggravating problems of its own. With the augmentation of the north-south commuter movement it would not only keep increasing commuting time to the heart of the island city but also traffic congestion on the transport network.

The pressure on the rail and road network can be relieved only by redirecting part of the movement into an east-west (towards Navi Mumbai) orientation. Having known the geography of the city, this can only be achieved by taking positive steps to encourage the development of residential areas on the mainland on the coast.

Need of the project

The need for the project arises from the undisputed fact that Greater Mumbai is already overcrowded and congested. The only solution to prevent the existing conditions from worsening is to expand on to the mainland, which to a limited extent, has already occurred in the northern half of Navi Mumbai. This is however, insufficient, and a major push to the development of the rest of Navi Mumbai can be given only by providing quick access to the southern half of Navi Mumbai.

At present, there are two road links connecting Mumbai to Navi Mumbai:

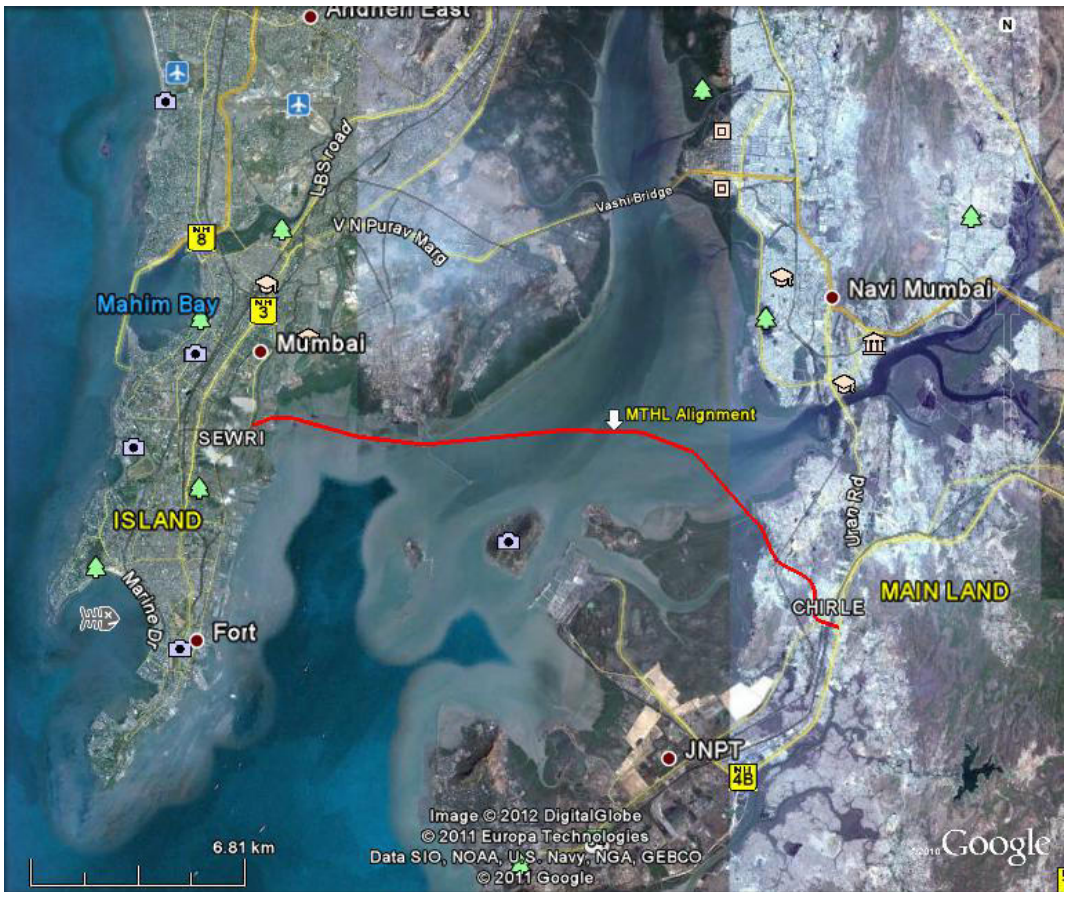
- The Thane Creek bridge
- Airoli bridge

Both these links together are near saturation and are not equipped to meet the combined future projected traffic, thereby necessitating creation of additional links to meet traffic growth. In this context, the proposed Mumbai Trans Harbour Link has become a necessity for the state government.

The proposed Mumbai Trans Harbour Link will, therefore, serve not only as an economic gateway to Navi Mumbai but also a panacea for the problems being faced by Mumbai. The link would also further strengthen the economic integration of island of Mumbai and the mainland. Navi Mumbai would therefore emerge as a vibrant satellite city to Mumbai in the same way as Gurgaon and Noida have emerged as satellites to New Delhi.

From this perspective, the MTHL project will not merely provide the most efficient solution to Mumbai's acute accommodation problem, but will provide the most viable solution

open to the city for its survival. The location of the MTHL alignment is shown in following Figure.



Index Map of the proposed MTHL

Need and Objective of EIA study

As per the notification on Environmental Impact Assessment (EIA) of developmental projects issued on 14th September 2006 under the provisions of Environment (Protection) Act, 1986, expansion or modernization of any activity (if pollution load is to exceed the existing one) or new project listed in the Schedule of the notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central or State Government in accordance with the procedure specified in the notification. Therefore EIA is mandatory for these categories of developmental projects.

It is pertinent to mention here that the MTHL project had already received environmental clearance from MoEF on 11th March 2005 (Copy of the same is enclosed). On receipt of the same, GoM through MSRDC Ltd had initiated the bidding process for construction of Sea Link but it could not be completed and the project got delayed. As per the EIA notification dt 27/01/1994, the validity of environmental clearance was 5 years and it has expired on 10th March 2010 in case of MTHL. Hence, the project is required to obtain necessary clearance as per the prevailing laws.

Now Government of Maharashtra has appointed Mumbai Metropolitan Region Development Authority (MMRDA as nodal agency for implementation of MTHL project on BOT basis. MMRDA is in the process of appointing Developer/ Concessionaire for Mumbai Trans Harbour Link (MTHL).

Policy, Legal and Administrative Framework

The principal Environment Regulatory Agency in our country is the Ministry of Environment & Forest (MoEF). The environment policies and environment clearance process for various projects are laid down by MoEF. The State Pollution Control Board (SPCB) grants No Objection Certificate (NOC) and consent for establishment and operation of the project. As per the EIA Notification of MoEF issued on 14th September, 2006, a National or State highway development or expansion projects fall in either Category A or B of the schedule of the notification. The proposed project does not completely fulfill either of the criterions described for Category A or B, i.e. the proposed alignment is a sea link which is 22km (less than 30km) and it is not a national/state highway. 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. Though construction of '**Sea link**' is a permissible activity as per CRZ notification, approval from Maharashtra Coastal Regulation Zone Management Authority (MCZMA) is required as per the MoEF Notification of January 2011.

The clause 3 and 8 of the CRZ Notification, January 2011 mentions that the construction of sea link is a permissible activity in CRZ. The same are referred below:

Clause "3 (iv) (Page 2). Prohibited activities within CRZ -
The activities such as Land reclamation, bunding or disturbing the natural course of seawater are declared as prohibited activities within the CRZ **except** those,-
(a) required for setting up, construction or modernisation or expansion of foreshore facilities like ports, harbours, jetties, wharves, quays, slipways, **bridges**, **sea link**, road on stilts, and such as meant for defence and security purpose and for other facilities that are essential for activities permissible under the notification;"

Clause "8 (Pg 9) Norms for regulation of activities permissible under this notification,-
(i) The development or construction activities in different categories of CRZ shall be regulated by the concerned CZMA in accordance with the following norms, namely:-
I. CRZ-I,-
(i) no new construction shall be permitted in CRZ-I ***except,***-
(e) **Construction of trans harbour sea link** and without affecting the tidal flow of water, between LTL and HTL."

"(ii) Areas between LTL and HTL which are not ecologically sensitive, necessary safety measures will be incorporated while permitting the following, namely:-
(g) **Construction of trans harbour sea links**, roads on stilts or pillars without affecting the tidal flow of water."

Project Benefits

MTHL will directly and indirectly lead to the betterment of MMR, both from an economic and social perspective.

Direct Benefits from MTHL

- Savings in travel times for commuters.
- Improved comfort and accessibility between the island and the mainland.
- Reduced operating costs of vehicles due to lesser congestion.
- Accelerated growth of Navi Mumbai.
- Smooth traffic flow from Navi Mumbai airport to Mumbai Island.

Indirect Benefits from MTHL

- Rationalization of real estate prices in Greater Mumbai
- Increased demand for land in Navi Mumbai and consequent improvement of land prices.
- Accelerated economic development of Navi Mumbai and nearby regions
- Greater economic integration of Mumbai island with Navi Mumbai and extended regions of Pune, Goa, Panvel and Alibaug
- Decongestion of Mumbai Island and dispersal of population to Navi Mumbai region and beyond
- Environmental improvement and reduced pollution levels
- Improved safety due to reduction in accidents
- Improvement in trade and trade competitiveness through faster and improved logistics

The proposed Mumbai Trans Harbour Link will therefore serve not only as an economic gateway to Navi Mumbai but also a panacea for the problems being faced by Mumbai. The link would also further strengthen the economic integration of Mumbai Island and Mainland Mumbai. Navi Mumbai would therefore emerge as a vibrant satellite city to Mumbai in the same way as Gurgaon and Noida have emerged as satellites to New Delhi.

Both Thane Creek Bridge and Airoli Bridge are near saturation, thereby necessitating creation of additional links to meet traffic growth. In this context, the proposed Mumbai Trans Harbour Link has become a necessity for the state government.

A number of developmental initiatives have been proposed in the Navi Mumbai region that will not only give rise to additional traffic movement, but also accentuate the need for greater economic integration of Mumbai Island with Mainland Mumbai. Some of the key infrastructure facilities proposed and / or already developed include:

- Navi Mumbai Integrated Special Economic Zone (SEZ)
- International airport at Navi Mumbai
- New container terminals at Jawaharlal Nehru Port Trust at Nhava Sheva
- Thane Vashi, Thane-Nerul and Nerul-Uran Rail link
- CBD – Taloja-Khandeshwar-ring metro
- Trans Thane Creek Industrial Area

Navi Mumbai is also well connected through rail and road links with Pune, Nasik and Thane, indicating the potential for the region to develop into a satellite city.

In this context, the proposed Mumbai Trans Harbour Link (MTHL) connecting Sewri to Nhava Sheva is expected to be a key driver in the development of the city by promoting horizontal growth as against vertical growth that has been experienced over the past few years. The link would help reduce the problems of congestion and pollution in Mumbai Island.

Early Studies

The origin of Mumbai (Island City) - Uran (Main Land) transport link goes back to 1970, when it was first recommended in the Draft Development Plan. Subsequently, committees were formed in 1972 and 1978 to study the possible alternatives for establishing the Transportation Links across the harbour. The Committees identified alternative routes, a northern route linking Sewri with Nhava and a southern route linking Colaba with Uran, and suggested necessary engineering studies for the alternative routes.

A Steering Group was constituted in February 1981, under the Chairmanship of Mr. J.R.D. Tata. The Steering Group reviewed the earlier studies and recommended that priority should be given to the construction of a link between Sewri and Nhava.

In 1982, an International Consortium of Consultants led by Peter Frankael and Partners (PFP), UK, was appointed by the Steering Group to carry out a feasibility study and to prepare detailed project report for the proposed Mumbai Trans-Harbour Link (MTHL). PFP submitted their feasibility study report in 1983. Six alternative alignments between Sewri on Mumbai island and Nhava on the main land were identified and studied. All the alignments started from Sewri. Out of these, four were proposed to terminate to the north and two to the south of Jawahar Lal Nehru Port (JNP). The route length varied from 20 kms. to 23 kms.

The study recommended the northern most alignment for the preferred transportation link. The recommended alignment was 22.61 kms long and comprised interchanges at Sewri and Nhava, sections across the mudflats over embankments on both sides of Sewri & Nhava, creek portion over viaducts/bridges and Nhava approach at grade. The recommended northern alignment was modified by the Expert Group by shifting it to south of the jetty head in order to satisfy Bhabha Atomic Research Center (BARC) requirements. This shifted alignment was approved by Prime Minister's Office (PMO) in 1984. This alignment is also as per the Regional plan of Mumbai – Metropolitan Region.

CES were appointed to review and update the feasibility study for the recommended northern alignment in 1996 taking into account the subsequent developments after completion of 1982 study. During the study, CES suggested further modifications to the alignments.

CWPRS Study

Central Water and Power Research Station (CWPRS, Pune) has studied the approved alignment finalized by the expert and also the span arrangement proposed for MTHL. They have given the observations that the proposed line will not cause any erosion or siltation in the creek. Further no unfavourable currents will be formed due to construction of Jetty.

The features of the proposed alignment are as follows:

Sewri Interchange & Approach Ramps to MTHL and connection to sea bridge	Vertical clearance over the existing road 5.5m	0.720 km
Main Structures :	Vert. Clearances	
Viaduct across Sewri Intertidal zone – 50 m spans	9.1 m above HHTL	4.650 km
Bridge across Pier Pau Jetty – 120 m spans	25m	0.740 km
Viaduct up to Central Channel (Thane Creek) – 50 m spans	9.1 m above HHTL	2.550 km
Bridge across Central Channel (Thane Creek) – 85+2x150+85 m spans	25.2 m above HHTL	0.540 km
Viaduct up to ONG Pipelines – 50 m spans	9.1 m	2.650 km
Bridge across ONG Pipelines I – 75+120+75 m span	9.1m	0.270 km
Viaduct between ONG Pipelines – 50 m span	9.1 m	0.650 km
Bridge across ONG Pipelines II – 85+160+85	9.1m	0.430 km
Viaduct up to Panvel Creek – 50 m span	9.1m	1.600 km
Bridge across Panvel Creek – 85+2x150+85 m	25.2 m above HHTL	0.320 km
Viaduct across Nhava Intertidal zone and Mangrove area which is on land	9.1 m 5.5m	3.000 km
Land Viaduct/Embankment up to Interchange at Chirle	5.5 m	3.730 km
Total Length		**21.85 km**

Navigation Clearances

The following clearances are proposed subject to the agreement of the port authority.

Viaduct	Horizontal Clearance	Headroom Clearance above H.H.T.L.
General Viaducts	50m minimum span	9.1m
Pir Pau and other Jetty heads	120	+6m above jetty level
Thane Creek Viaduct	2 x 100m / 2 x 170	25.2m
Panvel Creek Viaduct	1 x 100m / 2 x 150	25.2m

Proposed Navigation Requirements

Interchange and Connection to Eastern Freeway

It is proposed a 3 level grade separator at Sewri Opposite Sewri Railway Station to facilitate the dispersal of MTHL traffic through an interchange via the north south elevated Eastern Freeway which is under construction over Messant Road and proposed East West Sewri Worli elevated Connector which follows existing Acharya Donde Marg and proposed DP road along drainage channel and the local road network which is at-grade

Viaducts over Sewri Mudflats

It is proposed that a span of 50m would be the most appropriate and competitive span length for the low level viaducts both across the mudflats and also across the sea where dedicated navigation clearance is not required. A 50m span single cell box girder deck gives a wide choice of construction methods such as precast segmental balanced cantilever, precast segmental span by span, precast whole span. Engineering analysis has shown that at this span and a minimum soffit clearance of 9.1m above HHWL, foundations comprising of single large diameter bored piles under each box girder are feasible. Use of single large diameter piles would obviate the need for pile caps which would need to be buried over the extent of the mudflats and have negative environmental and financial impacts. Entire operation will be done from a temporary bridge constructed parallel to the permanent structures so as not to disturb the eco-sensitive mudflats. The 50m spans would be continuous over six spans with movement joints spaced at 300m intervals which would give a reasonable riding quality.

Main Bridge across the Harbour

The total length of the bridge is about 22 km. This length consists of obligatory spans at three locations which are as follows:

Location	Length	Name of Crossing
Ch. km 5.37 to km 6.11	740	Tata Jetty, Pir Pau Jetty, BPCL Jetty etc. and access channel.
Ch. km 8.66 to km to km9.20	540	Thane Creek Channel.
Ch. km 12.77 to km 13.2	430	Panvel Creek

Nhava Side Approach Road and Interchange

Proposed MTHL after crossing ‘Panvel Creek ‘ lands near Shivaji Nagar and traverses on land and terminates at NH-4B near Chirle. Between these two, proposed MTHL crosses number of CIDCO planned roads and existing roads. One of the proposed major roads is new Expressway link to JNP which will play a important role to disperse the traffic of MTHL to Navi Mumbai Airport, JNP and other parts of Navi Mumbai. Interchanges are proposed at Chirle where MTHL is terminating on NH-4B and at Shivaji Nagar where the MTHL crosses the proposed link to JNP.

- Proposed MTHL crosses SH-54 which will be one of dispersal links. Existing SH-54 is 4 lane road and has been proposed for widening to 6 lanes with service roads. Traffic from MTHL may use this dispersal link to go Dronagiri, JNP, Uran and Panvel.

- Proposed MTHL terminates at 4-lane NH-4B, which is considered as major dispersal point of traffic to NH-17, NH-3, NH-4 and JNP.
- MTHL traffic going to NH-17 will follow NH-4B up to Palaspa Phata near Panvel and then join NH-17. It is explored that MTHL could be directly connected to NH-17 near Dolghar through new virgin alignment. This link can be further extended to Mumbai Pune Expressway to connect it at Sanjgaon near Toll Station.

Projected Traffic on MTHL

The traffic forecast for the horizon years 2017, 2021, 2031 and 2041 are given in following table for Without and With Metro Scenarios. It is pertinent to mention that the

MTHL Metro is considered in the year 2021. The traffic forecast considers the generated traffic from Navi Mumbai Airport and Navi Mumbai Special Economic Zone.

Year	2017	2021	2031	2041
Car/Taxi	29725	36250	53550	71975
LCV	6325	9050	15300	20550
Bus	2325	2700	3575	4575
HCV	5225	7550	12800	16375
MAV	1375	1975	3325	4250
Total Vehicles	44975	57525	88550	117725
Total PCU	68050	89463	140588	184775

Daily Traffic Forecast – with MTHL Road only

Year	2017	2021	2031	2041
Car/Taxi	29725	33075	48225	64800
LCV	6325	9575	16075	21600
Bus	2325	1200	1675	2150
HCV	5225	7650	13075	16725
MAV	1375	1925	3600	4625
Total Vehicles	44975	53425	82650	109900
Total PCU	68050	82650	132788	174638

*Assumed Metro operational from 2021

Daily Traffic Forecast – with MTHL Road &Metro

Functional Cross Section

Carriageway Width

In order to meet the traffic flow demand three traffic lanes are required in each direction. Each traffic lane is 3500mm and the nearside and offside edge strips are also provided with a width of 500mm and 250mm respectively. The overall carriageway width in each direction **is 11.250mm**.

Parapets and Central Median

For enhanced long-term durability it is proposed to provide concrete profiled barrier and parapets. The designation of the barriers will be “P3 High Containment” in accordance with IRC: 06-2010.

Cross falls

In order to ensure safe driving conditions each highway carriageway is provided with a transverse cross fall of 2.5%.

Aesthetic Considerations

When considering bridge aesthetics the following well established principles will achieve an elegant bridge:

- Lighter and visually pleasant structural profile with a simple and elegant structural design.
- The span length of the viaducts shall be designed with regular rhythm and odd span length should be minimized.
- The visual experience from the road by users and outside the road shall be considered in the design of the viaduct structure.

The bridge is located in the middle of a vast bay and so significant architectural gestures will be largely unnoticed aside from the occasional passing fishing boat. Aesthetics should be considered in good detailing, which does not come at a significant extra cost. Some of the aesthetic features proposed for the preliminary design are:

- A shaped precast edge parapet is a highly visual feature that gives the bridge its identity. Pre-casting ensures a neat and consistent finish.
- A small radius curve (r=150mm) on box girders rather than sharp edges softens the shape of the bold concrete box girder form.
- Locating pile caps, if required, below the water line for spans away from the navigation span significantly reduces the visual impact of the bridge when viewed from afar.

Project Sites

A project of this nature demands careful planning of the entire management both from construction activities and Work Sites from the logistic point of view. Accordingly there will be one main work site free from all encumbrances, as far as possible.

Labour Camp

The labour camp would be located on Navi Mumbai side of the project. All the facilities and amenities will be provided to the labour camps as per the “The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996” and “The Inter-State Migrant Workmen (Regulation of Employment) and Conditions of Service Act, 1979”

Casting yard

The casting yards will be located at Mumbai and Navi Mumbai side of MTHL. About 40ha land has been identified for this purpose. This would also form the main fabrication/casting and stacking yard for the major bridge elements and storage yard for quarried materials like murrum, aggregates and sand required for the project. Since the project require movement of men, material and machinery for construction, a jetty will be constructed at the casting yard for this purpose.

The base camp will contain, in addition to the space normally required for offices, workshops, fuel storage, maintenance yards, and the like, large areas for the storage of the materials, for pre-casting and stacking yards and also for steel fabrication yards.

The Project Main Site will have the space for the following:

1. Project Office, Administration & Accounts, Works Superintendent Mechanical Cell and Quality Survey unit.
2. Workshops for Mechanical, Electrical, Automobiles, and the floating crafts -running & maintenance.
3. Fabrication yard, casting & stacking yards, for different bridge components
4. Material stacking yards like godowns for cement, HT steel, Admixtures etc. which require weather protection.

- Stacking yards for structural steel of all category reinforcements, rails, etc.
- Storage yard for miscellaneous activities to be divided into Civil/ Mechanical / Electrical and other miscellaneous materials.
- Tools and Tackles of all categories.

In addition to above there would be accommodation for the Site Staff for Senior/Junior categories, Foreman, skilled/semiskilled/unskilled labour, who have to work on the site on shift basis.

Construction Methodology

The link starts with viaducts from both sides with the central zone as major bridge. As major portion of the activity (about 70%) will be in the sea, which demands movement of the men and material by water transport. It is proposed to construct temporary approach bridges from both ends of the alignment as also the work sites where necessary so that movement can take place round the clock. These approach jetties will be provided with temporary steel piles with steel deck and concrete slab, to ensure the wave actions do not disturb the movements.

Apart from the approach jetties, concrete will be provided separately at all work sites for berthing of floating vessels which are required to transport not only construction materials but also heavy pre-cast segments, as major portion of the superstructure activity will be carried out using pre-cast elements/girders. This demands extending jetty up to the deep channel where adequate draft is available for the floating barges carrying heavy units at all times. It is proposed that the approach bridge brought out earlier could be combined with the jetty so that dual purpose is served.

Time frame required for project implementation.

Implementation Schedule will depend on Concessionaire's resources of men, material & equipment, technology available with them and Cash Flow of provision to be prepared to meet the dead line.

It is anticipated that the contract will be awarded in the final quarter 2012. There will be initial period of planning and preparation prior to construction commencing in the final quarter of 2013.

Factoring in the scale of this project with the anticipated skill and expertise available in India, it is expected that the construction period will take 5 years.

The financial study assumes a concessionary period of 40 years after the opening of the highway, which is anticipated to be in the final quarter of 2018.

Estimated cost of development of the project

The estimated base construction cost of the project based on experiences of similar bridges in India is approximately Rs 88,000 million. This includes the cost of approaches, the bridge across the sea, the bridge furniture, ancillary structures, traffic surveillance, illumination and environmental mitigation measures, toll plaza, parking etc. It also covers charges on account of design, supervision, administration by MMRDA, contingencies and the like with provision for utility diversion, new construction and other works.

Salient features of the proposed MTHL:

- The Link will have a 6-lane facility exclusively for the use of fast moving vehicles with controlled access and connection to Eastern Freeway in the Island city of Mumbai and NH 4B near Chirle village on the main land.

- A minimum vertical clearance of 25.2 m below the bridge above the highest High Tide Level (HTL) will be provided for navigational spans, while the minimum vertical clearance of 9.1 m is provided elsewhere.

- 1.5 m wide central median with appropriate landscaping to enhance the environment as well as to avoid glare.

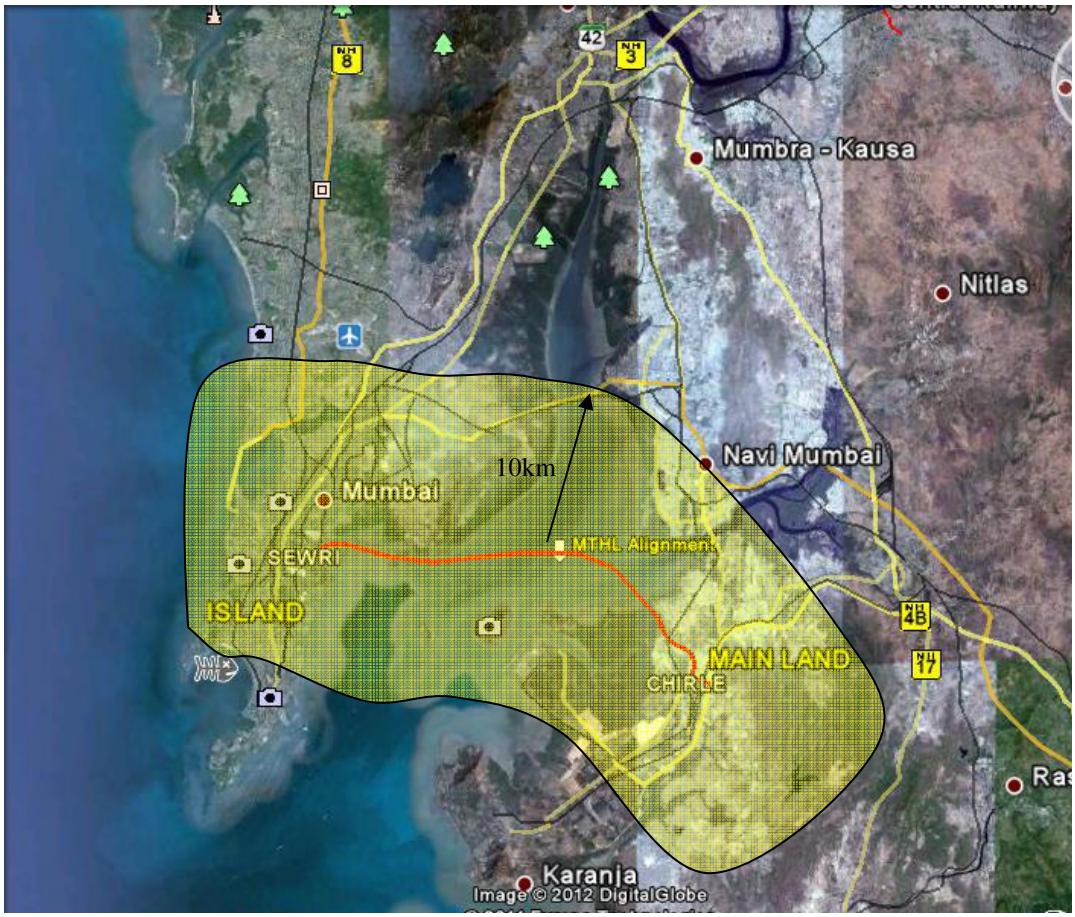
- Overall width of deck (28 m) consists of 11.25 m wide carriageway with 1.2 m wide utility corridor on either side of the carriage way. Anti crash barriers are provided at the edge of carriageway for protection of fast moving traffic. Provision of fenders for the protection of foundations against ship impact in the navigational spans.

- Foundations are proposed on piles with substructure of wall type pier. Suitable alternative will also be considered.

- The superstructure proposed is segmental construction in pre-stressed concrete. Alternative type of superstructure will also be considered.

BASELINE ENVIRONMENTAL STATUS

To know the existing environment, the baseline environment status for the study area was carried out by conducting a comprehensive primary and secondary data collection programme to prepare the Environment Impact Assessment (EIA) Report. The study area covered by 10 km. distance around the project site is shown in following figure.



Study Area of the Project

Environmental Setting

The following Table gives the Environmental setting along with the topographical features of study area within the 10 km. stretch from the proposed MTHL alignment site are shown in the following table

Geographical and Environmental Setting of the MTHL

Sr.	Item	Details
1	Location	Sewri (Mumbai island city) and Nhava (Mainland in Raigad district)
2	Latitude	Sewri End: 18° 59' 46.97'' (Google Earth) Nhava End: 18° 56' 18.08''
3	Longitude	Sewri End: 72° 51' 12.93'' Nhava End: 73° 01' 53.92''
4	General Elevation	14m average
5	Survey of India Topo Sheet No.	47 B/13

Sr.	Item	Details
6	Topography	The site topography involves mudflats on both the ends with a stretch of Arabian Sea in between for 28 km.
7	Soil type	The predominant soil cover in Mumbai city is sandy whereas in the suburban district, the soil cover is alluvial and loamy.
8	Climatic conditions	Avg Max Temp is 31.2 °C, Avg Min Temp is 23.7 °C. The average total annual rainfall is 2146.6 mm. (http://mdmu.maharashtra.gov.in/pages/Mumbai/mumbaiplanShow.php)
9	Nearest Highways	NH-4B and SH-54
10	Nearest Rly. Station.	Sewri Rly Station and Panvel Rly Station (Konkan Railway)
11	Nearest Airport	Santacruz Mumbai Airport
12	Present site land status	Out of 22km alignment 18 km falls in sea and rest is on land owned by MMRDA.
13	Nearest Water Bodies.	The alignment majorly passes through Arabian Sea
14	Nearest Hill	Ulwe hill
15	Archeologically Importance place.	Elephanta Caves
16	Seismic zone	Seismic Zone III as per IS: 1893 (Part-I) 2002.

BASELINE ENVIRONMENTAL STATUS

In order to assess the existing environmental status in the project area, primary and secondary data on various environmental attributes viz. air quality, noise levels, water quality, soil, ecology, land use etc have been collected and presented in the report.

The entire project area is divided in three segments with a zone wise demarcation of its environmental settings. It is indicated in the following table

Table Indicates Summary of Five Environmental Segments.

Sr. No.	Zone No.	Chainage	Length in km	Zone Division	Alignment Areas
1	I (Land)	0.5 to 1.0	0.5	Terrestrial Setting	Starts from E- of Sewri station in the E- central part of city of Mumbai near the Sewri Station on the Harbour line and ends on

					the edge of high water line at the thane creek.
2	II (Mudflats and sparse Mangroves)	1.0 to 2.5	1.5	Transition between Terrestrial and Marine setting	Extends between the high water and low water of Thane Creek hugging to the island of Mumbai.
3	III (Sea)	2.5 to 16.98	14.48	Marine setting	Stretches across the Thane Creek between the low water lines along the island of Mumbai and the mainland of Maharashtra.
4	IV (Mudflats and sparse Mangroves)	16.98 to 17.58	0.6	Transition between Marine to Terrestrial setting	Another mudflat flanking the mainland, bounded by low water and high water lines of the Thane Creek.
5	V (Land)	17.58 to 22.00	4.42	Terrestrial setting	Extends from the high line towards higher grounds on the mainland.

Topography and Geology

The proposed Mumbai Trans Harbour Link (MTHL) alignment mainly passes over the sea (Creek) except for a stretch of about 5 km where it runs over the land i.e. at Sewri and Nhava ends.

From the above it is observed that out of 22.0 km length of MTHL, 14.48 km falls in sea (66 %), 4.92 km on land (22 %) and 2.1 km (12%) passes through the mudflats. The geology of the region is typical of the west coast i.e. clayey soil underlain by basalt rock formations. The sediments on the Sewri Mudflats (Zone II) are composed of soft silty clay on the top, which is underlain by compact and hard silt.

The bottom lithology in the Sea (Zone III) is varying. On the top, is soft mobile silt. It is underlain by more compact silty clay of varying thickness. Under this, solid foundation is available in the shape of massive basalt. Except for a small area this basalt petrology is not geologically disturbed. However the alignment does not cross this disturbed zone.

The lithological features of the Nhava mudflats (Zone IV) are similar to that of Sewri mudflats. The terrain in the Zone V i.e. at Nhava end is rolling in nature and sparsely populated.

Air Quality

The air quality monitoring has been carried out at six different locations in the study area of the project. In general, the concentration of all the parameters is within the prescribed standard of MoEF except Sewri where the concentration of particulate matter is

exceeding the standard. This may be due to the ongoing construction of Eastern Freeway at Sewri.

Ambient Noise Levels

Ambient noise monitoring was carried out as per IS: 3029-1980 to know the existing ambient noise levels in the study area of MTHL at the same locations as discussed in air quality. it is observed that the existing noise levels are exceeding the permissible limit at Chirle, Shivaji Nagar, Gavan, Gate way of India and Sewri (Day time).Whereas the it is within the limit at Sewri (night time) and Mahul.

Heritage/Archaeological structures

There are three structures of historical/archaeological importance namely Sewri Fort, Gateway of India (about 6 km from MTHL) and Elephanta Caves (about 3 km from MTHL alignment) within the study area of project alignment. The no objection for Sewri Fort and Gateway of India has been received from Dept of Archaeology, GoM. The NOC for Elephanta from Archaeological Survey of India (ASI) has also been received.

Ecology

The general attributes of environment requires identification of the presence of any sensitive ecological system along the proposed alignment of the MTHL Project. The objective of this study is to ascertain the existence of such sensitive ecological system.

Ecological Status Report:

(A) Attributes of Zones:

Sewri Mud- flat (Zone II) :

- Physiochemical conditions in this zone was found to be in the normal range.
- Mangroves showed poor diversity, with presence of only *Avicennia* species.
- Among the phytoplankton species, the Shanon Weaver Index was found to be less than one. This indicates poor species diversity. Also, species found were stress tolerant.
- The zone showed absence of enteric coliforms. This indicates absence of fecal contamination.
- Thus the zone is found to be especially polluted due to presence of sea vessels, which could add in Zn & Cu & such other heavy metal contamination.
- On the whole, the zone has relatively less organic contamination due to sewage or such other effluent, but the heavy metal contamination was found in aquatic & sediment medium, which was further found to be accumulated in mangrove species.

Thane Creek (Zone III):

- Water in this region receives effluent discharges from industries & CETPs in the area. This may be one of the reasons for high levels of Cu, Zn & Cd in the zone.
- Bioaccumulation was also found in fin- fish in the zone.
- Specific enteric bacterial population was found to be absent in this zone.
- Water in this zone is found to be polluted by heavy metals & the biodiversity is also low.

Shivaji Nagar Mud- flat (Zone IV):

- Heavy metal concentration in this zone was similar to that observed in Sewri area.
- Physiochemical characteristics of water were found to be conducive to the growth of mangroves.
- Mangroves diversity was mainly dominated by presence of *Avicennia* species, with a few surviving *Sonneratia* species.
- The area towards the high tide region, near the road, was found to be contaminated due to anthropogenic activities; also the mangrove density was low at the periphery. However, the mid tide & low tide regions appeared relatively untouched by anthropogenic activities.

(B) Levels of Stress:

Sewri Mud- flat (Zone II):

- pH, temperature, Salinity, alkalinity was found to be normal.
- Dissolved oxygen was found to be less as compared to the Shivaji Nagar Mudflat area. However, the BOD & COD was found to be low, implying a lesser organic load.
- Heavy metal contamination was also found to be on the lower side in aquatic medium, except the presence of Zn, Cu, & Cd. Lead was found in the sediments.
- Nitrates concentration was found to be ranging from 2.6 – 2.75 mg/l. Phosphates & Silicates concentration too was found to be on the lower side.
- The mangrove density was found to be low as compared to the Shivaji Nagar mud-flat.

Thane Creek (Zone III):

- Zoo & Phytoplankton species showed diversity on the lower side.
- Heavy metal contamination was present.

Shivaji Nagar Mud- flat (Zone IV):

- Mangrove density was high in this region. Most of the mangrove species found were in the sapling stage (stunted growth), with only a few full grown trees.
- However, the diversity index was low, with *Avicennia* species indicating major dominance.
- Bioaccumulation of heavy metals was found in mangroves.
- The area did show presence of phytoplankton & zoo-plankton species of stress tolerant types.

Comparative Biodiversity:

	ZONE II	ZONE III	ZONE IV
Macro flora (qualitative)	Only avicennia species were observed in the area There were approximately an equal no of tree & seedings of *avicennia* found. Mangrove density was also found to be low.	--	Species of *avicennia* dominated the macro-flora diversity, with a few *sonneratia* species. Most of the macro- flora found were in sapling stage, with a few full grown trees present. Mangrove density was found to be high.
Macro flora (quantitative)	Very poor diversity, with index of dominance= 1	--	Poor diversity, with diversity index= 0.994 & shanon weaver index= 5.562%
Macro fauna (qualitative)	Poor	--	Moderate

	ZONE II	ZONE III	ZONE IV
Zooplankton diversity	Poor	Moderate	Poor
Phytoplankton diversity	Very poor	Poor	Poor
Avian diversity	9 species of birds were spotted in this zone a few of which included black headed ibis, white throated kingfisher, western reef egret etc.	--	About 12 bird species were spotted in this area, a few of which included red vented bulbul, common sandpiper, black headed gull etc.

Findings of the Ecological study

The findings of the above study lead to a number of important conclusions. These are as follows

1) The two tracts marked as CRZ I, namely the Sewri mud-flat and the Shivaji Nagar mud-flat, are under ecological stress. Detailed survey of mangrove in Shivaji Nagar site revealed that mangrove patches are degraded and dominated by Avicennia marina with stunted growth as low as .25 m - .75 m in height and low diversity. The major causes of destruction of mangroves is due to cutting for fuel purposes.

2) For the above reason, the existing eco-system cannot be described as sensitive.

3) The pollution load in the zone inhibits normal development of physiology and morphology. Hence the growth and reproduction of the different mangrove species get affected. In this zone, the mangroves growth will be hampered until the circumstances of pollution are radically amended.

4) The Shivaji Nagar mud-flat, has relatively less stress in terms of pollution. However, the tidal movement in this segment, which is one of the basic conditions of sustainance of mangrove ecosystem, has been drastically cut off by the ONGC road. This has not only inhibited the input of required nutrients to the system on which the mangroves are sustained, but the diversity of Phytoplankton has also been drastically reduced. This has paved the way of decline of several feeding filter bivalves.

The major repository of pollution is the waters of the Thane Creek in Segment III. To remove the circumstances of pollution is in itself a difficult task. With all the will that the managers of environment can muster, cleaning up will take a long time, because the heavy metals already deposited in the soil are not going to disappear soon.

Migratory Birds

The ecological settings of the project area have mudflats and mangrove area. The Sewri end of the mudflat experiences migratory birds during winter season. Out of the 17 species of birds spotted in the study area, 4 are migratory while the rest are known to be residents. Most birds seen were those that fell in the Least Concern category of the IUCN Red List, except for the black headed ibis (Threskiornis melanocephalus) which is Near Threatened. The Sewri mudflat area is widely known to attract lesser flamingoes (Phoeniconaias minor) and few number of greater flamingoes (Phoeniconaias rosues)

from November to June every year. About 10,000 to 15,000 flamingoes which are Near Threatened on the IUCN's Red List are known to visit this site.

These migratory birds have a stay for a limited period and leave the area in the beginning of summer back to their origin. They feed themselves on the minute aquatic creatures in the mudflats and also enjoy the high salinity nature. Monitoring programme will be taken up during construction phase to monitor the movement of the migratory birds. Due to slight increase in noise level during construction phase, the migratory bird colonies/areas will not have permanent shifting effect. It is expected that they may slightly shift, if at all, during construction phase, to avoid any disturbance. It has been observed during the study that during high tide period on the mudflats these birds shifts themselves to other areas and come back again during low tide. Even during movements of boats etc they tend to shift for temporary period. In fact there are few industries very near to these mudflats, which generate typical noise levels due to industrial operations. This level sometime reaches up to 40 to 50 dB but it does not affect these birds. It is expected that construction of this project will not affect the habitation of the migratory birds permanently.

Report on "MTHL Project: Study of flemingos and migratory birds by Salim Ali Centre for Ornithology and Natural History, Coimbatore" December 2008.

Salim Ali Centre for Ornithology and Natural History studied the Flemingos and other migratory birds in the Sewri - Mahul and Nhava Mudflats which will help to take necessary mitigation steps for the protection of birds in the area. Following are some of the observation in the report

- Total abundance of birds in the Sewri-Mahul region was much higher than in Nhava, >53000 birds of 54 species in 2008 in the former and only >2000 of 26 species in the latter.
- The lesser flamingo started arriving in the area during December 2006 in small numbers and increased slowly in March 2007 and in large numbers in April 2007reaching the peak in May 2007. They started leaving the area in June with a few juveniles remaining in June-July 2007.
- Distribution was caused by the ship repair activities at Sewri and tourist going closer to the flamingos by boat. The local people catching crabs did not cause much disturbance. Small construction works by Tata Power caused slight disturbance, but the birds got adjusted and went back to the area after the construction was over. This shows their adjustable nature with local movements as recorded elsewhere in the world.
- Heavy metal contamination in water, sediment and fish samples from the study locations showed high levels were of iron, nickel and copper in the sediment in Sewri and chromium and cadmium in Mahul because of effluents from industry, domestic sewage and ship repair. These would create toxicity to the biota on a long-term exposure.
- Levels of Pesticides, polychlorinated biphenyls (PCBs) and Polyclic aromatic hydrocarbons (PAHs) are higher than the guideline values. It is to be noted that the higher concentrations of Total PAHs found in sediment and fishes are demonstrated to be carcinogenic and mutagenic.

Some of the recommendations of the report are

- Flamingos have moved away from Sewri Port area probably because of the increased activity of ship repair. This also created pollution. Hence this needs to be shifted.
- Tourism has to be regulated and managed in an eco-friendly way to avoid disturbance to the birds. Ensure no or minimum disturbance to the flamingos in the feeding and nesting areas. Construction activities in this area may be restricted to then season when flamingos are not here (or not in larger flocks).
- Contamination by PCBs, oil and grease and PAHs is above the prescribed limits and hence of great concern. Necessary action may be taken with concerned authorities.
- Mangrove restoration programmes may be undertaken in suitable areas. These areas also need to be identified.
- Long term monitoring and detailed studies during the construction work of MTHL.

CRZ Areas of the Alignment

Table 3.27 Area Statement of bridge/Viaduct in CRZ

Sr No	Zone	Area of Bridge in CRZ in Sqm	No of Piers	Size of footprint	Total area of footprint envisaged in CRZ in sqm
SEWRI SIDE					
1	CRZ I	141495	208	3m x 4m	2496
			3	30m x 65m navigational span	5850
	Total CRZ I				**8346**
	Area of Mangroves affected		48	3m x 4m	576
2	CRZ II	8505	60	2.5m x 2.5m	375
			At grade road	8.5m x 135m	1148
CHIRLE SIDE					
1	CRZ I	112595	212	3m x 4m	2544
			6 nos solid ramps	150 x 8.5	7650
	Total CRZ I				**10194**
	Area of Mangroves affected				9306
2	CRZ II	3440	10	3m x 4m	120
CRZ IV		275000	**354**	3m x 4m	**4248**
			8	30 x 65 navigational span	**15600**
Casting yard on Navi Mumbai side					
	CRZ I (all of Mangroves)				**16.15 Ha**
	CRZ II				**2.82 Ha**
	Grand Total				
	CRZ-I				**17.24 Ha**
	CRZ-II				**2.99 Ha**
	CRZ-IV				**1.99 Ha**

- The size of footprint is tentative and likely to vary as per the alternative design of the contractor.

The Coastal Zone Management Plans (1:4000 scale) are enclosed with this report.

IMPACT ASSESSMENT & MITIGATION MEASURES

IMPACTS DURING CONSTRUCTION

Air Quality

Impact on Ambient Air Quality (AAQ) during construction stage of MTHL is anticipated. The adverse impact will be primarily due to transportation of construction material, road construction activities, loading and unloading of construction materials, and plying of construction vehicles along unpaved shoulders of access roads, emissions from asphalt mix plants, casting yards etc. Emission from these sources will have temporary but not significant impact on air quality.

MITIGATION MEASURES

During project initiation and construction period, the adverse impacts on ambient air quality are anticipated to occur mainly due to site clearance activities, construction material movement, and during various road construction activities.

a) For mobile source emissions

- Trucks carrying soil, sand or stone will be covered with traps to avoid spilling and blowing by wind from quarry to the site of construction.
- Fugitive dust entrainment at site and casting yard will be controlled by sprinkling water.
- Regular maintenance of machinery and equipment will be carried out.
- Mostly, pre-cast concrete elements will be used for construction. The construction yard will be located at Mumbai and Navi Mumbai on the mainland away from CRZ areas and will be away from the settlements to minimise disturbance to these settlements**.**
- The pre-cast blocks will be transported to the construction sites by barges.
- Latest construction equipment and technologies will be used with arrangements for dust and noise control.
- Regular maintenance of equipment will be ensured.
- Construction materials required at the construction yard will be obtained from the authorised borrow areas and quarry sites and will be transported in covered trucks.

b) For stationary source emissions

- Asphalt hot mix plants will be located at Mumbai and Navi Mumbai on the main land and will be away from inhabited areas.
- All stationary equipment will be located as far away as possible from sensitive receptor locations in order to allow dispersion of emitted pollutants.

- Areas prone to fugitive dust emissions due to activities such as demolition, excavation, grading sites and routes of delivery vehicles across patches of exposed earth, will be frequently watered to suppress re-entrained dust.

- Apart from these, the equipment/ machines and vehicles should be always kept in good state of repairs to minimize emissions. Low emission construction vehicles/ equipment will be used wherever feasible. Construction areas should be enclosed, wherever possible.

- Exhaust and noise emissions of construction equipments will adhere to emission norms as laid out by MoEF/CPCB.

- The Concessionaire shall ensure that the batching plant is located away from the residential areas and will be licensed and authorized for operation by the concerned authorities.

- Periodic inspection of the site will be carried out to ensure removal of construction debris to the landfill sites.

Ambient Noise Level

The main sources of noise during construction are construction equipment and the vehicles used for transporting various materials at the construction site. Operation of construction machinery e.g. hot-mixer, bulldozer, loader, backhoes, concrete mixer, etc will lead to rise in noise level to the range between 80-95 dB (A). The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Effect of increase in noise levels will be significant during night time near the residential area located close to the site.

Mitigation measures

The following mitigation measures are being recommended to control noise level

Source Control

- All construction equipment will be fitted with exhaust silencer. Damaged silencer to be promptly replaced by the Concessionaire.

- Proper maintenance of equipment will be undertaken with the provision of enclosures and intake silencers.

- DG sets, if used, will adhere to the noise standards of MoEF.

Scheduling of Project Activities

- Generally construction activities involving generation of noise will be carried out adhering to the noise standards of MoEF in the residential and sensitive areas.

- Provision of protection devices (ear plug) to be provided to the workers in the vicinity of high noise generating machinery.

Impacts due to "Construction and Labour Camps"

Construction camps include workers' residential areas and the grounds where equipment is stored and serviced and where materials are stockpiled. Careless construction camp design and management can lead to serious environmental degradation including

- sewage and garbage pollution;
- depletion of fauna and flora through illegal harvesting (poaching);
- infrastructure overloading- health services,
- sewage treatment,
- schooling
- law enforcement; and
- Spills from construction equipment operation and servicing.

Mitigation Measures:

The labour camp would be located at Mumbai and Navi Mumbai. All the facilities and amenities will be provided to the labour camps as per the "The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996" and "The Inter-State Migrant Workmen (Regulation of Employment) and Conditions of Service) Act, 1979"

The casting yards will be located at Mumbai and Navi Mumbai side. The 40ha land has been identified for this purpose. This location will be away from the habitation and CRZ areas and close to the sea. The jetties will be constructed to transport the precast segments at the project location through barges. The barricading to the proposed casting yard site will be provided.

Impacts due to Siting of Borrow and Quarry Material Areas

Mitigation Measures

i) Quarries will be opened from the rear end to keep its unaesthetic, noisy and pollution oriented activities away from the roads and the surrounding communities from where it can be seen.
ii) Collapsing of heavy rocks and boulders. Such a slope is also unstable.
iii) Quarrying will not be done up to ground floor level, as it results in preventing flooding Quarrying will not be carried out with a vertical sheet 90^0 slope, due to damage of and letting the surrounding water into the quarry-pits. It is also unsafe for the population in the surrounding area who might meet with accidents and may accidentally drown in the collected water.
iv) Quarrying will be done in benches i.e. at an angle and at regular angles. A bench of 5 m should provided before the next higher up slope is cut.
v) The sequence will be from the rear to front from aesthetic point of view.

vi) After the work is over, the quarry site will be planted with shrubs and trees of indigenous variety to merge within the existing landscape.
vii) Huge amount of debris will be generated due to dressing of stones. This material should be used to fill hollows and scars created in the process of quarrying. The material is also ideally suitable as fill material for embankment and can be used for the purpose.
viii) Quarries will be carefully leveled to avoid de-stabilization of slope and the general landscaping will be easier due to rock and soil content.

Water Quality

The major water body concern in the area is none other than the sea. There are no other water bodies and/or resources in the nearby project area. During construction there will be a slight change in the water quality at the construction location because of spillage of oil and grease and increase in turbidity due to the turbulence in water. However it will be insignificant and the change will be purely temporary. No permanent impact is anticipated on water quality due to sea link project. No impacts on ground water quality and its availability are anticipated as a result of the proposed actions at the sites.

MITIGATION MEASURES

- Proper Construction methodologies will be adopted in order to avoid turbidity problem.
- Care will be taken to avoid layer of suspended solids and spillage of oil and grease in the seawater during transportation as well as during shifting of girders.

Topography, Soil and Geology

The construction of roads on either side of the link will require excavation. This cutting material (excavation earth) will be disposed off in a scientific manner at a designated dumping site; thereby preventing the adjoining area from being disturbed. The link is passing through the mudflats area for a length of 2.1 km. (1.5 km at Sewri end and 0.6 km. at Nhava side). Thus to avoid the mudflats being disturbed during the construction, temporary bridge will be constructed for the movement of material and machinery.

0.117Ha mudflat area will be affected due to the number of piers located in the mudflat.

MITIGATION MEASURES

- Instead of solid embankments, Viaducts are proposed on Sewri and Shivaji Nagar side to avoid disturbance to the mudflats. This will allow vegetation below to maintain continuity and survive. Such phenomenon was also observed during construction of Airoli creek Bridge as shown in the photograph below.

Airoli Creek Bridge

- The road and bridge materials will be collected only from selected/approved/licensed borrow area.
- Rehabilitation of borrow pits using appropriate mix of local bushes and trees for vegetation coverage
- Cutting material will be utilized for earthwork filling requirement.
- Debris from cutting materials will be disposed at suitable sites properly, ensuring that it does not affect groundwater quality and soil quality of adjoining land.
- Pre-cast units will be used instead of cast in situ to avoid any adverse effect to mudflat area.

Reserved Forest and Fauna

The project area does not fall under any of the reserved forest area. There are no endangered species of flora and fauna within the project area, neither any endemic flora nor fauna species are found in the adjoining area. Wild life activity is also absent in the area.

Land use

The project area on the land side consists of main & arterials roads including residential and commercial establishments. This is a typical feature in the urban area. As approach roads are taken on viaducts instead of on solid embankment, quantity of filling material is drastically reduced as also the extent of borrow pits. Stone rubble, aggregate etc. is to be procured from existing authorized quarries.

MITIGATION MEASURES

- Development of any land will be in accordance with the government regulations

- Care will be taken to ensure that the construction worker's camp doesn't disturb the surrounding land use pattern which will be located in Navi Mumbai.

Impacts on Utility Services and Community Severance

Utility lines like electric poles, telephone poles, transformers high and low tension electric lines and telephone lines which may be affected by project will be identified with respect to their locations in the project area. Community severance and sensitive receptors like religious places community centers schools, inhabitant centers and cattle crossing location etc. will be taken in to consideration during construction phase.

Fisheries

Sufficient vertical and horizontal clearances are proposed below the sea link for the movement of fishing boats and barges.

Ecology and Biodiversity

It has been observed that the creek water has been thoroughly affected and polluted due to industrial and domestic waste water. There is an accumulation of various heavy metals and other organic and inorganic contents near ecological areas of the project including mudflats. There are two locations, Sewri on Mumbai side and Nhave on Navi Mumbai area having mudflats. There is sparsely scattered mangrove species (coastal halophytes) in this places and detail study has been carried out for ecological features and also Biodiversity of various components. The pollution has adversely affected the ecology of the mudflats particularly on Sewri side. At the same time constructive plans have been evolved for minimizing effect of construction activity on mudflats by adopting construction technologies which will not damage mudflat extensively. Following are some of the impacts, though they are of temporary nature

- Release of contaminants from disturbed sediments will result in pulses of contamination in water for a temporary duration
- Increase in turbidity during pile driving.
- Reduced water clarity/ light penetration leading to disturbance in zoo & phytoplankton & benthic biota for a short period during construction
- Zoo-plankton & phytoplankton species would be affected in the immediate vicinity of the link.
- Flamingoes are one of the important migratory bird species found in this area. The Sewri mud-flat areas are habitat grounds for these migratory birds from December to May. Though their stay is only for a limited period, these are of ecological importance. It also attracts nature lovers & tourist population, during their stay. Their habitat would be disturbed during construction phase.
- Generation of employment opportunities and providing short-term socio-economic benefits to the people engaged in the works.

Mitigation Measure

- Construction vessels to be kept at a slow speed to prevent disruption as far as possible to fishes & other marine biota
- Water pollution, dumping of waste, reclamation, are some of the major threats to wetlands which would be strictly looked into. Waste generated during construction phase should be disposed off at approved disposal sites.

- Construction technologies to be adopted in such away to minimize effect on mudflats.(Described in Chapter 2 of this report)
- Pre-cast units will be used to avoid any effect on mudflats during construction activity.
- Mangrove restoration plan is being initiated in lieu of loss of mangroves.
- Care will be taken to minimize any damage to aquatic flora – fauna etc and to restore biodiversity.
- Pollution prevention plans will be evolved and submitted to responsible authorities to minimize/prevent pollution at source.

Archaeological / Heritage:-

There are 3 archaeological monuments near the project site. It includes Gateway of India (within 7 km), Elephanta Caves (4 km) & Sewri fort (1km). The impact on these monuments due to the air and noise quality during operational stage have been predicted and it was found that there will not be any change in the air and noise quality at these site because of the MTHL. However NOC for the Sewri, Elephanta and Gateway of India has already been obtained from the Archaeological Department.

MITIGATION MEASURES:-

- Surveillance monitoring will be carried throughout entire construction period.

IMPACTS DURING OPERATION

Air Quality

During operation stage of the MTHL major impact will be on the air quality due to the vehicles plying on the MTHL. The impacts have been predicted along the MTHL alignment based on the existing levels of air quality, traffic, meteorology etc.

Mitigation Measures

- A thick vegetative cover along the approach roads (Sewri and Nhava side) of the sea link will act as a barrier & will help to absorb the emission of the vehicles.
- Road Furniture/Signboards will be put along the approach roads and at project building requesting motorists to avoid idling or/and stoppage of the vehicles at non-designated places.
- Continuous monitoring of parameter such as CO, will be carried out by installing monitoring stations on both the ends of the bridge. A mobile monitoring van will also have a vigil on the bridge for air quality monitoring.
- Micrometeorological station is proposed on the Sea Link which will continuously monitor wind speed, wind direction, relative humidity, and temperature. This will facilitate the knowledge of meteorological factors which are important and have co-relation with the ambient air quality.

In addition to the above mitigation measures, further technical improvement in form of superior engine design in order to meet the stringent Government regulations will also reduce emissions in the years to come. As a mitigation plan, competent authority shall enforce vehicular emission norms of the day.

Noise Levels

The prediction of noise levels due to the proposed MTHL have been carried out for the year 2017, 2021and 2031 using Federal Highway Noise Model developed based on the guidelines suggested by Federal Highway Administration (FHWA). The background noise levels and the noise generated due to the MTHL have been further added to the predicted noise levels to ascertain the resultant noise

It is observed that the noise level at the Elephanta is slightly exceeding the permissible limit of CPCB. This is due to the fact that the existing noise level is already much higher considering that there is no traffic. However the increase in noise levels at 30 m distance is about 11 dB(A) while it just 3.5 dB(A) at 3000 m distance. Therefore the impact due to noise generated by MTHL at Elephanta would be minimal.

Mitigation Measures

- Appropriate action would be initiated for declaring silence zone for about 2km length of MTHL on Sewri side and near to school/other sensitive receptors on Navi Mumbai side of MTHL.

- With the implementation of the mitigative measures proposed for air quality, the noise level can also be attenuated to acceptable limits by providing barrier of the Sealink (bridge).

Ecology

The sea link construction would lead to significant reduction of travel time, from Sewri to Nhava, i.e. connect the Mumbai main-land to the satellite town near Panvel, where main industrial activity and areas are located. It would further connect to the NH-4 Mumbai-Pune Express highway. This in-turn would have a beneficial impact to reduce traffic congestion, help in conservation of resources, & improve air quality to some extent. Therefore no significant impact is envisaged on the ecology during the operational stage of the project. Aquatic life of the Thane creek is also not affected when MTHL becomes functional. However certain measures have been proposed to ameliorate the existing environment. These should be seen as measures to enhance the quality of environment.

1) The huge pollution load in the Sewri mud-flat zone inhibit normal development of physiology and morphology of halophyte. Hence the growth and reproduction of the different mangrove species get affected. It is currently dominated by only one species (*Avicennia marina).*This signifies that this mud-flat does not support an ideal mangrove system. The poor biological diversity of fauna can also be correlated with the extremely hostile environmental conditions of the area in terms of presence of heavy metals, bacterial load, and high levels of oil and grease. The sources of pollution are the economic activities on both the adjoining land and the sea water.

2) *It is proposed to construct approach/access road in mudflat on viaduct structure to avoid impact on* sedimentation and erosional patterns or activities. This would allow growth of the coastal halophytic vegetation and revival of the mangrove species.

3) The pillars for the viaduct would occupy small area on the mud-flat and would not cause any serious erosion. Nevertheless, these pillars would alter biological diversity and would invite a large variety of benthic algae. These will, in turn, gradually form a secondary community a result of ecological succession. The water will also be biologically purified by the algae and other benthic organisms that will gradually settle on the pillars as per the law of succession. This will enhance, to some extent, the changes of growth of at least the halophytic vegetation.

4) To remove the circumstances of pollution is in itself a difficult task. As a means to purify environment by bio-engineering, it is useful to consider plantation of *Porteracea coarctata* in this area. It is a good remedial measure to purify the aquatic environment, as this species has a unique capacity for bio-accumulation. *Enteromorpha sp* which already exists in the local substrata in this zone, can also be fruitful if the plantation programme is taken up. This macro algae can accumulate high level of Cu, Zn, Mn, Fe and Pb and charge the system with O_2 during day time.

5) The major repository of pollution is the waters of the Thane Creek in Segment III. Here the MTHL project is designed in the shape of viaducts and bridge. The pillars in the bay region has the potential to adversely affect the benthic bio-mass; but these can also accelerate the biological diversity in the Segment by establishing the benthic algal community followed by animal communities to settle on them. But the need for taking actions to arrest pollution of water is necessary. This would require, *inter alia*, considerable investments on sewage treatment. Prohibition of ship-painting activities together with collection and disposal of bilge water in safer locations would be the other necessary measures.

6) The Shivaji Nagar mud-flat, has relatively less stress in terms of pollution. But the ONGC road has drastically cut off the supply of marine nutrients. Under such circumstances, it is necessary to consider construction of culverts across the ONGC road. In addition, construction of feeder canals with a grid layout in the mud-flat can possibly restore the eco-system. This will assist proper replenishment of the nutrients.

7) Across the Shivaji Nagar mud-flat, a viaduct structure would require a small amount of land and would not impede the flow of marine nutrients into the declining mangrove like eco-system on this mud-flat.

8) Compensatory afforestation would be taken up on 7 ha of land after construction phase. This would be in lieu of loss of 0.117 Ha mangroves that would be cut due to the construction of piers of sea link viaduct.

9) *MMRDA would beautify the area as tourist attraction in form of flamingo park, mangrove park. Certain area along the bridge can be managed as tourist spots and as environmental education centers along with the involvement of local community/NGO.*

10) *A nature interpretation centre would also be developed by MMRDA in the area to create awareness about importance of conservation of flora and fauna.*

The measures suggested above would only enhance the quality of the given environment and could hopefully bring back the mangrove-type eco-system eventually. Without these actions, the sensitivity of the given ecology need not be considered as factors to restrain construction of the MTHL project. To say the least, the existing ecology is either dead or moribund.

Water Quality

There could be occasional oil spills, grease and dirt due to the plying of vehicles on the MTHL, which may enter the creek waters due to surface runoff. However the impact is insignificant. During the monsoon the surface runoff from the road will be collected through the road side drains and will be discharged in to the natural streams nearby.

Mitigation Measures

Storm water drains will be proposed on either side of MTHL and also viaduct. Storm water from the ROB/Viaduct will be collected by spout and will be taken to the Chamber through downtake pipe which will be discharged in to the natural drain/storm water drains. The new roadside drain will also be connected to the existing storm drainage system / drains in the area at appropriate locations.

Solid Waste Management

Solid waste from the project during construction will be mainly domestic scraps & wastes from the construction camp and construction spoils from construction sites.

- The small amount of construction debris will be disposed of in suitable pre-identified dumping areas in tune with the local condition to avoid land degradation & water pollution due to indiscriminate dumping.
- Dumping areas will be biologically reclaimed through top soil cover & plantation.
- Regular inspection of haul roads, construction site & camp will be carried out to ensure regular and timely removal of construction debris to the dumping sites.

Impacts on Quality of Life

Socio-Economic Condition

The socio-economic scenario in the region will certainly change with positive impact on the existing regional socio-economic pattern. Lot of employment opportunities will be created for the local people which will have positive impact on the economic growth of the region and subsequently the increase in living standard of the people of the region. It will have positive effect on industrial sector in Navi Mumbai area. Also it will boost the port related activities as well as rapid growth of Navi Mumbai International Airport & Special Economic Zone (SEZ) being developed in the Navi Mumbai.

Accident hazards and safety

During operational phase accidents / hazards will be greatly minimized and will ensure further safety of the local people.

Aesthetics and landscape

It is proposed to plant avenue trees as well as hedges / shrubs wherever possible within the project corridor on Nhava side of MTHL.

A landscaping will be provided for viaduct and interchange during implementation. Adequate provision is made in the Project cost.

ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) has been recommended for the project. This EMP takes into account all the environmental impacts identified for MTHL and the corresponding mitigation measures to ameliorate the same.

ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) has been recommended in this chapter. This EMP takes into account all the environmental impacts identified for MTHL and the corresponding mitigation measures to ameliorate the same. The EMP presented includes:

- Specific actions to be taken vis-à-vis site-specific issues;
- Mitigation measures for abatement of the undesirable impacts caused during construction and operation stages
- Responsible agencies for its implementation & supervision;
- Time frame for implementing Mitigative actions;
- Post project environmental monitoring programme to be undertaken after commissioning of the project
- Environmental status reporting frequency; and
- Institutional arrangement, Strengthening of their capability, and role.

Environment Management Measures

Construction Stage

The construction stage of MTHL will involve impacts on the different environmental components but will be of purely temporary nature. The need for a balanced evaluation and planning for risks associated with construction activities such as accidental spillages and consequent damage to the surrounding environment in terms of loss of flora and fauna etc. continues to grow in importance. Other possible locations where safety measures will be useful include the locations of Hot Mix plants, casting yard, batching plants, quarries and labour-camp sites.

Operation Stage

The operation stage will essentially entail monitoring activity along the corridor. The monitoring for pollutants specified in the Monitoring Plan will serve two purposes. In addition to checking the efficacy of the protection/mitigation/enhancement measures implemented, this will help verify the predictions made as a part of the impact

assessment. Thus, it will complete a very important feedback for the MMRDA. The measures adopted and/or to be adopted during the different stages of the project have been detailed.

The mitigation measures recommended will become integral part of BOT Bid Documents. The major instruments of environmental management will be Bid Document and monitoring performance of the construction by the Environmental Management Cell (EMC).

Environmental Monitoring Plan

The purpose of the monitoring programme is to ensure that the envisaged purpose of the project is achieved and results in desired benefits. To ensure the effective implementation of the EMP, it is essential that an effective monitoring programme be designed and carried out. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP
- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in management plan, if required
- To enhance environmental quality
- To satisfy the legal and community obligations

Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters recommended for road transportation developments are Respirable Particulate Matter (RPM), Suspended Particulate Matter (SPM), Carbon Monoxide (CO), Oxides of Nitrogen (NO_x), Sulphur Dioxide (SO_2). These are to be monitored at designated locations during the operation phase. Data will be generated twice a week over a fortnight in all seasons (except monsoons) at all identified locations in accordance to the National Ambient Air Quality Standards. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan.

Noise Level Monitoring

The measurement for monitoring noise levels will be carried out at all designated locations in accordance to the ambient Noise Standards formulated by Central Pollution Control Board (CPCB). Sound pressure levels will be monitored on twenty four hour basis. The location, duration and the noise parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan.

Water Soil & Ecological Monitoring

Water, soil and ecology will be monitored as per Environmental Monitoring Plan.

Environmental Management Cell

The responsibility for the implementation of the EMP will be with the Concessionaire and Concessionaire (P & C). An environmental management cell (EMC) will be established by the P &C for implementing the mitigative measures. The environmental officer for MTHL will supervise all activities and accordingly advise the P & C to improve on areas where any short comings are observed. The EMC will provide all the monitoring results to him who will keep a record of all information and suggest suitable measures to be adopted by the Concessionaire if any aspect is found to be diverting from the anticipated values/ standards. To mobilize the appropriate expertise to design diverse type of mitigation measures, the P & C need to be collaborated with order institutions in the public and private sector viz. State forest Department, State Public Health Engineering Department, State Traffic Department, State Police Department etc. The EMC will ensure timely implementation of various mitigative measures at different stages of the project i.e. during construction and operation stage.

Institutional Training

The Environment Management Cell (EMC), in addition to implementing and monitoring different environmental attributes, will also be actively involved in imparting training and raising environmental awareness of Construction Engineers/ Concessionaires and other staff members/ workers so as to enable them take the environmental aspects into consideration as and when required. In the long run, the EMC can impart additional and specialized training in environmental management of the road system.

Budget for EMP

A capital cost provision of Rs. 4100 lakhs will be kept towards the environmental protection measures in the EMP. The budgetary cost estimate for implementation of the environmental protection measures is elaborated in **Table 5.3** of EIA report.

Apart from this, the measures/ issues that would form integral part of BOT Bid Document and which the BOT operator is bound to provide as part of his responsibility and legal obligations include the following:

- Providing labour camps and all other facilities as laid out in the EMP throughout the pre-construction and construction phase.

- Cost incurred towards maintaining labour camps, sanitation systems, and providing potable drinking water etc.,

- Cost incurred towards providing labourers with safety equipments and appliances during construction phase.

- Cost incurred towards organizing and conducting periodical health camps for the benefit of labourers and their families.

RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

Mumbai Trans Harbour Link will be 6-lane, 22 km long link involving about 16 km bridge with a design speed of 100 kmph. Therefore some risk is involved during operational stage. The risk may be due to accident, fire, sabotage, earthquake, collision of ship with

the bridge or spillage of oil and chemicals on the bridge and sea. This will, depending upon the type and intensity, involve disasters in terms of loss of life and damage to the bridge apart from disruption of traffic. Therefore to avoid and minimize this, disaster and emergency management plays a very important role.

Anticipated Emergencies or Disasters

The disasters can be classifieds manmade or artificial and natural. Both type of disasters causes' loss of life as well as properties. The anticipated disasters are:

- Accidents Or Medical Emergencies
- Fire
- Sabotage
- Collision of Ship/barge with bridge
- Explosion
- Bomb Threat
- Chemical Spill
- Local/Civil Disturbance
- Utility Failure
- Violent Crime Or Behaviour
- Health Emergency (Epidemic)
- Weather – Monsoon

Components of DMP

The efficient and effective Disaster Management System should have following components

- Emergency Response Team
- Public Affairs
- Telephone Services
- Dining Services
- Financial Services
- Planning Section

Emergency Services needed to meet the disaster

1. Fire fighting – Fire services available in the CIDCO/NMMC and MCGM area
2. Search and rescue – Fire services / Ambulance in CIDCO/NMMC and MCGM area
3. Medical emergency care – Trauma Care / First Aid Centre with additional services from identified hospitals of Mumbai and Navi Mumbai.
4. Facilities Services (public works) – damage prevention, debris, shoring up buildings, custodial, maintenance, and support to other agencies.

5. Scene security and traffic control – Traffic Control Centre
6. Hazardous materials operations – Fire Services
7. Communications Unit – information systems for tactical, regional and national information. Telecommunications, Main Control Centre, Human Resources, etc.
8. Food/Water unit – for emergency workers and patients.
9. Staffing – responsible for operations during the emergency; responsible for normal project operations. Pandemic – should plan that half of the staff will be unavailable.
10. Supply unit – equipment, personnel, supplies, medical supplies,
11. Shelter – Administration Building.
12. Transportation – Project vehicles

In addition to above following equipments are proposed to be stationed at **Bridge Control Station on the bridge for disaster management during Fire Fighting**

- Foam cum water tender
- Portable fire fighting pumps
- Fire jeeps / vehicles
- Foam fire extinguishers
- Dry chemical powder extinguishers
- CO_2 extinguishers
- Fire protections suits
- Full face and half face mask respirators
- Light water foam AFFF
- Spark proof torch
- Fire alarm system
- Gas measuring meter
- Fire tugs (in the water)

In addition to the above disaster mitigation measures, monitoring and surveillance system proposed for MTHL will greatly help to mitigate the disasters.

CHAPTER 1

INTRODUCTION

1.1. Preamble

Mumbai's peculiar geographical spread imposes constraints on expansion; its great job potential has nevertheless attracted migrants from many parts of the country. The result has been severe housing shortages, lack of open spaces and civic amenities and transport bottlenecks. As per the 2011 census, the population of Mumbai is 12.25 Million.

The port, market, industries, offices and above all increasing population has considerably overloaded the rail and road transportation infrastructure of the city, causing innumerable commuting hardships as well as severe strain on the city's civic services resulting in extremely poor living conditions for the majority of residents.

The northern & north eastern parts of Greater Mumbai are likely to be saturated in the near future. In that event, the only location for expansion (apart from Navi Mumbai) will be in areas to the north of Greater Mumbai up to Virar at the northern limit of the Mumbai Metropolitan Region. This northwards expansion however is aggravating problems of its own. With the augmentation of the north-south commuter movement it would not only keep increasing commuting time to the heart of the island city but also traffic congestion on the transport network.

The pressure on the rail and road network can be relieved only by redirecting part of the movement into an east-west (towards Navi Mumbai) orientation. Having known the geography of the city, this can only be achieved by taking positive steps to encourage the development of residential areas on the mainland on the coast.

1.2. Need of the project

The need for the project arises from the undisputed fact that Greater Mumbai is already overcrowded and congested. The only solution to prevent the existing conditions from worsening is to expand on to the mainland, which to a limited extent, has already occurred in the northern half of Navi Mumbai. This is however, insufficient, and a major push to the development of the rest of Navi Mumbai can be given only by providing quick access to the southern half of Navi Mumbai.

The southern half of Navi Mumbai is having 2,500 hectares of land for housing, which will benefit most in terms of commuting time by the construction of the Link between mainland and south of Mumbai. When completed, MTHL will reduce the distance between the island and the mainland by 17km viz-a-viz the existing road link and will help save approximately an hour in travel time.

At present, there are two road links connecting Mumbai to Navi Mumbai:

- The Thane Creek bridge

- Airoli bridge

Both these links together are near saturation and are not equipped to meet the combined future projected traffic, thereby necessitating creation of additional links to meet traffic growth. In this context, the proposed Mumbai Trans Harbour Link has become a necessity for the state government.

The proposed Mumbai Trans Harbour Link will, therefore, serve not only as an economic gateway to Navi Mumbai but also a panacea for the problems being faced by Mumbai. The link would also further strengthen the economic integration of island of Mumbai and the mainland. Navi Mumbai would therefore emerge as a vibrant satellite city to Mumbai in the same way as Gurgaon and Noida have emerged as satellites to New Delhi.

From this perspective, the MTHL project will not merely provide the most efficient solution to Mumbai's acute accommodation problem, but will provide the most viable solution open to the city for its survival. The location of the MTHL alignment is shown in **Figure 1.1.**

Figure 1.1: Satellite Map of the proposed MTHL

1.3. Need and Objective of EIA study

As per the notification on Environmental Impact Assessment (EIA) of developmental projects issued on 14th September 2006 under the provisions of Environment (Protection) Act, 1986, expansion or modernization of any activity (if pollution load is to exceed the existing one) or new project listed in the Schedule of the notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central or State Government in accordance with the procedure specified in the notification. Therefore EIA is mandatory for these categories of developmental projects.

Hence, the objective of this EIA study is to ensure that development options under consideration are environmentally sound and sustainable and that the environmental consequences of the project are recognized early and taken into account in the project design.

It is pertinent to mention here that the MTHL project had already received environmental clearance from MoEF on 11th March 2005 (The copy of the same is attached herewith). On receipt of the same, GoM through MSRDC Ltd had initiated the bidding process for construction of Sea Link but it could not be completed and the project got delayed. As per the EIA notification dt 27/01/1994, the validity of environmental clearance was 5 years and has expired on 10th March 2010 in case of MTHL. Hence, the project is required to obtain necessary clearance as per the prevailing laws.

Now Government of Maharashtra has appointed Mumbai Metropolitan Region Development Authority (MMRDA as nodal agency for implementation of MTHL project on BOT basis. MMRDA is in the process of appointing Developer/ Concessionaire for Mumbai Trans Harbour Link (MTHL).

1.4. Project Proponent

MMRDA was set up on 26th January, 1975 under the Mumbai Metropolitan Region Development Authority Act, 1974 by the Government of Maharashtra as an apex body for planning and co-ordination of development activities in the Mumbai Metropolitan Region comprising of Mumbai and its influence area. The Mumbai Metropolitan Area consists of the metropolis of Mumbai and its hinterland. The region has an area of 4,355 sqkm and a population of more than 2.2 crores in 2011. MMRDA is the project proponent for development of MTHL. The project is envisaged to be taken up on a Design, Build, Finance, Operate and Transfer (DBFOT) basis, on a PPP (Public Private Partnership) structure under Viability Grant Funding (VGF) scheme of Government of India.

1.5. Policy, Legal and Administrative Framework

The principal Environment Regulatory Agency in our country is the Ministry of Environment & Forest (MoEF). The environment policies and environment clearance process for various projects are laid down by MoEF. The State Pollution Control Board (SPCB) grants No Objection Certificate (NOC) and consent for

establishment and operation of the project. As per the EIA Notification of MoEF issued on 14th September, 2006, a National or State highway development or expansion projects fall in either Category A or B of the schedule of the notification. The proposed project does not completely fulfill either of the criterions described for Category A or B, i.e. the proposed alignment is a sea link which is 22km (less than 30km) and it is not a national/state highway. 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. Though construction of '**Sea link**' is a permissible activity as per CRZ notification, approval from Maharashtra Coastal Regulation Zone Management Authority (MCZMA) is required as per the MoEF Notification of January 2011.

The clause 3 and 8 of the CRZ Notification, January 2011 mentions that the construction of sea link is a permissible activity in CRZ. The same are referred below:

Clause "3 (iv) (Page 2). Prohibited activities within CRZ -
The activities such as Land reclamation, bunding or disturbing the natural course of seawater are declared as prohibited activities within the CRZ **except** those,-
(a) required for setting up, construction or modernisation or expansion of foreshore facilities like ports, harbours, jetties, wharves, quays, slipways, **bridges**, **sealink**, road on stilts, and such as meant for defence and security purpose and for other facilities that are essential for activities permissible under the notification;"

Clause "8 (Pg 9) Norms for regulation of activities permissible under this notification,-
(i) The development or construction activities in different categories of CRZ shall be regulated by the concerned CZMA in accordance with the following norms, namely:-
I. CRZ-I,-
(i) no new construction shall be permitted in CRZ-I ***except,-***
(e) **Construction of trans harbour sea link** and without affecting the tidal flow of water, between LTL and HTL."

"(ii) Areas between LTL and HTL which are not ecologically sensitive, necessary safety measures will be incorporated while permitting the following, namely:-
(g) **Construction of trans harbour sea links**, roads on stilts or pillars without affecting the tidal flow of water."

1.6. Purpose of Study

The purpose of carrying out Environment Impact Assessment (EIA) study is to assist in the decision making process and to ensure that the project option under consideration is environmentally sustainable and sound. EIA identifies ways and means for improving the project environmentally friendly by preventing, minimizing, mitigating or compensating for adverse impact, so as to achieve a sustainable development.

1.7. Project Benefits

MTHL will directly and indirectly lead to the betterment of MMR, both from an economic and social perspective.

Direct Benefits from MTHL

- Savings in travel times for commuters.
- Improved comfort and accessibility between the island and the mainland.
- Reduced operating costs of vehicles due to lesser congestion.
- Accelerated growth of Navi Mumbai.
- Smooth traffic flow from Navi Mumbai airport to Mumbai Island.

Indirect Benefits from MTHL

- Rationalization of real estate prices in Greater Mumbai
- Increased demand for land in Navi Mumbai and consequent improvement of land prices.
- Accelerated economic development of Navi Mumbai and nearby regions
- Greater economic integration of Mumbai island with Navi Mumbai and extended regions of Pune, Goa, Panvel and Alibaug
- Decongestion of Mumbai Island and dispersal of population to Navi Mumbai region and beyond
- Environmental improvement and reduced pollution levels
- Improved safety due to reduction in accidents
- Improvement in trade and trade competitiveness through faster and improved logistics

The proposed Mumbai Trans Harbour Link will therefore serve not only as an economic gateway to Navi Mumbai but also a panacea for the problems being faced by Mumbai. The link would also further strengthen the economic integration of Mumbai Island and Mainland Mumbai. Navi Mumbai would therefore emerge as a vibrant satellite city to Mumbai in the same way as Gurgaon and Noida have emerged as satellites to New Delhi.

Both Thane Creek Bridge and Airoli Bridge are near saturation, thereby necessitating creation of additional links to meet traffic growth. In this context, the proposed Mumbai Trans Harbour Link has become a necessity for the state government.

A number of developmental initiatives have been proposed in the Navi Mumbai region that will not only give rise to additional traffic movement, but also accentuate the need for greater economic integration of Mumbai Island with Mainland Mumbai. Some of the key infrastructure facilities proposed and / or already developed include:

- Navi Mumbai Integrated Special Economic Zone (SEZ)
- International airport at Navi Mumbai
- New container terminals at Jawaharlal Nehru Port Trust at Nhava Sheva
- Thane Vashi, Thane-Nerul and Nerul-Uran Rail link

- CBD – Taloja-Khandeshwar-ring metro
- Trans Thane Creek Industrial Area

Navi Mumbai is also well connected through rail and road links with Pune, Nasik and Thane, indicating the potential for the region to develop into a satellite city.

In this context, the proposed Mumbai Trans Harbour Link (MTHL) connecting Sewri to Nhava Sheva is expected to be a key driver in the development of the city by promoting horizontal growth as against vertical growth that has been experienced over the past few years. The link would help reduce the problems of congestion and pollution in Mumbai Island.

1.8. Structure of the Report

The rest of the report is presented in following chapters:

Chapter 2 Project Description

This chapter presents the brief history of the project and the brief details of the proposed project including the suggested construction methodology.

Chapter 3 Baseline Environmental Status

Presents baseline environmental status in terms of air quality, noise levels, water quality, soil quality, meteorology, coastal and marine ecology, archaeological monuments, etc.

Chapter 4 Impact Assessment and Mitigation Measures

This chapter presents the assessment of various impacts on different environmental attributes with mitigation measures to ameliorate the same. The impacts are identified for pre-construction, construction and operation stages of the project on various environmental parameters and site-specific issues both during project construction and operation phases of the project.

Chapter 5 Environmental Management Plan

Presents the recommended EMP, both for construction and operation phases of the project. This chapter also presents suitable environmental monitoring plan/ schedule for the key environmental parameters, recommended mitigation measures, and Institutional strengthening/ environmental risk and disaster management plan.

Chapter 6 Risk assessment and Disaster Management Plan

Presents the analysis of associated risks and anticipated disaster due to the proposed project. The mitigation measures in case of disaster.

CHAPTER 2

PROJECT DESCRIPTION

2.1 Background

2.1.1 Early Studies

The origin of Mumbai (Island City) - Uran (Main Land) transport link goes back to 1970, when it was first recommended in the Draft Development Plan. Subsequently, committees were formed in 1972 and 1978 to study the possible alternatives for establishing the Transportation Links across the harbour. The Committees identified alternative routes, a northern route linking Sewri with Nhava and a southern route linking Colaba with Uran, and suggested necessary engineering studies for the alternative routes.

A Steering Group was constituted in February 1981, under the Chairmanship of Mr. J.R.D. Tata. The Steering Group reviewed the earlier studies and recommended that priority should be given to the construction of a link between Sewri and Nhava.

In 1982, an International Consortium of Consultants led by Peter Frankael and Partners (PFP), UK, was appointed by the Steering Group to carry out a feasibility study and to prepare detailed project report for the proposed Mumbai Trans-Harbour Link (MTHL). PFP submitted their feasibility study report in 1983. Six alternative alignments between Sewri on Mumbai island and Nhava on the main land were identified and studied. All the alignments started from Sewri. Out of these, four were proposed to terminate to the north and two to the south of Jawaharlal Nehru Port (JNP). The route length varied from 20 km to 23 km.

The study recommended the northern most alignment for the preferred transportation link. The recommended alignment was 22.61 kms long and comprised interchanges at Sewri and Nhava, sections across the mudflats over embankments on both sides of Sewri & Nhava, creek portion over viaducts/bridges and Nhava approach at grade. The recommended northern alignment was modified by the Expert Group by shifting it to south of the jetty head in order to satisfy Bhabha Atomic Research Center (BARC) requirements. This shifted alignment was approved by Prime Minister's Office (PMO) in 1984. This alignment is also as per the Regional plan of Mumbai – Metropolitan Region.

CES were appointed to review and update the feasibility study for the recommended northern alignment in 1996 taking into account the subsequent developments after completion of 1982 study. During the study, CES suggested further modifications to the alignments.

CWPRS Study

Central Water and Power Research Station (CWPRS, Pune) has studied the approved alignment finalized by the expert and also the span arrangement proposed for MTHL. They have given the observations that the proposed line will not cause any erosion or siltation in the creek. Further no unfavourable currents will be formed due to construction of Jetty.

2.1.2 CES 2004 Study

The study reviewed various recommendations made in the past on MTHL alignment and the approaches, the dispersal of traffic on Island side in Mumbai at Sewri and Main land side in Navi Mumbai at Chirle, obligatory requirements for passing over Pir Pau jetty and navigation across Thane and Panvel Creeks.

The Link was proposed to commence at grade from east side of Sewri Railway Station on the Harbour Line of Central Railway, proceed to Timber Pond Depot along Sewri Container Depot, cross the inter tidal zones at Sewri and Shivaji Nagar and encompass Thane Creek and Panvel Creek in between and terminate at the north of Chirle village near Nhava through an interchange to National Highway 4B on the mainland.

The study recommended the Mumbai Trans Harbour Link (MTHL) to be developed having six lane dual carriageway Road Bridge and separate rail bridge connecting Sewri on Mumbai side to Nhava on Navi Mumbai side.

The MTHL was proposed to be taken up as follows:

Phase I	Construction of main bridge with 6 lane facility from Sewri to Nhava including approaches at grade near Sewri end, interchange at NH4B near Chirle village and underpasses at road and railway crossings.
Phase II	Dispersal System at Sewri connecting Eastern Freeway and Acharya Donde Marg to MTHL (Sewri Interchange). Extension of MTHL from Chirle to Mumbai-Pune Expressway (at Sanjgaon).
Phase III	Construction of a broad gauge double track rail link from Sewri to Nhava on the north of the above mentioned facility with connection to the 6th Corridor of Railway near Sewri and a connection to Uran-Panvel rail link on Nhava side.

The features of alignment proposed by CES and accepted and proposed to be taken forward for construction were:

The features of the proposed alignment are as follows:

Sewri Interchange & Approach Ramps to MTHL and connection to sea bridge	Vertical clearance over the existing road 5.5m	0.720 km
Main Structures :	Vert. Clearances	
Viaduct across Sewri Intertidal zone – 50 m spans	9.1 m above HHTL	4.650 km
Bridge across Pier Pau Jetty – 120 m spans	25m	0.740 km
Viaduct up to Central Channel (Thane Creek) – 50 m spans	9.1 m above HHTL	2.550 km
Bridge across Central Channel (Thane Creek) – 85+2x150+85 m spans	25.2 m above HHTL	0.540 km
Viaduct up to ONG Pipelines – 50 m spans	9.1 m	2.650 km
Bridge across ONG Pipelines I – 75+120+75 m span		0.270 km
Viaduct between ONG Pipelines – 50 m span	9.1 m	0.650 km
Bridge across ONG Pipelines II – 85+160+85	9.1m	0.430 km
Viaduct up to Panvel Creek – 50 m span	9.1m	1.600 km
	25.2 m above HHTL	0.320 km

Sewri Interchange & Approach Ramps to MTHL and connection to sea bridge	Vertical clearance over the existing road 5.5m	0.720 km
Bridge across Panvel Creek – 85+2x150+85 m Viaduct across Nhava Intertidal zone and Mangrove area which is on land	9.1 m 9.1m 5.5m	3.000 km
Land Viaduct/Embankment up to Interchange at Chirle	5.5 m	3.730 km
Total Length		**21.85 km**

Table 2.1 Elements of the CES 2004 Alignment

2.1.3 Rites 2010 Railway Provision on MTHL

With a view to providing a Metro system across Mumbai with a link between Sewri and Navi Mumbai, MMRDA commissioned a study to investigate the addition of a railway to MTHL.

The study concluded that a railway corridor could be constructed on a separate viaduct offset 50m from the proposed highway viaduct.

2.2. Recent Alignment Recommendations

2.2.1 Horizontal Alignment

The MTHL will start from 3 level Interchange proposed at Sewri where the Eastern Freeway which is a north south 4 lane elevated road presently under construction and the proposed Sewri-Worli East West connector would integrate with MTHL. From the interchange the alignment will follow the earlier approved alignment passing along Timber Depot Road and enter Sewri Mudflats and then continue towards east and traverses over Sewri mudflats, pir-pau jetty, Thane Creek Channel, Panvel Creek Channel and the intertidal zone before turning south to enter the main land at Shivaji Nagar in Navi Mumbai.

The alignment further traverse south-east to meet the NH 4 B by keeping Shivaji Nagar and Selghar villages on the south and Kharkopar on the north before crossing SH-54 and Panvel-Uran railway line. Between Shivaji Nagar and SH 54, the link crosses existing local roads and proposed coastal Road of CIDCO, and Seawoods Uran rail link east of Kharkopar.

The start of the alignment (km 0.0) has been considered from Sewri interchange where the MTHL connects the alignment of Eastern Freeway. The recommended alignment along Timber Depot Road has been slightly modified considering the layout of proposed interchange at Sewri and its integration with Eastern Freeway and East-West Connector.

The following design standards have been considered for the design of MTHL:

Sl No	Particulars	Unit	Value	
A. MTHL-Main Link				
1 (a)	Bridge portion Cross section			
	Width of each carriageway	m	3 x 3.50	
	Width of Median (excluding edge strip)	m	1.50	
	Width of Shy Distance (edge strip) on median side	m	0.25	
	Width of Shy Distance (edge strip) on parapet side	m	0.50	
	Walkway & Cableway (excluding anti crash barrier)	m	1.20	
1 (b)	Land portion Cross Section			
	Width of Pavement on Each Carriageway	m	3 x 3.50	
	Width of Paved Shoulder	m	1.20	
	Width of Granular Shoulder	m	2.00	
	Width of Shy Distance (Edge Strip) on median side	m	0.25	
	Width of Median (excluding edge strip)	m	4.00	
2	Design Speed for main line	Kmph	100	
3	Camber for Carriageway & Paved Shoulder	%	2.5	
4	Camber for Granular Shoulder	%	3.0	
5	Maximum Super elevation (Rotation about median edge)	%	4.0	
6	Minimum Horizontal Radius (Ruling)	m	400	
7	Minimum Horizontal Radius without transition	m	2000	
8	Minimum vertical gradient	%	0.5	
9	Maximum vertical gradient	%	2.5	
10	Maximum grade change not requiring vertical curve	%	0.5	
11	Minimum distance between points of change in vertical gradient	m	500	
12	Minimum length of vertical curve	m	60	
13	Vertical Clearance over NH/SH	m	6.00	
14	Vertical Clearance over rail line	m	6.525/8.40 for DFC	
15	Minimum Sight Distance	m	250	
16	Minimum K-Value for Summit curves		75	
17	Minimum K-Value for Valley curves		45	
B. Interchanges Ramps				
			Rural(Chirle)	**Urban (Sewri)**
1	Design Speed	Kph	50	50
2	Carriageway Width	m	2x3.50	2x3.5
3	Paved Shoulder Width (Inner side)	m	1.00	0.25 edge strip
4	Paved Shoulder Width (Outer side)	m	1.00	0.25 edge strip

Sl No	Particulars	Unit	Value	
5	Minimum Radius	m	180	27
6	Maximum Super elevation	%	7.0	4.0
7	Maximum Longitudinal Gradient	%	3.3	3.3
8	Extra Widening on Curves	m	0.6/0.9	-
C. Interchange Loops				
			Rural(Chirle)	**Urban (Sewri)**
1	Design Speed	Kph	50	30
2	Carriageway Width	m	2x3.50	2x3.5
3	Paved Shoulder Width (Inner side)	m	1.50	0.25 edge strip
4	Paved Shoulder Width (outer side)	m	1.00	0.25 edge strip
5	Minimum Radius	m	85	85
6	Maximum Super elevation	%	7.0	4.0
7	Maximum Longitudinal Gradient	%	3.3	3.3

The proposed alignment is follows:

Approaches at Sewri : Approach Ramps to MTHL and connection to Messant Road & local network	0.72 km
Main Structures :	
Viaduct across Sewri Intertidal zone	4.650 km
Bridge across Pier Pau Jetty	0.740 km
Viaduct up to Central Channel (Thane Creek)	2.550 km
Bridge across Central Channel (Thane Creek)	0.540 km
Viaduct up to ONG Pipelines	2.650 km
Bridge across ONG Pipelines I	0.270 km
Viaduct between ONG Pipelines	0.650 km
Bridge across ONG Pipelines II	0.430 km
Viaduct up to Panvel Creek	1.600 km
Bridge across Panvel Creek	0.320 km
Viaduct across Nhava Intertidal zone	3.000 km
Road on Embankment up to Interchange at Chirle	3.730 km
Total Length	**21.85 km**

Table 2.2: Elements of the Recommended Alignment

The recommended alignment is shown in **Figure 2.1.**

2.2.2 Navigation Clearances

Earlier Studies

Previous studies identified the need for navigation spans across Thane and Panvel Creek with further consideration at the Pir Pau Jetty. The following summarises the

findings of previous studies and earlier discussions with MbPT on the navigation requirements:

- The depth maintained alongside the Pir Pau Jetty currently 6.1 to 6.7 m, although the berth was originally designed for depths of 8.8 m below chart datum (CD). It was the view of officials that maintaining depths at - 8.8 m CD was not practical due to continuous siltation and constant slippage of mud from the mudflats immediately adjacent to the channel. The Port Department thus advised that the vessels could be up to 15000 DWT maximum, that could be taken up to the Jetty though it is understood that present ships up to 8500 DWT only can reach the jetty after dredging.

- At present there is no night navigation to / from Pir Pau (old) Pier and there is presently no plan to change this.

- The width of central Thane channel is over 500 m. The channel is not demarcated as vessels tend to “yaw” as a result of considerable cross currents in the rising tides when the loaded vessels are maneuvered to the berths. Though practically the full 500 m width of the Central Channel up to the “bend” i.e. the junction of the Central and Pir Pau channel is available, the ships are piloted through the central 200 m portion on the way to the bend. The approach channel leading to jetty is, however, about 120 m wide.

- Vessel speed is therefore much less than 4 - 5 knots in the channels which reduces to zero at the loop bend. Loaded vessels navigate central Pir Pau channel on rising tides to take advantage of extra depths. Vessels with ballast can sail out at any state of tide, but only during daytime.

- It is understood that the channel leading to old Pir Pau jetty gets silted owing to cross currents. Hence, it is becoming uneconomical to operate vessels from old Pir Pau and vessels less than 5000 DWT capacity can only use this jetty. A new Pir Pau jetty has been developed in the main channel and was commissioned in 1997. As per the understanding reached while finalizing the alignment in 1984, MbPT was supposed to decommission the old Pir Pau jetty, once the new Pir Pau jetty is commissioned. State Government has requested MbPT to decommission the old Pir Pau jetty and accordingly the jetty is likely to be decommissioned.

The CES 2004 study identified the following navigation requirements:

	Horizontal Clearance (m)	Vertical Clearance (m)
Pir Pau & other Jetty heads	95	25
Central Channel	95	25
Thane Creek	95	25
Panvel Creek	95	25

Table 2.3: CES 2004 Study Navigation requirements

The choice of navigation span and vertical clearance has an impact on the construction and operation costs. The following objectives are desired:

- Maintain marine safety
- Minimise the width of the navigation channel to reduce the navigation span. This offers greater choice in the type of structures and allows for more cost-effective structural solutions, in terms of construction, and operation and maintenance costs.
- Minimise the navigation headroom requirement so that pier heights can be reduced. Pile bents are a cost effective foundation and substructure choice. By reducing the height of the alignment to maximise the use of this form of structure, cost savings will be achieved.
- Incorporate the views and gain approval from MbPT.

A review of the current usage of the harbour area suggests that the navigation envelope could be reduced relative to earlier studies and therefore these objectives can be satisfied.

The following clearances are proposed subject to the agreement of the port authority.

Viaduct	Horizontal Clearance	Headroom Clearance above H.H.T.L.
General Viaducts	50m minimum span	9.1m
Pir Pau and other Jetty heads	120	+6m above jetty level
Thane Creek Viaduct	2 x 100m / 2 x 170	25.2m
Panvel Creek Viaduct	1 x 100m / 2 x 150	25.2m

Table 2.4: Proposed Navigation Requirements

2.3 Interchange and Connection to Eastern Freeway

It is proposed a 3 level grade separator at Sewri Opposite Sewri Railway Station to facilitate the dispersal of MTHL traffic through an interchange via the north south elevated Eastern Freeway which is under construction over Messant Road and proposed East West Sewri Worli elevated Connector which follows existing Acharya Donde Marg and proposed DP road along drainage channel and the local road network which is at-grade. The interchange layout at Sewri is shown in **Figure 2.2.**

2.4 Viaducts over Sewri Mudflats

It is proposed that a span of 50m would be the most appropriate and competitive span length for the low level viaducts both across the mudflats and also across the sea where dedicated navigation clearance is not required. A 50m span single cell box girder deck gives a wide choice of construction methods such as precast segmental balanced cantilever, precast segmental span by span, precast whole span. Engineering analysis has shown that at this span and a minimum soffit clearance of 9.1m above HHWL, foundations comprising of single large diameter bored piles under each box girder are feasible. Use of single large diameter piles would obviate the need for pile caps which would need to be buried over the extent of the mudflats and have negative environmental and financial impacts. Entire operation will be done from a temporary bridge constructed parallel to the permanent structures so as not to disturb the eco-sensitive mudflats. The 50m spans would be continuous over six spans with movement joints spaced at 300m intervals which would give a reasonable riding quality.

2.5 Main Bridge Across the Harbour

The total length of the bridge is about 22 km. This length consists of obligatory spans at three locations which are as follows:

Location	Length	Name of Crossing
Ch. km 5.37 to km 6.11	740	Tata Jetty, Pir Pau Jetty, BPCL Jetty etc. and access channel.
Ch. km 8.66 to km to km9.20	540	Thane Creek Channel.
Ch. km 12.77 to km 13.2	430	Panvel Creek

Table 2.5 Obligatory Span Location

The chainages given above are tentative and need to be adjusted to suit site conditions, span arrangement etc chosen at the detail design stage by the Concessionaire.

For the viaducts between the obligatory spans, the span lengths of 50m are proposed to be retained. The viaduct vertical alignment will be modified to lower the height of the viaduct with a view to using single large diameter piles under each box as the foundations.

At Pir Pau Jetty and other jetties the span lengths will be in the order of 120m to clear the jetties. At this span an economical span length would be 120m and can be constructed as a variable depth single celled concrete box girder either as insitu or segmental construction.

The navigation requirements as currently agreed with MMD are as follows :

- Thane Creek – Two spans each 170m wide and vertical clearance of 31m above chart datum
- Panvel Creek – Two spans 170m wide and vertical clearance of 31m above chart datum.
- Considering the size of vessels that use these two creeks presently, it is not clear necessity 31 m vertical clearances for navigational span. It is proposed

to have further discussions with MMD to try and reduce the vertical clearance as this will lead to more economic foundations.

- The MTHL alignment crosses both Thane and Panvel Creek at a skew angle and it is proposed to provide navigation spans as follows :
- Thane Creek – two navigation spans each of 170m (100 m + 170 m + 170 m + 100 m)
- Panvel Creek- two navigation spans of 170m (45 m + 170 m + 170 m + 45 m)
- At these span lengths the bridges could comprise of single celled variable depth continuous concrete box girders constructed either insitu or as a combination of in-situ and precast segmental.

2.6 Nhava Side Approach Road and Interchange

Proposed MTHL after crossing 'Panvel Creek ' lands near Shivaji Nagar and traverses on land and terminates at NH-4B near Chirle. Between these two, proposed MTHL crosses number of CIDCO planned roads and existing roads. One of the proposed major roads is new Expressway link to JNP which will play a important role to disperse the traffic of MTHL to Navi Mumbai Airport, JNP and other parts of Navi Mumbai. Interchanges are proposed at Chirle where MTHL is terminating on NH-4B and at Shivaji Nagar where the MTHL crosses the proposed link to JNP. The interchange layout at Chirle is shown in **Figure 2.3**.

- Proposed MTHL crosses SH-54 which will be one of dispersal links. Existing SH-54 is 4 lane road and has been proposed for widening to 6 lanes with service roads. Traffic from MTHL may use this dispersal link to go Dronagiri, JNP, Uran and Panvel.

- Proposed MTHL terminates at 4-lane NH-4B, which is considered as major dispersal point of traffic to NH-17, NH-3, NH-4 and JNP.

- MTHL traffic going to NH-17 will follow NH-4B up to Palaspa Phata near Panvel and then join NH-17. It is explored that MTHL could be directly connected to NH-17 near Dolghar through new virgin alignment. This link can be further extended to Mumbai Pune Expressway to connect it at Sanjgaon near Toll Station.

2.7 Projected Traffic on MTHL

The traffic forecast for the horizon years 2017, 2021, 2031 and 2041 are given in **Table 2.6** and **Table 2.7** for Without and With Metro Scenarios. It is pertinent to mention that the MTHL Metro is considered in the year 2021. The traffic forecast considers the generated traffic from Navi Mumbai Airport and Navi Mumbai Special Economic Zone.

Year	2017	2021	2031	2041
Car/Taxi	29725	36250	53550	71975
LCV	6325	9050	15300	20550
Bus	2325	2700	3575	4575
HCV	5225	7550	12800	16375
MAV	1375	1975	3325	4250
Total Vehicles	44975	57525	88550	117725
Total PCU	68050	89463	140588	184775

Table 2.6 Daily Traffic Forecast – with MTHL Road only

Year	2017	2021	2031	2041
Car/Taxi	29725	33075	48225	64800
LCV	6325	9575	16075	21600
Bus	2325	1200	1675	2150
HCV	5225	7650	13075	16725
MAV	1375	1925	3600	4625
Total Vehicles	44975	53425	82650	109900
Total PCU	68050	82650	132788	174638

*Assumed Metro operational from 2021

Table 2.7 Daily Traffic Forecast – with MTHL Road &Metro

2.8. Regional Geology

The Deccan Traps are the most extensive geological formation in the region underlain by few patches of metamorphic and igneous complex of Archean age. These traps are overlain by calcareous day and sandstone of Cenozoic age and undifferentiated quaternary sediments. The traps of this region (upper traps) are having an average thickness of 450m with numerous inter-trappean beds and layers of volcanic ash. Ash beds are particularly well seen in the upper part of the traps, for instance around Bombay and Pune. These traps had a low viscosity and flooded large areas. Series of basalt Rows usually lie one on the top of the other. These basalt flows covered the older topography, resulting in extensive, virtually horizontal plateaus. The thickness between the individual lava flows may be highly variable and usually is very limited. The thickness of the individual flows may vary between 1m and 20m with an average of a few meters. Fine columnar basalt 40m high is exposed at Andheri in Mumbai city, but it is disappearing as a result of quarrying operations. The traps attain their maximum thickness near the Bombay cast where they are estimated to be well over 2000m thick. Near the Bombay coast as well as north of Bombay they dip towards the sea at an angle of about 10. During the sequential out-flowing of the lavas, the hot lava flowed over the relatively cool basalt surface of previous flows. At this contact, the lava cooled down relatively fast, leaving a very porous, irregular and often cindery inter-flow. In other places, weathering may have formed a clayey soil. These soils may have become some meters thick before they were covered by the next lava flows. Also these baked soils can be found as intercalation between the lava flows, in other places, the sequential flows may lie apparently seamless on top of each other. The cindery inter-flows and fossil soil generally form the main water bearing zones in the plateau basalts.

2.8.1. Sea Condition

To supplement the historical data already available Geotechnical Investigation were carried out along the proposed MTHL alignment. This investigation was carried out at 14 borehole locations. The main aim of the investigation was to gain

knowledge of the stratification and physical parameters for design of a suitable foundation system.

The water depth along the alignment was observed from 2.50 m to 12.00m. The depth is shallower on the either end of the alignment deeper in the middle stretch particularly in Vashi and Panvel creeks. During the field investigations the tidal variation was of the order of 2.50m to 5.00m and the maximum current was 4 - 6 knots. The maximum wind speed observed during the investigation period was around 40 knots.

2.8.2 Sub-Seabed Condition

The sub-seabed litho-stratigraphic conditions are presented in **Table 2.8**

Table 2.8. Sub Surface Profiles of Sub-seabed Lithostratigraphic Conditions

Sr. No.	Soil Description	Layer Designation	Thickness in Meter		
			Max.	Min.	Avg.
1	Very Soft to Soft Marine Clay	Layer 1	15.50 MBH-6	2.00 MBH-9	7.84
2	Residual Soil/ Completely weathered weak to very weak Basalt (Grade V / VI)	Layer-2	18.10 MBH-4	0.45 MBH-2	9.50
3	Moderately to Highly Weathered Basalt (Grade III/ IV)	Layer-3	8.5 MBH-1A	1.00 MBH-6	3.17
4	Fresh to Slightly Weathered Basalt (Grade I/ II)	Layer-4	34.30 MBH-2	9.90 MBH-1	16.37

2.9. Villages and Settlements

The Sewri end of the proposed MTHL link is a very congested area located on the eastern side of the Mumbai island city whereas, the Nhava end is not very populous except for few settlements such Shivaji nagar and Chirle. The main part of the link falling on land majorly passes through the mudflats at both the ends. Hence, no major rehabilitation of communities living in the vicinity of the alignment is required.

2.10. Toll Plaza

A toll plaza is proposed at the Nhava end of MTHL. The following guidelines in the planning and design of toll plaza will be followed.

1. The toll plaza buildings and associated structure and facilities will be designed as per prescribed standards
2. To provide low height barriers along main lanes to segregate tolled and non-tolled traffic
3. To provide traffic signs and markings for guiding traffic to and from toll plazas/posts/barriers.
4. To maintain the traffic lanes and toll plaza area to a roughness level as prescribed.
5. The install high mast lights of adequate numbers for maintaining clear visibility in the night.
6. To control rooms within the toll plaza shall have the following facility along with the equipments duly fitted and furnished as below:
   - Electrical UPS, generator, control panel for mains, sub mains etc
   - Air conditioning including panels, ducting around equipments etc.
   - False floors/false ceilings and other decorations.
   - Equipment rooms, equipment housing cabinets and ducting etc
   - I/C operation room, UPS room etc and decorations of these rooms.
   - Large screen projection including projector compatible with the system, installation, ducting screens etc
   - Control Centre equipments, cabinets, furniture etc.
   - Maintenance unit and allied functions, cabins and associated fixtures and furniture.
7. To provide 25KVA generator with Auto-On facility for maintaining power back up
8. To ensure adequate water supply with two (2) overhead tanks of 2500 litre capacity each.
9. Execution of all electrical works including cabling, cable trays etc required to facilitate the operational requirements.
10. To provide adequate furniture for the operation of the installed equipments and manpower.
11. To ensure adequate safety of the property, manpower and equipments, to fence the toll plaza.
12. To provide a solid waste management system to ensure high sanitation and health standards as prescribed by the authorities from time to time.
13. To enhance the landscape quality of the area with hard and soft landscape.
14. To make necessary provision for installation of other equipments such as X-ray machines, weigh-in-motion equipments or any other equipments.
15. All the computerized toll plazas will have the following facilities at the Toll Plazas for the maintenance of information records and functions-
    - Control room
    - Toll office and toll collection booth
    - Rest Areas and Canteen for Staff
    - First aid centre
    - Toilets, washroom
    - Parking spaces for commercial vehicles

- Arrangements for cranes/ambulance for moving damaged/disabled persons.
- Surveillance vehicles
- Round the clock security arrangement
- Uninterrupted communication/data transmission facilities (landlines, mobile phone internet)
- Adequate sanitary arrangements such as dustbins.
- CCTVs: The computerized toll collection centres to be equipped with CCTVs to enable seamless and real time data transmission through the electronic medium.
  - CCTV cameras will be installed for monitoring and regulating the toll collection from the traffic control centres and will support the toll plazas
  - Real time images of the toll collections being done at the toll plazas can also be transmitted to/from the toll plaza and the main toll control centre of MCD
  - The toll plazas will be equipped with video cameras capable of transmitting clear pictures.

16. Toll plazas shall have the necessary hardware i.e. furniture, computers, printers, servers, UPS, photocopier, telephones, fax machines, refrigerators and other equipment installed in adequate numbers so as to ensure uninterrupted toll collection and provide a satisfactory quality of working environment at all of them.

2.11 Electrical Systems

This being an urban link, it will be illuminated with street lighting of urban street standards. It is proposed that the lighting system be carried on double armed columns located in the central median on road portion while on bridges and viaducts on single arm column located adjacent to the RCC crash barriers/ parapet.

Navigation lights will be fixed on the underside of structures crossing navigation channels. Beacon/air control lights will also be provided on top of lower mast in case of a cable stayed bridge. A special electrical substation will be constructed and maintained for the link.

2.12 Bathymetry Survey

Generally the dry soundings were observed the landward side of the proposed alignment. All the depths were reduced to chart datum. The survey was conducted for a length of 16.0 out of 22.0 km for a band width of 500m. A minimum of 3 longitudinal lines for a continuous profiling of seabed with one line along the centre line and two wings line at 250 m apart on either side of proposed alignment were taken incorporating side scanner sensor, sub bottom profiler, echo sounder and associated DGPS. In addition the transverse lines for full width of 500 m run at 50 m interval were considered to cover the entire corridor. Thus the details are collected at every 50 m grid in both directions, i.e. longitudinal and traverse.

Additional runs by side scan sensor for detection of buried pipelines crossing the corridor were carried out.

a) The chart datum and tide levels were established for the project site.

b) Underwater current along with their directions were observed for one lunar cycle.

c) Shallow seismic / geophysical survey done along the proposed bridge alignment.

Table 2.9 Results of Bathymetry Survey

Sr. No.	Location	Ch. @ C/L of Proposed Alignment (km)	Depth of Seabed w.r.t. Chart Datum at Ch. @ C/L of Proposed Alignment (m)	Remarks
1.	Intertidal Zone on Sewri side	1.5	+ 2.5	Inter-Tidal Zone
2.		2.0	+ 2.6	
3.		2.5	+ 2.5	
4.		3.0	+ 2.3	
5.		3.5	+ 2.5	
6.		4.0	+ 2.8	
7.	Cluster of Jetties	4.5	-	
8.		5.0	-	
9.		6.0	-	
11.		6.5	-	
12.	Main Sea	7.0	- 4.6	Shallow portion
13.		7.5	- 4.0	
14.		8.0	- 4.5	
15.		8.5	- 6.9	Deep Sea - Main Navigational Channel
16.		9.0	- 6.4	
17.		9.5	- 6.5	
18.		10.0	- 6.4	
19.		10.5	- 5.8	
20.		11.0	- 4.8	Shallow Sea
21.		11.5	- 3.3	
22.		12.0	- 3.4	
23.		12.5	- 3.5	
24.		13.0	- 1.6	
25.		13.5	- 2.6	
26.		14.0	- 2.3	

Sr. No.	Location	Ch. @ C/L of Proposed Alignment (km)	Depth of Seabed w.r.t. Chart Datum at Ch. @ C/L of Proposed Alignment (m)	Remarks
27.		14.5	- 2.2	
28.		15.0	- 1.1	
29.	Intertidal Zone on Nhava side	15.5	+ 0.2	
30.		16.0	+ 0.8	
31.		16.5	+ 1.1	

Note: The positive (+) sign indicates level above chart datum.

2.13 Seismic Profile

The echo sounder used for record reveals medium to low reflectivity pattern in the entire area of survey suggestive of the presence of silty clay and clayey silts all along the proposed alignment. At few places the presence of sand was observed. The sea bed is mildly undulating with presence of sand ripples at few places. Seabed undulations were observed sparsely between Ch. 6.5 km to 9.0 km. Few sea-beds scars were also observed between Ch. 9.0 km to 9.5 km. This layer is underlain by granular sediments and possibly highly weathered rock fragments beneath which hard rock is prevalent. However the thickness of the strata is not uniform and varying at many places along the proposed alignment of bridge. The Band of Pipelines crosses the proposed alignment at Ch. 13.1 km to 13.3 km.

Table 2.10 Generalized Sub-Soil Profile of the Alignment

Sr. No.	Description of Strata	Thicknesses Encountered in Bore holes (m)		
		Maximum	Minimum	Average
1	Very soft to soft Marine Clay	15.50	2.00	7.84
2	Residual Soil / completely weathered weak to very weak Basalt	18.10	0.45	9.50
3	Moderately to highly weathered Basalt	8.50	1.00	3.17
4	Fresh to slightly weathered Basalt	34.30	9.90	16.37

2.14 Intelligent Transportation System

An Intelligent Transportation System (ITS) is proposed for MTHL. The main purposes of the ITS are to monitor the traffic behaviour and provide appropriate direction and advice to motorists in response to events affecting the Link. The

design of the ITS should be based on the traffic management and operation strategies devised to achieve the following broad objectives:

(a) Close and continuous monitoring of the traffic conditions;

(b) Prompt and accurate identification of any events that are likely to be a safety risk or a threat to the efficient operation of the road network;

(c) Maintain continuous traffic movements during different traffic operation schemes;

(d) Facilitation of road works and maintenance activities;

(e) Traffic management for adverse weather; and

(f) Efficient incident response.

The system would include the following features:

(g) Full video surveillance of the bridge and approaches by pole mounted close circuit television cameras located at regular intervals on the bridge.

(h) Emergency call boxes are proposed at regular intervals and are intended for public use and safety and provide direct communication to the bridge control centre. The call boxes would also include a fire extinguisher and an external emergency alarm push button.

(i) Continuous monitoring from the bridge control centre with warning of change in road conditions and/or abnormal changes in weather (wind, rain, storm, fog etc.)

(j) Traffic control devices will include traffic signals, variable speed signs, static signs, lane markings etc

(k) Changeable message signs will provide real-time information about bridge conditions e.g. “Road Maintenance ahead - 7 km”

(l) Variable speed signs shall be electronic signs displaying adjusted speeds. The signs are installed to outer the maximum speed units dependent on road and driving conditions.

(m) Vehicles carrying hazardous goods and special loads will be required to report to the bridge control centre to receive crossing authorization.

(n) Continuous bridge patrolling is proposed through Bridge Patrollers equipped with patrol vehicles.

(o) A bridge control station is proposed for this purpose in the middle of the link. A special platform 50m x 20m size is proposed to be constructed for this purpose with a provision of Ambulance, Police patrolling van, control tower, towing crane, fire brigade system etc.

2.15 Functional Cross Section

Carriageway Width

In order to meet the traffic flow demand three traffic lanes are required in each direction. Each traffic lane is 3500mm and the nearside and offside edge strips are also provided with a width of 500mm and 250mm respectively. The overall carriageway width in each direction is 11.250mm.

Parapets and Central Median

For enhanced long-term durability it is proposed to provide concrete profiled barrier and parapets. The designation of the barriers will be "P3 High Containment" in accordance with IRC: 06-2010.

Cross falls

In order to ensure safe driving conditions each highway carriageway is provided with a transverse cross fall of 2.5%.

Aesthetic Considerations

When considering bridge aesthetics the following well established principles will achieve an elegant bridge:

- Lighter and visually pleasant structural profile with a simple and elegant structural design.
- The span length of the viaducts shall be designed with regular rhythm and odd span length should be minimized.
- The visual experience from the road by users and outside the road shall be considered in the design of the viaduct structure.

The bridge is located in the middle of a vast bay and so significant architectural gestures will be largely unnoticed aside from the occasional passing fishing boat. Aesthetics should be considered in good detailing, which does not come at a significant extra cost. Some of the aesthetic features proposed for the preliminary deisgn are:

- A shaped precast edge parapet is a highly visual feature that gives the bridge its identity. Pre-casting ensures a neat and consistent finish.
- A small radius curve (r=150mm) on box girders rather than sharp edges softens the shape of the bold concrete box girder form.
- Locating pile caps, if required, below the water line for spans away from the navigation span significantly reduces the visual impact of the bridge when viewed from afar.

2.16 Construction Methodology

Construction methodology will depend upon BOT Concessionaire's resources, their planning to execute the project to meet the target dates. Proper appreciation of the

various construction problems involved in the context of the situation at the construction site, including supply, storage and transportation of the construction materials and planning and sequencing of various construction activities need to be studied in detail before arriving at a workable solution. It is anticipated that the construction of MTHL may present a number of problems. Many of these problems stem from the site conditions lead to the inescapable conclusion that a major portion of the works will have to be constructed from the sea and hence will have to rely heavily on sea access for the supply of materials.

2.16.1 Construction of Viaducts and Bridges

The link starts with viaducts from both sides with the central zone as major bridge. As major portion of the activity (about 70%) will be in the sea, which demands movement of the men and material by water transport. It is proposed to construct temporary approach bridges from both ends of the alignment as also the work sites where necessary so that movement can take place round the clock. These approach jetties will be provided with temporary steel piles with steel deck and concrete slab, to ensure the wave actions do not disturb the movements.

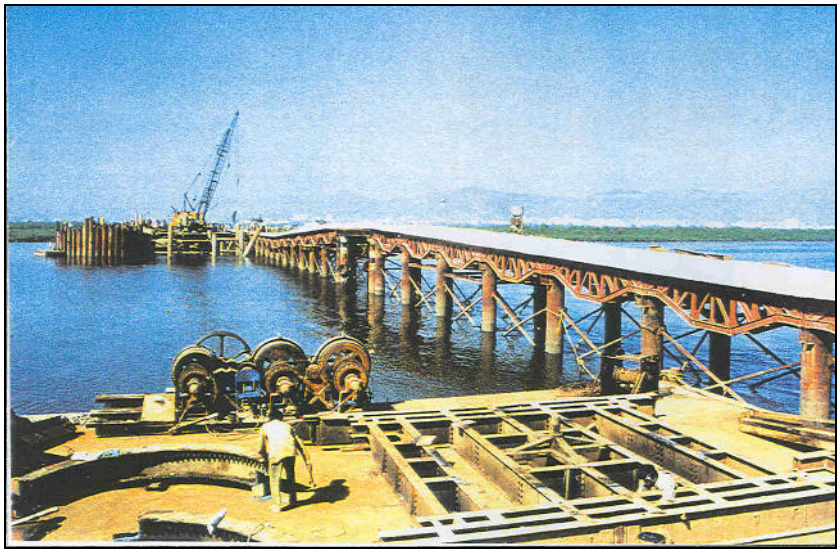


Figure 2.5 Temporary Bridge to be constructed in the Mudflats to avoid disturbance of Mudflats

Apart from the approach jetties, concrete will be provided separately at all work sites for berthing of floating vessels which are required to transport not only construction materials but also heavy pre-cast segments, as major portion of the superstructure activity will be carried out using pre-cast elements/girders. This demands extending jetty up to the deep channel where adequate draft is available for the floating barges carrying heavy units at all times. It is proposed that the approach bridge brought out earlier could be combined with the jetty so that dual purpose is served.

2.16.2 *Foundations*

The MTHL alignment has both viaducts and bridge. Though the proposal highlights provision of well (caisson) foundations on account of the alignment passing through the navigational zone, it is seen that for zones/areas which are less prone to ship

impact, large dia bored insitu piles could be provided. This would ensure speedy construction with rotary drilling equipments at a speed of 3 to 4 piles per week with adequate socketing in the rock. Pile foundations can be carried out using large capacity floating jack up platforms. The platforms will be large enough to accommodate the drilling unit complete with all requirements like jetty equipment, drilling equipments, compressor, generator etc. with accommodation for the crew working overnight. In case of well foundations mainly for marine bridge portion it envisage difficulties and hence recommend the use of two phase activity namely the first phase using pre fabricated floating steel caisson, grounded at location and anchored. The second phase starts with making a sand island within the caisson and to sink the well foundations by conventional method or dewatering the anchored caisson fully to make an open foundation as per the concessionaire's proposal. It is envisaged that such activity can be synchronized by having the fabrication yard at the main base camp from where the floating caisson of required site, floated, toed and grounded using concrete and water ballast to ensure controlled sinking and locating. Once the caisson is grounded to the required position the central zone could be dredged and well made to sink and made to rest evenly on the rock using the chisels and/or divers. In the event of the diving does not yield result, pneumatic arrangements could be installed making the area dry, ensuring even seating of the caisson. It is preferable to sink this caisson at least 150 mm in the rock as it can then be converted into permanent cofferdam providing necessary arrangement to the foundation to be built inside, thus serving the dual purpose i.e. acting as cofferdam & fender during operation.

In case of pile foundations however a special arrangement like sheet pile cofferdam or fender or row of piles or diaphragm wall surrounding the foundation will be escorted to provide fendering arrangement if the concessionaire opts for the pile foundation scheme.

2.16.3 *Piers*

Construction of the piers will not present particular problems other than that of access which is general to all aspects of MTHL construction. Being of constant cross-section and of significant height they are ideally suited to slip form construction.

2.16.4 *Superstructure*

The 50m PSC box girders used in the viaduct portion can be constructed either cast-in-situ or by placing over the piers the pre cast, pre-stressed girders that are cast in a casting yard. In the cast-in-situ method the formwork will be attached to the supporting steel girders spanning in between two consecutive piers.

If the box girders are proposed to be precast, prestressed in casting yards the operation of shifting these girders to their final locations and placing them over piers would not be easy as each girder's weight will be very high. Specially designed barges containing two tandem cranes with high capacity lifting hoists and tackles will be used for carrying out the above operations. The plan area of these barges will be carefully designed so that they require minimum draft of not more than 2.0m for

convenient operations. The advantage with this method is that the girders can be cast in casting yards during the same period as piers are constructed and within least time the superstructure can be erected.

Figure 2.6 Girder Shifting during Launching

Keeping in view the multipoint construction, stringent time schedules, the need for the excellent quality control, difficulties in providing number of temporary supports on poor soil strata and the need for large quantities staging and form work and transportation of construction materials across the sea, the precast method of construction will be used for 50 meter spans.

For the main viaducts of 120 m spans two methods of construction are possible, cast-in-situ cantilever construction and precast segmental construction.

In the cast-in-situ cantilever method, the section of the superstructure immediately above the pier is first cast using formwork supported from the pier. Next the cantilever construction gantries are erected over the cast section and “free cantilevering” begins simultaneously on both sides of the pier. Such method was successfully used for bridges in the state. As the operation has to be in the open sea, for the very reasons explained above, precast segmental construction with match cast elements will be used, as it would ensure both quality control as also faster construction.

In general every bidder bidding for the project is required to submit his scheme of span arrangement as also the methodology of construction, with the plant & equipment and the site organization for prior appreciation and evaluation of his bid. However provision will be made in the bid that the bidder should use the environment friendly technology for the construction and also should follow the mitigation measures suggested in the EMP during construction and operation.

2.16.5 Project Sites

A project of this nature demands careful planning of the entire management both from construction activities and Work Sites from the logistic point of view.

Accordingly there will be one main work site free from all encumbrances, as far as possible.

2.16.6 Labour Camp

The labour camp would be located on Mumbai and Navi Mumbai side of the project. All the facilities and amenities will be provided to the labour camps as per the "The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996" and "The Inter-State Migrant Workmen (Regulation of Employment) and Conditions of Service Act, 1979"

2.16.7 Casting yard

The casting yard will be located on Mumbai and Navi Mumbai side of MTHL (**Figure 2.4**). The 40ha land has been identified for this purpose. This would also form the main fabrication/casting and stacking yard for the major bridge elements and storage yard for quarried materials like murrum, aggregates and sand required for the project. Since the project require movement of men, material and machinery for construction, jetties will be constructed at the casting yard for this purpose.

The base camp will contain, in addition to the space normally required for offices, workshops, fuel storage, maintenance yards, and the like, large areas for the storage of the materials, for pre-casting and stacking yards and also for steel fabrication yards.

The Project Main Site will have the space for the following:

1. Project Office, Administration & Accounts, Works Superintendent Mechanical Cell and Quality Survey unit.

2. Workshops for Mechanical, Electrical, Automobiles, and the floating crafts - running & maintenance.

3. Fabrication yard, casting & stacking yards, for different bridge components

4. Material stacking yards like godowns for cement, HT steel, Admixtures etc. which require weather protection.

- Stacking yards for structural steel of all category reinforcements, rails, etc.

- Storage yard for miscellaneous activities to be divided into Civil/ Mechanical / Electrical and other miscellaneous materials.

- Tools and Tackles of all categories.

In addition to above there would be accommodation for the Site Staff for Senior/Junior categories, Foreman, skilled/semiskilled/unskilled labour, who have to work on the site on shift basis.

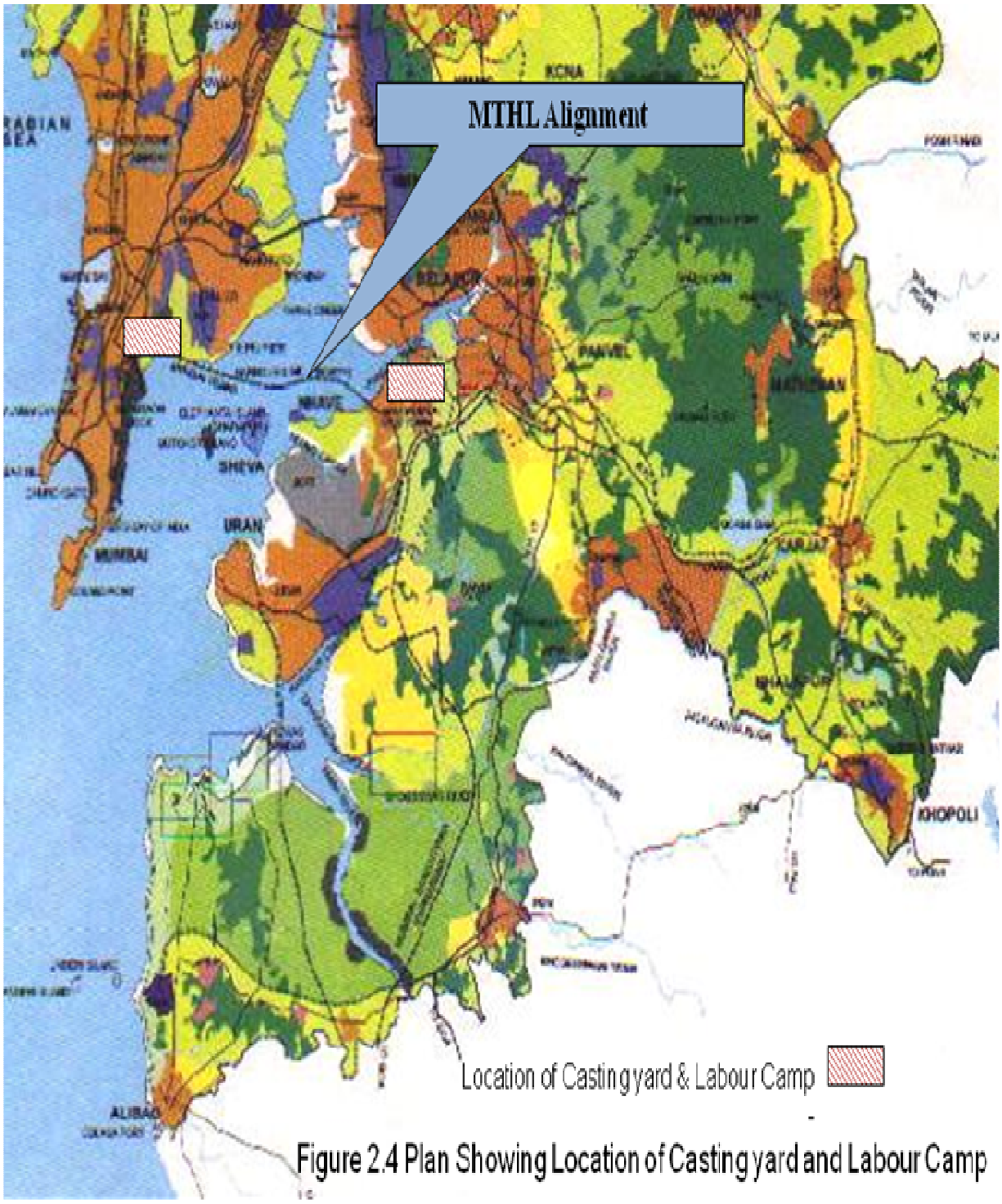


Figure 2.4 Plan Showing Location of Casting yard and Labour Camp

2.17 Quarry Sites

A project of this nature requires quarried materials like murrum, aggregate, sand in large quantity. This material will have to be transported to the site for storage till it is consumed in the project. It has to be kept in mind that the area available for the work site is limited to have a large storage space as it will have to accommodate the casting yard, stacking yards, fabrication yards, workshop, stores etc. Transportation and storage of the material will be a stupendous task demanding heavy toll of transportation cost besides double handling and loss of material in the process.

In view of this, it is felt advisable to develop a quarry area in such a manner that there is adequate space to store the materials of different categories like fill materials, stone materials in each grade. These materials will have to be transported to sites on a planned basis in such a way that the main site can have a storage facility for two weeks of production. This would ensure a continuous operation at all level of fields thus optimizing the resources in terms of manpower and the machinery, besides helping to develop/acquire i.e. needed to fulfill the minimum requirements of the project. The concessionaire will have to prepare his own plans in this respect and get the same cleared through MMRDA before proceeding with the project. This needs to be the first action to be taken as a part of initial planning. The locations of some of the quarries available in the vicinity of the project are shown in **Figure 2.7.**

2.18 Time frame required for project implementation.

Implementation Schedule will depend on concessionaire's resources of men, material & equipment, technology available with them and Cash Flow of provision to be prepared to meet the dead line.

It is anticipated that the contract will be awarded in the final quarter 2012. There will be initial period of planning and preparation prior to construction commencing in the final quarter of 2013.

Factoring in the scale of this project with the anticipated skill and expertise available in India, it is expected that the construction period will take 5 years.

The financial study assumes a concessionary period of 40 years after the opening of the highway, which is anticipated to be in the final quarter of 2018.

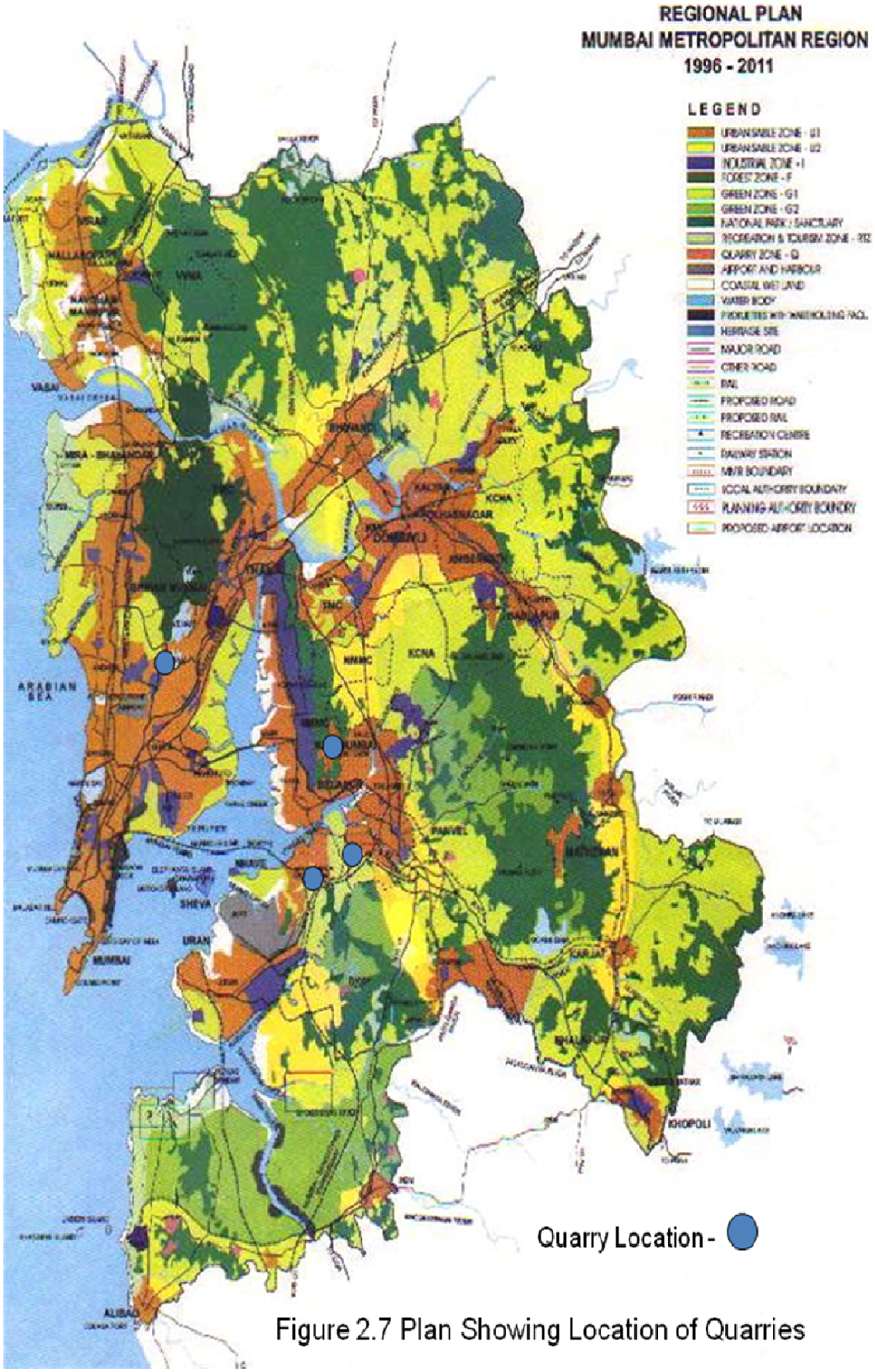


Figure 2.7 Plan Showing Location of Quarries

2.19 Estimated cost of development of the project

The estimated base construction cost of the project based on experiences of similar bridges in India is approximately Rs 88,000 million. This includes the cost of approaches, the bridge across the sea, the bridge furniture, ancillary structures, traffic surveillance, illumination and environmental mitigation measures, toll plaza, parking etc. It also covers charges on account of design, supervision, administration by MMRDA, contingencies and the like with provision for utility diversion, new construction and other works.

2.20 Salient features of the proposed MTHL:

- The Link will have a 6-lane facility exclusively for the use of fast moving vehicles with controlled access and connection to Eastern Freeway in the Island city of Mumbai and NH 4B near Chirle village on the main land.

- A minimum vertical clearance of 25.2 m below the bridge above the highest High Tide Level (HTL) will be provided for navigational spans, while the minimum vertical clearance of 9.1 m is provided elsewhere.

- 1.5 m wide central median with appropriate landscaping to enhance the environment as well as to avoid glare.

- Overall width of deck (28 m) consists of 11.25 m wide carriageway with 1.2 m wide utility corridor on either side of the carriage way. Anti crash barriers are provided at the edge of carriageway for protection of fast moving traffic. Provision of fenders for the protection of foundations against ship impact in the navigational spans.

- Foundations are proposed on piles with substructure of wall type pier. Suitable alternative will also be considered.

- The superstructure proposed is segmental construction in pre-stressed concrete. Alternative type of superstructure will also be considered.

- The typical cross-section of bridge superstructure is shown in **Figure 2.8**.

CHAPTER 3

BASELINE ENVIRONMENTAL STATUS

3.1. Introduction

To know the existing environment, the baseline environment status for the study area was carried out by conducting a comprehensive primary and secondary data collection programme to prepare the Environment Impact Assessment (EIA) Report. The study area covered by 10 km. distance around the project site is shown in **Figure.3.1**.

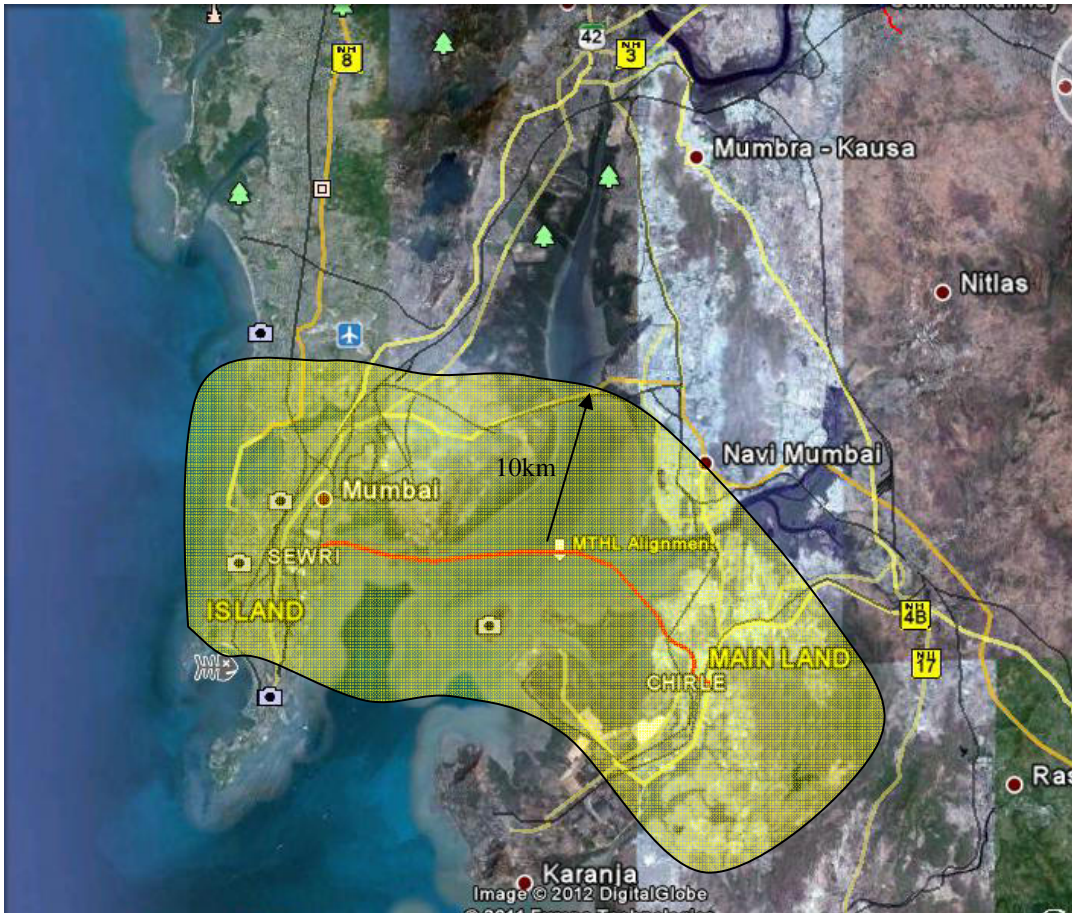


Figure 3.1 Study Area of the Project

3.2 Environmental Setting

The following Table gives the Environmental setting along with the topographical features of study area within the 10 km. stretch from the proposed MTHL alignment site are shown in the following **Table 3.1**

Table 3.1 Geographical and Environmental Setting of the MTHL

Sr.	Item	Details
1	Location	Sewri (Mumbai island city) and Nhava (Mainland in Raigad district)
2	Latitude	Sewri End: 18° 59' 46.97'' (Google Earth) Nhava End: 18° 56' 18.08''
3	Longitude	Sewri End: 72° 51' 12.93'' Nhava End: 73° 01' 53.92''
4	General Elevation	14m average
5	Survey of India Topo Sheet No.	47 B/13
6	Topography	The site topography involves mudflats on both the ends with a stretch of Arabian Sea in between for 28 km.
7	Soil type	The predominant soil cover in Mumbai city is sandy whereas in the suburban district, the soil cover is alluvial and loamy.
8	Climatic conditions	Avg Max Temp is 31.2 °C, Avg Min Temp is 23.7 °C. The average total annual rainfall is 2146.6 mm. (http://mdmu.maharashtra.gov.in/pages/Mumbai/mumbaiplanShow.php)
9	Nearest Highways	NH-4B and SH-54
10	Nearest Rly. Station.	Sewri Rly Station and Panvel Rly Station (Konkan Railway)
11	Nearest Airport	Santacruz Mumbai Airport
12	Present site land status	Out of 22km alignment 18 km falls in sea and rest is on land owned by MMRDA.
13	Nearest Water Bodies.	The alignment majorly passes through Arabian Sea
14	Nearest Hill	Ulwe hill
15	Archeologically Importance place.	Elephanta Caves
16	Seismic zone	Seismic Zone III as per IS: 1893 (Part-I) 2002.

3.2. BASELINE ENVIRONMENTAL STATUS

In order to assess the existing environmental status in the project area, primary and secondary data on various environmental attributes viz. air quality, noise

levels, water quality, soil, ecology, land use etc have been collected and presented in the following paragraphs.

The entire project area is divided in three segments with a zone wise demarcation of its environmental settings. It is indicated in the following **Table 3.2**

Table 3.2: Following Table Indicates Summary of Five Environmental Segments.

Sr. No.	Zone No.	Chainage	Length in km	Zone Division	ALIGNMENT AREAS
1	I (Land)	0.5 to 1.0	0.5	Terrestrial Setting	Starts from E- of Sewri station in the E- central part of city of Mumbai near the Sewri Station on the Harbour line and ends on the edge of high water line at the thane creek.
2	II (Mudflats and sparse Mangroves)	1.0 to 2.5	1.5	Transition between Terrestrial and Marine setting	Extends between the high water and low water of Thane Creek hugging to the island of Mumbai.
3	III (Sea)	2.5 to 16.98	14.48	Marine setting	Stretches across the Thane Creek between the low water lines along the island of Mumbai and the mainland of Maharashtra.
4	IV (Mudflats and sparse Mangroves)	16.98 to 17.58	0.6	Transition between Marine to Terrestrial setting	Another mudflat flanking the mainland, bounded by low water and high water lines of the Thane Creek.
5	V (Land)	17.58 to 22.00	4.42	Terrestrial setting	Extends from the high line towards higher grounds on the mainland.

3.3. Topography and Geology

The proposed Mumbai Trans Harbour Link (MTHL) alignment mainly passes over the sea (Creek) except for a stretch of about 5 km where it runs over the land i.e. at Sewri and Nhava ends. The different lengths of the alignment falling within various environmental zones are shown in **Table 3.3.**

From the above it is observed that out of 22.0 km length of MTHL, 14.48 km falls in sea (66 %), 4.92 km on land (22 %) and 2.1 km (12%) passes through the

mudflats. A longitudinal elevation of the MTHL showing these zones is depicted in **Figure 3.1.**

The geology of the region is typical of the west coast i.e. clayey soil underlain by basalt rock formations. The sediments on the Sewri Mudflats (Zone II) are composed of soft silty clay on the top, which is underlain by compact and hard silt.

The bottom lithology in the Sea (Zone III) is varying. On the top, is soft mobile silt. It is underlain by more compact silty clay of varying thickness. Under this, solid foundation is available in the shape of massive basalt. Except for a small area this basalt petrology is not geologically disturbed. However the alignment does not cross this disturbed zone.

The lithological features of the Nhava mudflats (Zone IV) are similar to that of Sewri mudflats. The terrain in the Zone V i.e. at Nhava end is rolling in nature and sparsely populated.

3.4 Land use

Total land requirement for MTHL is as given below-

Land requirement:

At Sewree	
Right of Way (ROW)	9.91 Ha
Casting yard	15.17 Ha
At Nhava	
Right of Way (ROW)	96.36 Ha
Casting yard	18.97 Ha
TOTAL	

All this is in urban area, under CIDCO notified area on Nhava side and MBPT land on Sewri side. The land is almost plain with gentle slope with altitude varying from sea level to about 60 m. As approach roads are taken on viaducts instead of solid embankment, quantity of filling material is considerably reduced. Stone rubble, aggregate etc. are to be procured from existing authorized quarries.

3.5. Climate and Meteorology

The historical data collected from India Meteorological Department (IMD) and other secondary sources to represent the metrological conditions of the project area has been reviewed and presented below:

3.5.1 Temperature

India Meteorological Department (IMD) records indicate that Mumbai experiences tropical coastal climate. The moderating effects of the nearby sea and the fairly high amount of relative humidity in the atmosphere have restricted the variability. The seasonal variations of temperature follow closely the course of the sun.

January is invariably the coldest month and May the warmest. With the onset of monsoon in early June there is a reversal of the temperature curve and the temperature during the period of monsoon remains very nearly uniform at about 27^0C. The slight rise in temperature in October falls gradually till it reaches the coldest month in January. Based on past data, the mean daily temperature during the year varies from 24^0C to 33^0C. Highest recorded temperature is 40.6^0C. The mean daily maximum and minimum temperatures for the Mumbai region are given in **Table 3.2**.

Table 3.2 Maximum and Minimum Temperature at Mumbai

Month	Temperature	
	MD Max	MD Min
January	31.8	16.9
February	29.9	17.5
March	32.7	20.7
April	32.0	23.2
May	32.8	26.5
June	32.7	27.5
July	31.2	25.9
August	29.8	25.2
September	31.2	24.8
October	32.6	23.8
November	34.3	21.8
December	33.4	19.0

Note: MD Max – Mean Daily Maximum, MD Min- Mean Daily Minimum
Source: India Meteorological Department

3.5.2 Wind

The predominant direction of wind during October to May is from north-east in the mornings and north-west during the afternoons. However, during the monsoon months i.e. June to September, the wind is predominant from the south-west quarter, both in the morning and afternoon. The maximum wind speeds for most of the time during the year is from north-west quarter with strong winds predominant during south –west monsoon period. The average wind speed and direction for Mumbai is presented in **Table 3.3**. The wind speed is observed to be between 4.8 km/hr to 12.7 km/hr.

Table 3.3 Wind Direction and Wind Speed at Mumbai

Month	Morning 08:30 hrs		Evening 17:30 hrs.	
	Direction	Average Speed (kmph)	Direction	Average Speed (kmph)
January	NE	5.7	NW	5.7
February	NE	6.9	NW	6.9
March	NE	7.8	NW	7.8
April	S	9.0	NW	9.0
May	SW	9.3	W & NW	9.3
June	W	11.8	W	11.8
July	W	12.7	W	12.7
August	W	10.5	W	10.5
September	W	7.7	NW	7.7
October	E	4.8	NW	4.8
November	E	4.8	NW	4.8
December	E&W	4.9	NW	4.9

Source: Draft Regional Plan of MMRDA (1998-2011)

3.5.3 Humidity

The Relative Humidity (RH) ranges between 61% to 87% in the monsoon period. Between November to January i.e. in the winter months, the relative humidity varies from 57% to 72%. The Relative Humidity generally is higher than 60% throughout the year. The monthly variation of relative humidity in the region is shown in **Table 3.4**

Table 3.4 Relative Humidity in Mumbai

Month	Relative Humidity	
	Mean Maximum (%)	Mean Minimum (%)
January	81	23
February	82	34
March	86	37
April	85	45
May	81	60
June	80	63

Month	Relative Humidity	
	Mean Maximum (%)	Mean Minimum (%)
July	87	74
August	92	80
September	90	66
October	88	59
November	81	37
December	82	26

Source: India Meteorological Department

3.5.4 Cloud Cover

Skies are mostly overcast during the monsoon months i.e. starting from May right till September. During the winter and the post monsoon seasons skies are generally clear. Maximum number of overcast days is observed during the month of May. The cloud cover data for Mumbai is presented in **Table 3.5**.

Table 3.5 Cloud Cover in Mumbai

Month		No. of Days with Cloud Amount (All Clouds) OKTAS					No. of Days with Low Cloud Amount OKTAS				
		0	1-2	3-5	6-7	8	0	1-2	3-5	6-7	8
January	M	17	7	5	2	0	27	3	1	0	0
	E	16	8	4	3	0	27	4	0	0	0
February	M	16	7	4	1	0	24	3	1	0	0
	E	18	6	2	2	0	26	2	0	0	0
March	M	17	7	5	2	0	24	5	2	0	0
	E	18	8	3	2	0	25	5	1	0	0
April	M	7	9	10	4	0	14	8	7	1	0
	E	11	12	5	2	0	18	9	3	0	0
May	M	1	4	19	6	1	3	5	21	2	0
	E	4	9	13	4	1	7	10	13	1	0
June	M	0	1	8	12	9	0	3	20	7	0
	E	1	1	8	11	9	1	4	19	6	0
July	M	1	0	2	12	16	0	2	21	8	0
	E	0	0	2	13	16	0	1	21	9	0

Month		No. of Days with Cloud Amount (All Clouds) OKTAS					No. of Days with Low Cloud Amount OKTAS				
		0	1-2	3-5	6-7	8	0	1-2	3-5	6-7	8
August	M	1	0	2	14	14	0	2	22	7	0
	E	1	0	2	14	14	1	1	21	8	0
September	M	1	1	8	13	7	1	6	18	5	0
	E	0	2	8	13	7	1	7	18	4	0
October	M	5	8	9	8	1	17	8	6	0	0
	E	6	9	8	7	1	12	11	7	1	0
November	M	11	8	6	4	1	25	3	2	0	0
	E	11	8	5	5	1	22	6	2	0	0
December	M	13	9	6	3	0	27	3	1	0	0
	E	13	9	5	4	0	25	5	1	0	0

Note : M = Morning E = Evening
Source: India Meteorological Department

3.5.5 Rainfall

Monsoon generally sets in around the second week of June and continues till late September. July and August are the wettest months all over the region. There is hardly a day without rain, in these two months. Towards the later part of the season, there are breaks in between, when the oppressive hot weather is associated with high humidity along the coast. The average rainfall in the region is nearly 2000 mm. Average monthly rainfall for Mumbai is indicated in **Table 3.6.**

Table 3.6 Normal Rainfall at Mumbai
(Based on 50 years data)

Month	Rainfall in mm
January	4.1
February	2.0
March	1.5
April	1.5
May	18.3
June	464.8
July	613.4
August	328.9
September	286.0

Month	Rainfall in mm
October	64.5
November	17.5
December	2.3
Annual	**1804.8**

Source: India Meteorological Department

3.5.6 Cyclone

The west coast is subject to occasional severe cyclonic storms. These storms normally occur in the period of May/June and October/November. **Table 3.7** presents the detailed data on hail thunder, fog, dust storm and squall.

Table 3.7 Weather Phenomena

Weather Phenomena	No. of Days with					
	Precipitation > 0.3 mm	Hail	Thunder	Fog	Dust Storm	Squall
Month						
January	0.2	0.0	0.0	0.8	0.0	0.0
February	0.3	*0.0*	0.1	0.9	0.0	0.0
March	0.2	0.0	0.1	0.6	0.0	0.0
April	0.3	0.0	0.4	0.0	0.0	0.1
May	1.9	0.0	1.5	0.0	0.0	0.2
June	19.4	0.0	5.9	0.0	0.0	1.4
July	28.2	0.0	2.5	0.0	0.0	3.6
August	28.2	0.0	1.4	0.1	0.0	1.5
September	18.6	0.0	4.0	0.3	0.0	0.6
October	5.0	0.2	2.9	0.1	0.0	0.4
November	1.7	0.0	0.9	0.1	0.0	0.1
December	0.4	0.0	0.1	0.3	0.0	0.0

Source: India Meteorological Department

3.5.7 Visibility

The visibility in this area is normally good except high peaks of hills which are not visible clearly from a distance of more than 5 km. Foggy condition prevail during winter and heavy rains. As per the atmospheric visibility data obtained from IMD, the number of days during which visibility is poor (upto 4 km) are very few. Visibility is 4 to 10 km during 25% of the days in the year. The number of days with poor visibility is maximum during the month of December. Visibility during

evening is much better than the early morning hours. Detailed data on visibility is presented in **Table 3.8.**

Table 3.8 Atmospheric Visibility

Month		No. of Days with Visibility				
		Upto 1 km	1-4 km	4-10 km	10-20 km	Over 20 km
January	M	1.1	16.1	12.4	1.3	0.1
	E	0.0	0.2	5.2	25.2	0.4
February	M	0.5	14.6	11.7	12.0	0.0
	E	0.0	0.1	3.2	24.5	0.2
March	M	0.2	12.2	15.7	2.9	0.0
	E	0.0	0.1	3.1	26.9	0.9
April	M	0.0	4.6	17.4	7.8	0.2
	E	0.0	0.1	2.1	27.0	0.8
May	M	0.1	0.8	14.2	14.9	1.1
	E	0.0	0.1	2.1	28.3	0.5
June	M	0.0	3.4	14.9	11.5	0.1
	E	0.0	2.3	8.3	19.1	0.3
July	M	0.0	4.6	18.5	17.7	0.2
	E	0.0	2.6	13.5	14.6	0.3
August	M	0.0	3.8	19.4	7.8	0.0
	E	0.0	2.6	11.0	17.2	0.2
September	M	0.1	4.3	16.3	9.2	0.1
	E	0.0	1.0	6.9	20.7	1.4
October	M	0.1	3.7	17.2	9.2	0.4
	E	0.0	0.4	2.9	20.7	2.1
November	M	0.1	4.4	18.4	9.6	0.0
	E	0.0	0.0	2.2	25.6	1.5
December	M	0.2	9.6	16.8	7.1	0.1
	E	0.0	0.2	4.9	26.3	0.6

Note: M = Morning E = Evening
Source: Climatological Tables of India, 1951-1980

3.6. Air Quality

In order to know the ambient air quality status, air quality monitoring was carried out at six different locations in the influence zone of MTHL alignment as per CPCB guidelines. These locations are shown in **Figure 3.2 above**. The monitoring was carried out in post monsoon season during October to December 2011 for Rapid EIA study.

a) Selection of Monitoring Stations

The monitoring stations were selected considering the spatial relationship of various land use along the project road & wind direction in accordance with BIS guidelines [IS: 5182 (part-14)-1985].

b) Monitoring Methodology

Monitoring of ambient air quality was carried out as per CPCB guidelines. The concentration of ambient air is measured as per the methods given in MoEF notification dt 18/11/2009 in respect of National Ambient Air Quality Standards.

Table 3.9 Existing Ambient Air Quality (Average Values)

LOCATION	Chirle	Shivaji Nagar	Mahul	Sewree	Gate Way of India	Elephanta Island	UNIT
PARAMETER							
Particulate Matter (SPM)	266.33	135.58	153.33	393.58	220	92	µg/m^3
Respirable Particulate Matter (RSPM)	79.92	42.83	48.42	141.00	48.5	24	µg/m^3
Sulphur Dioxide (SO2)	53.67	31.33	32.02	66.85	37.1	12.6	µg/m^3
Nitrogen Dioxide (NO2)	61.83	39.25	38.18	74.82	53.4	13.8	µg/m^3
Ammonia (NH3)	21.97	10.15	16.70	31.32	26.2	28.5	µg/m^3
Lead (Pb)	0.61	0.33	0.47	0.82	BDL	BDL	µg/m^3
Carbon Monoxide (CO)	2.04	1.08	1.52	2.54	1.8	2.27	mg/m^3
Hydrocarbon (HC)	1086.27	973.92	1090.42	1348.92	861	1083	µg/m^3
Ozone (O3)	16.00	9.77	11.66	19.68	17.8	10.5	µg/m^3
Benzene (C6H6)	BDL	BDL	BDL	BDL	BDL	BDL	µg/m^3
Benzopyrene (BaP)	BDL	BDL	BDL	BDL	BDL	BDL	ng/m^3
Arsenic (As)	BDL	BDL	BDL	BDL	BDL	BDL	ng/m^3
Nickel (Ni)	2.12	1.32	1.81	3.43	BDL	BDL	ng/m^3

Note: *SPM: Suspended Particulate Matter RPM: Respirable Particulate Matter NO_x: Oxides of Nitrogen, SO_2: Sulphur Dioxide, CO: Carbon monoxide*

Table 3.10: Ambient Air Quality Monitoring Standards (CPCB)

Pollutant	Time Weighted Average	Industrial, Residential Rural and Other Areas	Sensitive Areas
Sulphur Dioxide (SO_2) ($\mu g/m^3$)	Annual *	50	20
	24 hours**	80	80
Oxides of Nitrogen (NOx) ($\mu g/m^3$)	Annual *	40	30
	24 hours**	80	80
Particulate Matter (Size less than 10μm or PM_{10}) ($\mu g/m^3$)	Annual *	60	60
	24 hours**	100	100

Pollutant	Time Weighted Average	Industrial, Residential Rural and Other Areas	Sensitive Areas
Particulate Matter (Size less than 2.5μm or $PM_{2.5}$) ($\mu g/m^3$)	Annual *	40	40
	24 hours**	60	60
Ozone (O_3) ($\mu g/m^3$)	8 hours**	100	100
	1 hour	180	180
Lead (Pb) ($\mu g/m^3$)	Annual *	0.50	0.50
	24 hours**	1.0	1.0
Carbon Monoxide (CO) (mg/m^3)	8 hours**	2	2
	1 hour**	4	4
Ammonia (NH_3) ($\mu g/m^3$)	Annual *	100	100
	24 hours**	400	400
Benzene (C_6H_6) ($\mu g/m^3$)	Annual *	05	05
Benzopyrene (BaP) (ng/m^3)	Annual *	01	01
Arsenic (As) (ng/m^3)	Annual *	06	06
Nickel (Ni) (ng/m^3)	Annual *	20	20

*Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

The Ambient Air Quality Standards stipulated by CPCB are presented in **Table 3.10**. At Chirle, PM concentrations are lower than the CPCB standards while SO_2 and NO_x concentrations are lower than the standards stipulated for 24 hours. The CO concentrations are below standard stipulated for residential areas. Whereas at Shivaji Nagar, the concentrations for all of the air parameters are lower than the ambient air CPCB standards. At Mahul it can be seen that except for SPM all other parameters are below the CPCB norms. At Sewri, the ambient concentrations of SPM, RSPM are above the CPCB standards whereas concentrations of SO_2 and NO_x are below the CPCB stipulations. Thus it can be seen from the above table that concentration of all the parameters are within the prescribed standard of MoEF except Sewri where the concentration of particulate matter is exceeding the standard. This may be due to the ongoing construction of Eastern Freeway at Sewri.

3.7. Ambient Noise Levels

Ambient noise monitoring was carried out as per IS: 3029-1980 to know the existing ambient noise levels in the study area of MTHL at the same locations as discussed in air quality. The analysis of the monitoring is presented in the **Table 3.11.** Permissible standards prescribed by CPCB are presented in **Table 3.12**.

Table 3.11 Ambient Noise Levels

Location (Area Code)	Date	Noise Levels in dB(A)						
		Leq (Day)	Leq (Night)	Lmax	Lmin	L90	L50	L10
Sewri (A)	03/10/11 to 05/10/11	76	61.1	80	50	54	72	78
	10/10/11 to 12/10/11	75.4	60.5	80	50	53	72	78
	20/10/11 to 22/10/11	75.4	61.6	80	50	53	72	78
	29/10/11 to 31/10/11	76	62.6	80	50	54	72	79
	1/12/11 to 03/12/11	75.8	61.8	80	50	53	72	79
	07/12/11 to 09/12/11	76	61.9	80	50	52	73	79
	14/12/11 to 16/12/11	75.8	61.8	80	50	52	73	79
	21/12/11 to 23/12/11	76	61.9	80	50	52	73	79
Shivaji Nagar (C)	03/10/11 to 05/10/11	62.6	54.6	69	44	46	59	65
	10/10/11 to 12/10/11	62.1	56.2	69	44	47	59	64
	20/10/11 to 22/10/11	62.1	56.4	69	44	48	59	64
	29/10/11 to 31/10/11	62.3	54.4	69	44	58	63	53
	1/12/11 to 03/12/11	62.2	55.3	69	44	46	59	65
	07/12/11 to 09/12/11	62.3	55.6	69	44	45	60	65

Location (Area Code)	Date	Noise Levels in dB(A)						
		Leq (Day)	Leq (Night)	Lmax	Lmin	L90	L50	L10
	14/12/11 to 16/12/11	65.3	59	72	47	51	62	68
	21/12/11 to 23/12/11	65.2	60	72	47	50	62	68
Chirle (C)	03/10/11 to 05/10/11	67	60.4	72	49	50	63	70
	10/10/11 to 12/10/11	68	61.3	74	50	53	65	71
	20/10/11 to 22/10/11	68	61.2	75	50	53	65	70
	29/10/11 to 31/10/11	67.7	62	85	57	61	78	82
	1/12/11 to 03/12/11	68.5	62.2	75	50	52	65	71
	07/12/11 to 09/12/11	68.3	62.3	75	50	52	64	71
	14/12/11 to 16/12/11	68.7	60.8	75	50	52	62	72
	21/12/11 to 23/12/11	68.5	62.5	75	50	53	65	71
Mahul (I)	03/10/11 to 05/10/11	66.6	59.2	72	48	49	63	69
	10/10/11 to 12/10/11	67.2	59.9	74	49	51	64	70
	20/10/11 to 22/10/11	67.3	61	74	49	50	64	70
	29/10/11 to 31/10/11	67.2	59	74	49	52	64	70

Location (Area Code)	Date	Noise Levels in dB(A)						
		Leq (Day)	Leq (Night)	Lmax	Lmin	L90	L50	L10
	1/12/11 to 03/12/11	67.1	60.4	73	49	51	64	70
	07/12/11 to 09/12/11	67.1	61.5	74	49	52	64	69
	14/12/11 to 16/12/11	67.4	60.3	74	49	51	64	70
	21/12/11 to 23/12/11	67.7	61.6	74	49	53	64	70
Gate Way of India (B)	14/12/11 to 16/12/11	66.2	60.2	73	48	50	63	69
	21/12/11 to 23/12/11	66.3	59.3	73	48	52	62	69
Gavan (C)	14/12/11 to 16/12/11	68.8	60.4	75	50	52	65	71
	21/12/11 to 23/12/11	68.3	60.4	75	50	53	65	70

Note:

- *Figure in the bracket indicates the category of area as per the CPCB standards*
- *Leq - Equivalent continuous sound pressure level in dB(A)*
- *Lmax - Maximum Instantaneous Noise Level in dB(A)*
- *Lmin - Minimum Instantaneous Noise Level in dB(A)*
- *L10 - Sound pressure level exceeded 10 percent of the total sampling time in dB(A)*
- *L50 - Sound pressure level exceeded 50 percent of the total sampling time in dB(A)*
- *L90 - Sound pressure level exceeded 90 percent of the total sampling time in dB(A)*

Table 3.12 Ambient Air Quality Standards in Respect of Noise (MoEF Standards)

Area Code	Category of Area/Zone	Limits in dB(A) Leq*	
		L_{eq} Day time	L_{eq} Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note –

1. *Day time shall mean from 6.a m to 10 p.m.*
2. *Nighttime shall mean from 10 p.m. to 6 p.m.*
3. *Silence zone is defined as an area comprising not less than 1000 metres around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.*
4. *Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.*

**dB(A)Leq denotes the time weighted average of the level of sound in decibles on scale A which is related to human hearing.*

From the above Table 3.14, it can be observed that the existing noise levels are exceeding the permissible limit at Chirle, Shivaji Nagar, Gavan, Gate way of India and Sewri (Day time).Whereas the it is within the limit at Sewri (night time) and Mahul.

3.9 Heritage/Archaeological structures

There are three structures of historical/archaeological importance namely Sewri Fort, Gateway of India (about 6 km from MTHL) and Elephanta Caves (about 3 km from MTHL alignment) within the study area of project alignment. The no objection for Sewri Fort and Gateway of India has been received from Dept of Archaeology, GoM. The NOC for Elephanta from Archaeological Survey of India (ASI) has also been received.

3.10 Ecology

The general attributes of environment requires identification of the presence of any sensitive ecological system along the proposed alignment of the MTHL Project. The objective of this study is to ascertain the existence of such sensitive ecological system.

The proposed alignment of the MTHL Project would have a total length of about 22 km. After connecting the Messant Road in the central part of the City of Mumbai to facilitate traffic dispersion, the MTHL will cross the Sewri mud-flat, the Thane Creek and the Shivaji Nagar of Nhava mudflat to connect the National Highway 4-B (NH 4-B) on the mainland. The sensitive ecological systems, if any, are likely to be found only on the Sewri and the Shivaji Nagar or Nhava Mud-flats. Both have been classified a Coastal Regulation Zone-I. These two mud-flats receive the tides and, therefore, can be said to represent a transition zone between terrestrial and marine environment. The Thane Creek, sustaining a marine environment, is the source of nutrients to the two mud-flats flanking it.

These two mud-flats have been studied in detail in this report to ascertain the existence of any sensitive ecological systems and to assess the state of their health. The Thane Creek has also been studied. It conclusively indicates that the MTHL Project is not likely to cause any injury to the suspected sensitive ecological systems on the two mud-flats.

3.10.1 Processes Conditioning the Ecological Systems of Mud Flats

It is necessary to mention that coastal mud-flats are not static features of landscape. These are process bound and, therefore, subject to change. Sometimes the changes are slow and at other times these are rapid.

The formation of mud-flats along the northern Konkan coast is a product of regional tectonics and geomorphologic processes. Being process bound, these are subjected to change. For example, due to sustained sedimentation, a mud-flat can eventually become a part of terra firma. These can also disappear due to changes in sea level caused by the eustatic or tectonic processes.

Under both these conditions, the coastal halophytic biota found on mud-flat would also disappear. With erosion of mud-flat, the biota would no longer get the required moorings in the soil. Due to increased sedimentation, the tidal sources of nutrients would be gradually cut off to destroy the given biotic assemblage.

Formation of coastal mud-flats requires specific topographic orientation and interactions between marine and terrestrial hydrology. There are hilly promontories extending into the sea along the Konkan coast. On the gentler slopes between these hilly promontories are generally found the mud-flats. These are formed of variable admixtures of terrestrial and marine sediments.

The land supporting the city of Mumbai was originally a cluster of islands, which has now emerged into a single mass due to human intervention. Mud-flats are also found within the tidal creeks flushed by tidal ingress. The Sewri mud-flat is one such formation within the Thane creek. The Shivaji Nagar or Nhava mud-flat has also formed within the Thane creek at the confluence of the Panvel creek and the Nhava creek.

The point to note is that formation of mud-flat by itself does not create a sensitive ecological system. Such tracts become ecologically sensitive when some critical assemblages of specialized biota grow on the mud-flats by consuming the available nutrients. A given biotic assemblage can be composed of many types of flora. But more often these get constituted of both flora and fauna.

Not all biotic assemblages are considered as constituents of sensitive ecological systems. Mangroves are one such sensitive biotic assemblage found in coastal tracts within the tropical zones. These are considered sensitive ecological systems, because of their highly interactive state of interdependence between the constituent members of flora and fauna. These have typical marker flora and fauna so as to become distinguishable from other coastal floral assemblages.

It has already been mentioned that the mud-flats of the Konkan coastal area describe variable associations between terrestrial and marine environment. Because of such variable dispositions, the available nutrients necessary for the initiation and sustenance of biotic assemblages vary both in composition and density. For example, the Shivaji Nagar or Nhava mud-flat, compared to the Sewri mud-flat, receives more nutrients from the two flanking creeks, namely the Panvel Creek and the Nhave Creek. In contrast, the Sewri mud-flat is flanked by a land mass supporting urban activities, from which it receives very specialized types of chemicals, some of which are killers of halophytic flora. The biotic assemblages in these two mud-flats are, therefore, likely to be different.

3.10.2 Marine Ecology:

Study area includes Thane creek, flanked by Sewri mud- flat & Shivaji Nagar mud-flats on either side. For study purpose, the area was divided into 3 zones:
Zone II : Sewri mud- flat
Zone III : Thane Creek (sea)
Zone IV : Shivaji nagar mud- flat
Zone III represents marine ecology, whereas Zone II & IV are transition zones between terrestrial and marine ecology. The two mud- flat areas and the intermittent creek has been studied in this report.
Water samples were taken during high and low tides in each zone. Mangrove estimation was done by laying quadrants in the High, mid and low tide regions.

3.10.3 Mud Flats:

Mudflat ecosystems are affected by a range of physical characteristics. These physical characteristics keep mudflats in constant flux, making them dynamic systems. Catastrophic events sometimes create situations that completely alter the properties of a mudflat for short periods of time.

With erosion of mud-flat, the biota would no longer get the required moorings in the soil. Due to increased sedimentation, the tidal sources of nutrients would be gradually cut off to destroy the given biotic assemblage.

Formation of coastal mud-flats requires specific topographic orientation and interactions between marine and terrestrial hydrology. There are hilly promontories extending into the sea along the Konkan coast. On the gentler slopes between these hilly promontories are generally found the mud-flats. These are formed of variable admixtures of terrestrial and marine sediments.

Figure 3.3: Alignment of MTHL across Thane Creek

Mudflats indicate association of terrestrial and marine ecology. Variable depositions lead to various biotic environments in areas. Thus the Shivajinagar mudflat has high deposition due to presence of Panvel & Thane creek. In contrast, the Sewri mud-flat is flanked by a land mass supporting urban activities, from

which it receives effluent & chemicals, some of which are killers of halophytic flora. The biotic assemblages in these two mud-flats are, therefore, likely to be different.

3.10.4 Baseline Environment:

Baseline environment of the area under consideration mainly included study of flora, fauna, and other abiotic components viz. heavy metals, pH, temperature, alkalinity, DO, BOD etc.

A) Sensitivity Test:

Nutrient content of the sediments in mudflat area was also considered. This study comprised determining levels of nitrate, phosphate & silica.

Sensitivity test really implies evaluation of the nature of nutrients available and the state of balance obtaining between imports and exports of nutrients within the system. Both these assessments indicate the state of health of the biotic assemblages found in the given tract. If some nutrients are found inadequate or in excessive quantities and if the nutrient flow lacks internal balance, then the given ecological system would be considered as functioning under conditions of ecological stress. The intensity of ecological stress, given by the composition of the available nutrients, would indicate whether the observed biota could survive in the long run. Ecological stress analysis not only defines the state of health of the biotic assemblages, but also indicates the future sustainability of the biota of the given system.

B) Biodiversity Study:

Ecological diversity of the given area was determined using Shannon-Wiener Index, Index of Dominance of the mangrove species quantitatively estimated in the mudflat areas.

3.10.5 Method of Data Collection/ Sampling:

6 sampling sites were considered in the study area, keeping in view, tidal influences, and a holistic picture of the wetlands on both sides and the thane creek. These sites were distributed as two sites each in the mud- flat areas, & 2 sites in the Thane creek.

A) Quantitative Estimation of Flora in Wetland areas :

Flora in the wetland areas mainly included mangrove species. These were quantitatively estimated using quadrants of 10 x 10 m^2 dimensions. The wetland areas were further divided as per the tidal influence viz. high tide, mid tide & low tide. Thus quadrants were laid accordingly in each tidal area, and species and count of flora was estimated.

Figure 3.4 : Survey to estimate Mangrove species & count

B) Quantitative estimation of fauna in Wetland areas :

Mud-flats are very important as this type of habitat provides home and food for animals like Crustaceans, Mollusk's, Insects, Pisces, Reptiles, Avian's, as well as Mammals. These were determined similarly, in each tidal zone mentioned above, by laying 1x1 m^2 quadrants.

Figure 3.5 : Burrows present in Mud flat area of Shivaji Nagar

Figure 3.6 : Shells present in Mud flat area of Shivaji Nagar

C) Collection of Water Samples :

Water samples were collected in the mud flat areas during high and low tides. Similarly surface water samples were collected in the Thane Creek during high and low tides.

3.10.6 Ecology Report :

A) BASELINE FOR DEFINING AQUATIC MEDIUM:

1. Surface Water Temperature:

Mangrove species cannot grow either where any freezing occurs or where the water temperature is seasonally cold. Hence temperature factor indicates presence of such type of forest land. Steep gradients of sea water temperature across the depths bear direct impact on the productivity and animal colony of the region.

Method of Analysis:
Surface water temperature was measured immediately after the sample was retrieved using a graduated centigrade thermometer.

2. Water pH:

pH plays a role in mangroves growth as acidic water doesn't allow growth of mangroves. Identifying pH for acidic or alkaline disturbances enables one to locate zones of pollution and other quality conditions for the use of sea water.

Method of Analysis:
pH of water in 3 zones was measured immediately after the water sampler was retrieved using a portable pH meter. The instrument was calibrated using standard buffer solutions.

3. Water Salinity:

Mangroves thrive in soils which are a transition zone between terrestrial and marine environment. Water salinity is an indicator of presence of marine environment.

Method of Analysis:
Salinity of the samples was assessed using a portable refractometer FG-201/211. The salinity obtained by refractometer was cross examined by Argentometric method.

4. Dissolved Oxygen:

Dissolved oxygen in water is necessary for good water quality. Natural water purification needs adequate DO to provide for aerobic life forms.

Method of Analysis:
DO was fixed on site, immediately after sample collection & analyzed by Winklers Method.

5. BOD & COD:

BOD & COD levels indicates rate of depletion of dissolved oxygen levels.

Method of Analysis:
BOD of water samples was determined after 5 days of incubation, by Winklers method. COD was determined using reflux titrimetric method, using Potassium Dichromate.

6. Alkalinity:

As mentioned above, mangroves and other halophytes cannot thrive in acidic water. Hence alkalinity of water is one of the major limiting factors for halophytic growth.

Method of Analysis:
Alkalinity of sea water was determined by acid titration method using phenolphthalein and methyl orange as indicator.

7. Hardness:

Hardness of ambient aquatic medium is another important parameter defining healthy ambiance for coastal halophytic vegetation.

Method of Analysis:
Hardness was determined by EDTA titrimetric method.

8. Results & Findings:

Water quality of Sea water was determined based on the physical & chemical attributes is as given in **Table 3.13** below :

Table 3.13 Physical & Chemical Attributes in Aquatic medium

Sites	Tide	pH	Temp ºC	Salinity ‰	Alkalinity ppm	Hardness mg/L	DO (mg/L)	BOD (mg/L)	COD mg/L
Zone II	High	7.5	28	32.95	14	46	1.20	0.97	100
	Low	7.5	24.5	32.95	14	47	1.48	1.32	105
Zone III	High	7	23.5	32.95	12	32	3.10	0.42	105
	Low	7	28	32.95	14.5	34	2.40	0.42	76
Zone IV	High	7	26	32.95	10	36	3.03	0.83	100
	Low	7	28	32.95	9.5	30	2.05	0.12	85

Observations:
pH: The pH of the water samples was found to be between 7-7.5. There is no significant difference in high tide and low tide. Acidity is measured using the pH scale, where items are given a numerical value between 0 and 14. Historically, ocean pH has averaged around 8.17, meaning that ocean waters are slightly basic. But with the rising CO_2 concentration causing acidification, today the pH levels are around 8.09, edging the waters closer to neutral.

Temperature: Surface water temperature was found to be between 23 to 28 ºC. But the temperature was found to low at Zone III during high tide. However, considering the ambient temperature range for the west coast of India is in normal range. The study revealed the temperature was in a normal range but it was found that the temperature at low tide was found to be more than the high tide.

Salinity: The salinity range of the surface waters around India shows great seasonal fluctuations owing to the influence of the monsoon rains as a result of river discharge. The salinity was found to be 32.95‰ at all the Zones.

Alkalinity: Alkanility in itself is not harmful to human beings, still the water supplies with less than 100mg/L are desirable for domestic use. The alkalinity ranges from 9.5 to 14 ppm.

Hardness: Hardness was found to be in the range of 30 to 47mg/L

DO: DO values ranges between 1.2 to 3.1 mg/L.

BOD: During the recent study the BOD_1 varied from 0.12 mg/L to 1.32 mg/L. The BOD was found to be lowest at Zone III during low tide. The BOD values were found to be comparable to that of standard value. High BOD values results from high oxygen demanding substances disposed to coastal waters. This suggest that the sewage contamination may be less in these areas.

COD: The COD was found to be highest at low tide at Zone II and high tide at Zone III with values 105 mg/L; and within acceptable limits of 250 mg/L.

B) DETERMINATION OF NUTRIENTS IN AQUATIC MEDIUM:

Nutrients in an aquatic medium encourage/ deplete the growth of biota. Three primary nutrients of the coastal aquatic medium, namely, nitrate, phosphate and silica, were determined.

Results & Findings:

Nitrates, Phosphates, Silicates in aquatic medium is given in **Table 3.14 below :**

Table 3.14 Nutrients in Aquatic Medium :

Sites	Tide	Nitrates µg/l	Phosphates µg/l	Silicates mg/L
Zone II	High	2600	76.06	0.125
	Low	2750	64.79	0.227
Zone III	High	1200	45.07	0.227
	Low	1700	14.08	0.193
Zone IV	High	440	25.35	0.17
	Low	1700	33.8	0.079

Observations:

Nitrates : Nitrate is considered to be the micronutrient, which controls primary production in the euphotic surface layer. The lowest nitrate values of 440 µg/L was

found at high tide at Zone IV and the highest values of 2750 µg/L was found at the low tide at Zone II.

Phosphates : Inorganic phosphate is also an important nutrient like nitrogen compound in the primary production of the sea. The concentration of phosphate especially in the coastal waters is influenced by the land run off, fertilizers used in nearby areas and domestic sewage. The lowest value of phosphates was found to be 14.08 µg/l at Zone III and the highest at Zone II with 76.06 µg/l.

Silicates : Silicon is the most abundant element in the earth after oxygen. Despite its overabundance in nature, it occurs in meagre quantities in water. The concentration of silica in natural waters is usually between 1 to 30 mg/L but may reach as high as 100mg/L in hot springs. The silicates ranged from 0.079 to 0.227 mg/L.

The analysis of the above three nutrients showed that they were within the permissible limits (10mg/L or less for nitrate) and (0.1 mg/L or less for phosphate).

C) ANALYSIS OF DISSOLVED TRACE METALS IN AQUATIC MEDIUM :

Dissolved trace metals taken up by the coastal halophytic biota are required in minute quantities for survival, though in high amount it injures their physiology and morphology. The presence of the following dissolved trace metals were investigated, viz. zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), cobalt (Co), lead (Pb) and cadmium (Cd).

Zinc

Zinc forms a weak thiosulphate complex in presence of acetate buffer. The coloured complex formed with dithizone is extracted in organic solvent to detect Zinc at low concentrations.

Copper

Reaction of sodium diethyl dithiocarbamate reagent with copper give copper salt of diethyldithiocarbamate which has a golden coloured complex measured at 440nm.

Lead, Manganese, Iron, Cobalt, Cadmium

The samples were tested by Atomic Absorption Spectroscopy.

Results & Findings :

Heavy metal in water samples is given in **Table 3.15** below:

Table 3.15 Heavy metals concentration in Aquatic Medium

Sites	Tide	Zinc mg/l	Copper µg/l	Magnesium mg/l	Iron mg/l	Lead mg/l	Cobalt mg/l	Cadmium mg/l
Zone II	High	50	37.5	Nil	Nil	Nil	Nil	0.0000027
	Low	12.5	Nil	Nil	Nil	Nil	Nil	0.000012
Zone III	High	37.5	25	Nil	Nil	Nil	Nil	0.000017
	Low	62.5	Nil	Nil	Nil	Nil	Nil	0.000014
Zone IV	High	12.5	50	Nil	Nil	Nil	Nil	0.000013
	Low	37.5	Nil	Nil	Nil	Nil	Nil	0.000045

Observations:

Zinc : Zinc is present in the galvanising paints, pigments, insecticides, cosmetics and their discharge increases their concentration in the waste. The zinc values are ranging from 12 mg/l to 63 mg/l

Copper : Copper in the natural waters also results in higher concentration due to pollution. Samples from low tides at all the three Zones did not show any presence of copper whereas at high tide they were in the range of 25 to 50 µg/l.

Cadmium : Cadmium is present in the waste water from electroplating, chemical industries and milling and mining wastes from lead-zinc mines. It accumulates in various parts of the body. The concentration of cadmium varied between 0.0000027 to 0.000045 mg/l.

Magnesium, Iron, Lead and Cobalt were found to be absent in the water samples from all the Zones.

D) BIO-DIVERSITY FOR DEFINING RICHNESS OF ECOLOGY:

Biodiversity:

Biodiversity is the variety and differences among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. Many variables are united in a common string of biosphere and the tiers of variability are :

- Ecosystem tier
- Community tier
- Species tier
- Genetic tier

Present study deals with studying diversity of flora & fauna at species level through Shannon Weaner Index, Index of dominance.

Shannon Weaner Index:

The **Shannon Weaner Index (H')**, is one of several diversity indices used to measure diversity in categorical data.

$$H' = -\sum(Ni/N) \times \ln (Ni/N)$$

Where;

Ni= Number of individuals in a species

N= Total number of individuals of all the species in the quadrant

Index of dominance:

Index of dominance = $\sum(Ni^2/N^2)$

Where;

Ni= Number of individuals in a species

N= Total number of individuals of all the species in the quadrant

Stress Index :

Stress Index (I) = **K [(No- Ns)/N(Nt)]**

Where;

N= Number of species

K= Dimension of Quadrant

No= Number of opportunistic species

Ns= Number of sensitive species

Nt= Total no. of individual of all species in quadrants

Method of sampling & Analysis:

1. Phytoplankton, their biomass and diversity:

Phytoplankton samples were collected in 3 zones. Phytoplankton net was towed 0.5m below the water surface for 10 minutes and the collected samples were immediately preserved in Lugol's solution. Samples were allowed to settlement; 1 ml of aliquot of sample was taken for quantitative population analysis. Depending upon biomass concentration, subsamples were taken to study the species diversity. Organisms were counted under microscope using standard identification key. Phytoplankton biomass was calculated by gravimetric method

2. Zooplankton, their biomass and diversity

Zooplankton samples were collected in 3 zones. Zooplankton net was towed 0.5 m below the water surface for 10 minutes and the collected samples were immediately preserved in 5% formalin solution. Samples were allowed to settle; 1 ml of aliquot of sample was taken for quantitative population analysis. Depending upon biomass concentration, subsamples were taken to study the species diversity. Organisms were counted under microscope using standard identification key. Biomass values of zooplankton were calculated from the displacement volume of water.

3. Benthos diversity (quantitative estimation of fauna)

Quadrat sampling is a classic tool for the study of ecology, especially biodiversity. In general, a series of squares (quadrats) of a set size (1x1 m^2) are placed in a habitat of interest and the species within those quadrats are identified and recorded. Abundances of organisms found at the study site can be calculated using the number found per quadrat and the size of the quadrat area.

4. Benthos diversity (quantitative estimation of flora)

Biodiversity of Flora was estimated using quadrant method. Quadrants of dimensions 10x10 m^2 area were laid at 3 different tide intervals (i.e. High, medium & low tide).

Results & Findings:

1. Phytoplankton, their biomass and diversity :

Phytoplankton is a primary source of food in the marine environment. The concentration and the numerical abundance of the phytoplankton indicate the fertility of a region.

The diversity index (Shanon-Weaver index –H') which is less than 1, indicating poor species diversity in many of the sites . Many of the phytoplankton does not appear to form food source for economically important species. Majority of the phytoplankton species encountered are stress tolerant which grow in polluted creek water. Various phytoplankton groups were observed and their Shanon Weaver index is shown in **Table 3.16.**

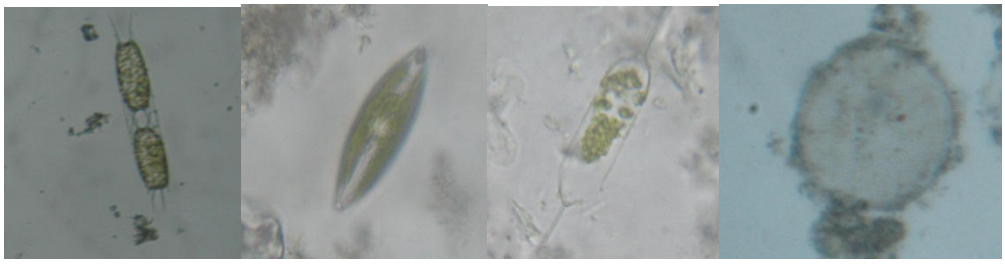
Faunal diversity fluctuates from 4 to 12 genera. The common forms were **Skeletonema spp., Bidulfia spp., Cosinodiscus spp., Nitzchia spp., Pleurosigma spp., Rhizosolenia spp**. which are stress tolerant and withstand estuarine pollution.

Phytoplankton population analysed at various sites showed that their **numerical abundance varied from 20 x 10^3 to 93 x 10^3 nos/L.** The **biomass varied from 0.055 to 0.705 gm/L** in the region shown in **Table 3.16.** Phytoplanktons observed under microscope are indicated in **Figure 3.7.**

Table 3.16 Phytoplanktons observed in aquatic medium :

Stn	Tide	Cell count (×10^3/L)	No. Of genera	Major Genera	Freq-uency	Domi-nance	Shanon weaver index
II	High	58	6	Skeletonema Bidulphia Coscinodiscus	0.9397	0.883	0.05847
	Low	92.5	7	Skeletonema Coscinodiscus Pleurosigma	0.9355	0.8752	0.0623
III	High	31.6	6	Skeletonema Coscinodiscus Rhizosolenia	0.869	0.756	0.122
	Low	51.6	5	Skeletonema Bidulphia Coscinodiscus	0.913	0.8336	0.083
IV	High	20.3	5	Skeletonema Bidulphia Nitzchia	0.689	0.4748	0.256
	Low	44.8	5	Nitzchia Bidulphia Skeletonema	0.3495	0.349	0.3674

Figure 3.7 Phytoplankton Species:



Bidulfia spp. *Navicula spp.* *Diatylum spp.* *Cosinodiscus spp.*

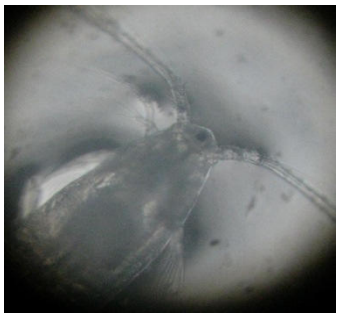
2. Zooplankton, their biomass and diversity

The concentration and the numerical abundance of the zooplankton indicate the fertility of a region. Various zooplankton groups were observed as indicated in **Figure 3.8,** and their Shanon weaver index are shown in **Table 3.17** below :

Table 3.17 Zooplankton observed in aquatic medium:

Zone	Tide	Cell count ($\times 10^3$/L)	No. Of genera	Major Genera	Freq-uency	Domi-nance	Shanon weaver index
II	High	5.5	5	Tintinnopsis Rhabdonellopsis	0.6364	0.405	0.2876
	Low	2.5	5	Tintinnopsis fish eggs	0.2667	0.01711	0.3525
III	High	4	7	Sagitta Eutintinnus Dyphis	0.3334	0.1112	0.3662
	Low	6.6	8	Fish eggs codonellopsis copepods	0.2272	0.5165	0.33675
IV	High	5.66	5	tintinnopsis eutintinnus	0.3235	0.10467	0.3651
	Low	2.5	8	tintinnopsis barnacal nauplius	0.3334	0.1112	0.3662

Figure 3.8 Zooplankton Species:



Copepod

Mysis larva

Faunal diversity showed 7 types of genera. The common forms were **Nauplii spp., Zoea of crab, Copepods and Tintinids.**

The Shanon Weaver Index was found to be less than 1 at all the sites. This shows that the population density of zooplankton is found to be not good at the time of sampling. Large population of zooplankton could graze the phytoplankton population to near extinction. This in turn would cause collapse of zooplankton and the entire food chain until phytoplankton recover.

Table 3.18 Biomass quantity of Phytoplankton & Zooplankton:

Zone	Tide	Phytoplankton g/L	Zooplankton g/L
II	High	0.055	0.22
	Low	0.105	0.47
III	High	0.16	0.85
	Low	0.47	0.325
IV	High	0.165	0.465
	Low	0.705	0.325

3. Benthos diversity (quantitative estimation of fauna)

Biological diversity of fauna in the 2 segments is given in **Table 3.19** below.

Table 3.19 Biodiversity of Fauna:

Name of the animal species	Zone II		Zone III		Zone IV	
	HT	LT	HT	LT	HT	LT
			Water analysis Parameter			
Crabs	8	3			156	9
Mud Skippers	-	-			1	-
Telescopium Telescopiaum	-	-			1	1

Name of the animal species	Zone II		Zone III	Zone IV	
Cerithium Morus	-	6	s	-	562
Nerita Crepidularia	14	11		-	-
Polycheat Worms	-	36		-	-
Slugs	12	15		-	-
Total (N)	34	71		158	572
Index Of Frequency (C)	0.4117	0.5071		0.9287	0.9825
Index Of Dominance (D)	0.1715	0.2572		0.9873	0.9657
Shannon Weaner Index (H)	0.365433	0.34445		0.01262	0.01734
Stress Index (I)	0.05	0.093		0.327	0.3269

4. Biological Diversity of Flora :

Biological diversity of flora in the 2 segments is given in **Table 3.20** below.

Table 3.20 Biodiversity of Flora:

	Name of species	No/ quadrant (zone ii)			No/ quadrant (zone iii)	No/ quadrant (zone iv)		
Trees (mangroves)		Ht	Mt	Lt		Ht	Mt	Lt
1	Avicennia marina	0	0	3		3	6	4
2	Sonneratia apetala	0	0	1		--	--	--
Shanon weaner index	Shannon-wiener index (log):0.8113					--	--	--
	Shannon-wiener index (ln):0.5623					--	--	--
	Shannon-wiener index (adjusted)* : 81.13%					--	--	--
Index of dominance	0.9					1		
Stress index (i)						--		
Sapling (mangroves)		Ht	Mt	Lt		Ht	Mt	Lt
1	Avicennia marina	54	52	50		7	0	0
2	Sonneratia apetala	0	0	1		--	--	--
Shanon weaner index	Shannon-wiener index (log):0.05562					--	--	--
	Shannon-wiener index (ln):0.03855					--	--	--

	Name of species	No/ quadrant (zone ii)	No/ quadrant (zone iii)	No/ quadrant (zone iv)		
	Shannon-wiener index (adjusted)*: 5.562%			--	--	--
Index of dominance	0.994			1		
Stress index (i)	25			48.039		

HT: High Tide; MT: Mid Tide; LT: Low Tide

Observations:

Phytoplankton, their biomass and diversity:

Phytoplankton is a primary source of food in the marine environment. The concentration and the numerical abundance of the phytoplankton indicate the fertility of a region. The diversity index (Shanon-Weaver index –H') which is less than 1, indicates poor species diversity in many of the Zones. Many of the phytoplanktons do not appear to form food source for economically important species. Majority of the phytoplankton species encountered are stress tolerant which grow in polluted creek water.

Zooplankton, their biomass and diversity:

The concentration and the numerical abundance of the zooplankton indicate the fertility of a region. The shanon weaver index was found to be less than 1 at all the Zones. This shows that the population density of zooplankton is found not to be good at the time of sampling. Large population of zooplankton could graze the phytoplankton population to near extinction. This in turn would cause collapse of zooplankton and the entire food chain until phytoplankton recover.

Microbial population:

Bacterial count in the water at all Zones was analyzed. All high tide samples show absence of enteric coli colonies.

E) ANALYSIS OF MICROBES IN AQUATIC MEDIUM:

Microbial population

The water samples were collected at all sites using sterile 250 ml sterile polyvinyl bottles and preserve for analysis. Pour plate method was use to culture the organisms. The agar media used for analysis were Nutrient agar, MacConkey agar. Plates were incubated at 37°C for 24 hrs and total viable count was taken. Organisms were identified and counted on the basis of their colour characteristics.

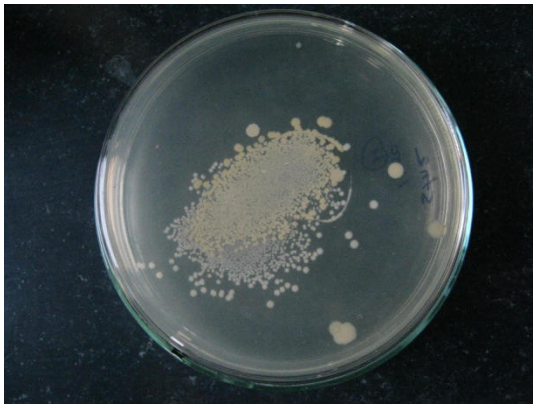
Table 3.21 Bacterial population in surface waters (number × 10^3/ml)

Zone	Tide	Mac Conkey Agar SPC/ml	Nutrient Agar SPC/ml
1	High	Nil	80
	Low	Nil	Nil

Zone	Tide	Mac Conkey Agar SPC/ml	Nutrient Agar SPC/ml
2	High	Nil	0.5
	Low	Nil	Nil
3	High	Nil	2.4
	Low	Nil	9

Figure 3.9 Bacterial Colonies

Absence of coliform enteric in Mac Agar



Presence of E.coli and other bacteria In NA

F) LIST OF AVIFAUNA SPECIES:

Avifauna species were spotted during the field survey & sample collection. Head count of the Avian(Birds) and Lepidopteron (Butterflies) population is given in **Table 3.10 below :**

Table 3.22 Avian (Birds) species spotted:

	Zone II	Zone III	Zone IV
	Common sandpiper	-	Red vented bulbul
	Western reef egret		Indian pond heron
	Blue rock pigeon		Small green bee eater
	Intermediate egret		Shikra
	White throated kingfisher		Black kite
	Small blue kingfisher		Intermediate egret
	Black headed gull		Red wattled lapwing
	Black headed ibis		Bush lark sp.
	Little egret		Black headed ibis
			Common sandpiper
			Little stint
			Black headed gull
TOTAL	**9**		**12**

Table 3.23 Lepidopteron (Butterflies) species spotted:

	ZONE II	ZONE III	ZONE IV
	Plain tiger		Yellow orange tip
	Striped tiger		Common jezebel
	Common crow	—	Striped tiger
	Denied eggfly (female)		Small salmon arab
TOTAL	**4**		**4**

G) LEVELS OF BIO-ACCUMULATION AS INDICATOR OF INTERACTION WITH ECOLOGY:

Conservative pollutants like heavy metals are non-biodegradable in nature and hence get accumulated within the body tissues of the organisms. Such accumulations are injurious to the biota, often leading to morbidity as well as mortality. The concentrations of bio-accumulation were determined by acid digestion method. The residue materials were tested by Atomic Absorption Spectroscopy.

Results & Findings :

Heavy metals in root, shoot & leaves of ***Avecinia marina*** was analysed & results of analysis is given in **Table 3.24** below :

Table 3.24 Concentration of heavy metals in halophytic vegetation

Sites	sample	Magnesium mg/l	Iron mg/l	Lead mg/l	Zinc mg/l	Copper µg/l
Zone II	Stem	0.0000065	0.153	0.00746	2050	950
	Root	0.0000045	0.128	0.0207	1500	350
	Leaves	--	--	--	1400	1200
Zone IV	Stem	0.000011	0.184	0.0394	1800	2200
	Root	0.000043	0.0651	0.0439	2400	2550
	Leaves	--	--	--	1800	1150

Heavy metals muscles of ***Cupia toli*** was analysed & results of analysis is given in **Table 3.25** below :

Table 3.25 Concentration of heavy metals in commercial fin fishes

Sites	Magnesium mg/l	Iron mg/l	Lead mg/l	Zinc mg/l	Copper µg/l
Zone III	0.000037	0.391	0.0302	1200	250

H) SEDIMENT ANALYSIS:

Sediment characteristics:

Physico- Chemical Characteristics:

	% composition of sand					Type of sediment	Organic carbon content (%)
	Granule/ very coarse	Medium sand	Fine sand	Very fine sand	Coarse silt		
Zone II	31.4	54.4	5.4	2.3	6.5	Sand	3.28
Zone IV	4	42.3	5.6	10.8	37.3	Sand with some amount of silt	2.83

Heavy/ Trace Metals:

1) Zinc

   Zinc was found to be around 250 mg/l in Zone IV & around 1800 mg/l in Zone I.

2) Copper

   Zone II and Zone IV showed 2000 and 1500 µg/l.

3) Manganese

   The total manganese was found to be absent in Zone IV. Zone III showed the presence of 0.000053 mg/L of Manganese.

4) Lead

   Zone II and Zone IV showed 0.483 and 0.498 mgL

5) Cadmium

   Cadmium was found to be around 0.00084 mg/L and 0.00061 mg/L in Zone II and Zone IV.

6) Iron

   There was complete absence of iron in the sediments.

7) Cobalt

   There was complete absence of iron in the sediments.

3.10.7 Inference :

Surface water Physical and Chemical Properties.

Physical properties

1. Temperature : Water temperature was measured at Zone II, III and IV. Temperature was measured at the top of water column between 11 am and 3 pm. The study revealed the temperature was in a normal range but it was found that the temperature at low tide was found to be more than the high tide.

2. pH : Acidity is measured using the pH scale, where items are given a numerical value between 0 and 14. Historically, ocean pH has averaged around 8.17, meaning that ocean waters are slightly basic. But with the rising CO_2 concentration causing acidification, today the pH levels are around 8.09,

edging the waters closer to neutral. In this study too, the pH was found to be between 7 – 7.5.

3. Salinity : The salinity was found to be in around 32.95‰.

4. DO : The DO values were found to be less in the Zone III as compared to the other two Zones.

5. BOD : The BOD values were found to be comparable to that of standard value. High BOD values results from high oxygen demanding substances disposed to coastal waters. This suggest that the sewage contamination may be less in these areas.

6. COD : COD values were found to be within the acceptable limits of 250mg/L.

7. Alkalinity : Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes (keeps the pH fairly constant) and makes water less vulnerable to acid rain. The values of alkalinity was found to be almost similar to the earlier report.

8. Hardness : The hardness of all the three Zones was found to be low as compared to the previous data.

Chemical Properties of water

1. Nitrate, Phosphate and silicate

   The analysis of the above three nutrients showed that they were within the permissible limits (10mg/L or less for nitrate) and (0.1 mg/L or less for phosphate).

2. Heavy metals

   The amount of zinc present was found to be more than the standard limit of 0.1mg/L. Copper was found to be absent in low tide readings of all the three Zones. But it was found to be slightly higher in Zone II and IV and its was more than the standard limit of 0.02mg/L in Zone IV during high tide. Cadmium was also found to be very less as compared to the standard limit. Manganese, Iron, Lead and cobalt were absent in all the three Zones.

   Heavy metals in sediments : Manganese was found to be absent in sediments from Zone IV and present in meagre amounts in Zone II. Lead was found to be more than the permissible limits (0.05mg/L). Cadmium was found to be less than the permissible limits (0.1mg/L). Iron and cobalt are absent in the sediments. Zinc and copper were found to be higher than their standard values.

Heavy metals in mangrove vegetation : Stem, root, leaves of *Avecinia marina* were analysed for the presence of heavy metals. Zinc and copper were found to be high in all three parts of *A. marina* in both the Zones. Manganese, Iron and Lead were absent in the leaves from both the Zones. Iron and lead were found to be less than the permissible amount as compared to the sediment concentrations.

Heavy metals in commercial fin fishes : Iron and lead were found to be less than the permissible amount of 20mg/l and 0.05mg/l respectively. Zinc and copper was found to be higher as seen similar to the sediments.

Sediment analysis and organic carbon content : The organic content of soil greatly influences the plant, animal and microorganism populations in that soil. Decomposing organic material provides many necessary nutrients to soil inhabitants. Both, Zone II and IV have poor organic content. The sediment type is sandy having particle size $\pm$ 0.2mm.

Analysis of phytoplankton : All these Zones show the presence of stress and pollutant related phytoplanktons. Shanon weaver index and biomass were found to be less indicating poor diversity in this area. The population of phytoplanktons were not healthy.

Analysis of zooplankton : The diversity of zooplankton was found to be poor. The biomass and Shanon weaver index were also less.

Bacterial study : Enteric coliforms were found to be absent in all the three Zones. Nutrient agar showed the presence of *E.coli* and some other types of bacteria.

3.10.8 Ecological Status Report:

(A) Attributes of Zones:

Sewri Mud- flat (Zone II) :

- Physiochemical conditions in this zone was found to be in the normal range.
- Mangroves showed poor diversity, with presence of only *Avicennia* species.
- Among the phytoplankton species, the Shanon Weaver Index was found to be less than one. This indicates poor species diversity. Also, species found were stress tolerant.
- The zone showed absence of enteric coliforms. This indicates absence of fecal contamination.
- Thus the zone is found to be especially polluted due to presence of sea vessels, which could add in Zn & Cu & such other heavy metal contamination.

- On the whole, the zone has relatively less organic contamination due to sewage or such other effluent, but the heavy metal contamination was found in aquatic & sediment medium, which was further found to be accumulated in mangrove species.

Thane Creek (Zone III) :

- Water in this region receives effluent discharges from industries & CETPs in the area. This may be one of the reasons for high levels of Cu, Zn & Cd in the zone.
- Bioaccumulation was also found in fin- fish in the zone.
- Specific enteric bacterial population was found to be absent in this zone.
- Water in this zone is found to be polluted by heavy metals & the biodiversity is also low.

Shivaji Nagar Mud- flat (Zone IV) :

- Heavy metal concentration in this zone was similar to that observed in Sewri area.
- Physiochemical characteristics of water were found to be conducive to the growth of mangroves.
- Mangroves diversity was mainly dominated by presence of *Avicennia* species, with a few surviving *Sonneratia* species.
- The area towards the high tide region, near the road, was found to be contaminated due to anthropogenic activities; also the mangrove density was low at the periphery. However, the mid tide & low tide regions appeared relatively untouched by anthropogenic agtivities.

(B) Levels of Stress:

Sewri Mud- flat (Zone II):

- pH, temperature, Salinity, alkalinity was found to be normal.
- Dissolved oxygen was found to be less as compared to the Shivaji Nagar Mudflat area. However, the BOD & COD was found to be low, implying a lesser organic load.
- Heavy metal contamination was also found to be on the lower side in aquatic medium, except the presence of Zn, Cu, & Cd. Lead was found in the sediments.
- Nitrates concentration was found to be ranging from 2.6 – 2.75 mg/l. Phosphates & Silicates concentration too was found to be on the lower side.
- The mangrove density was found to be low as compared to the Shivaji Nagar mud-flat.

Thane Creek (Zone III):

- Zoo & Phytoplankton species showed diversity on the lower side.
- Heavy metal contamination was present.

Shivaji Nagar Mud- flat (Zone IV):

- Mangrove density was high in this region. Most of the mangrove species found were in the sapling stage (stunted growth), with only a few full grown trees.
- However, the diversity index was low, with *Avicennia* species indicating major dominance.
- Bioaccumulation of heavy metals was found in mangroves.

- The area did show presence of phytoplankton & zoo-plankton species of stress tolerant types.

Table 3.26 Comparative Biodiversity:

	ZONE II	ZONE III	ZONE IV
Macro flora (qualitative)	Only avicennia species were observed in the area There were approximately an equal no of tree & seedings of *avicennia* found. Mangrove density was also found to be low.	--	Species of *avicennia* dominated the macro-flora diversity, with a few *sonneratia* species. Most of the macro- flora found were in sapling stage, with a few full grown trees present. Mangrove density was found to be high.
Macro flora (quantitative)	Very poor diversity, with index of dominance= 1	--	Poor diversity, with diversity index= 0.994 & shanon weaver index= 5.562%
Macro fauna (qualitative)	Poor	--	Moderate
Zooplankton diversity	Poor	Moderate	Poor
Phytoplankton diversity	Very poor	Poor	Poor
Avian diversity	9 species of birds were spotted in this zone a few of which included black headed ibis, white throated kingfisher, western reef egret etc.	--	About 12 bird species were spotted in this area, a few of which included red vented bulbul, common sandpiper, black headed gull etc.

3.11 Findings of the study

The findings of the above study lead to a number of important conclusions. These are as follows

1) The two tracts marked as CRZ I, namely the Sewri mud-flat and the Shivaji Nagar mud-flat, are under ecological stress. Detailed survey of mangrove in Shivaji Nagar site revealed that mangrove patches are degraded and dominated by Avicennia marina with stunted growth as low as .25 m - .75 m in height and low diversity. The major causes of destruction of mangroves is due to cutting for fuel purposes.

2) For the above reason, the existing eco-system cannot be described as sensitive.

3) The pollution load in the zone inhibits normal development of physiology and morphology. Hence the growth and reproduction of the different mangrove species get affected. In this zone**,** the mangroves growth will be hampered until the circumstances of pollution are radically amended.

4) The Shivaji Nagar mud-flat, has relatively less stress in terms of pollution. However, the tidal movement in this segment, which is one of the basic conditions of sustainance of mangrove ecosystem, has been drastically cut off by the ONGC road. This has not only inhibited the input of required nutrients to the system on which the mangroves are sustained, but the diversity of Phytoplankton has also been drastically reduced. This has paved the way of decline of several feeding filter bivalves.

The major repository of pollution is the waters of the Thane Creek in Segment III. To remove the circumstances of pollution is in itself a difficult task. With all the will that the managers of environment can muster, cleaning up will take a long time, because the heavy metals already deposited in the soil are not going to disappear soon.

3.12. Migratory Birds

The ecological settings of the project area have mudflats and mangrove area. The Sewri end of the mudflat experiences migratory birds during winter season. Out of the 17 species of birds spotted in the study area, 4 are migratory while the rest are known to be residents. Most birds seen were those that fell in the Least Concern category of the IUCN Red List, except for the black headed ibis (Threskiornis melanocephalus) which is Near Threatened. The Sewri mudflat area is widely known to attract lesser flamingoes (Phoeniconaias minor) and few number of greater flamingoes (Phoeniconaias rosues) from November to June every year. About 10,000 to 15,000 flamingoes which are Near Threatened on the IUCN's Red List are known to visit this site.

These migratory birds have a stay for a limited period and leave the area in the beginning of summer back to their origin. They feed themselves on the minute aquatic creatures in the mudflats and also enjoy the high salinity nature. Monitoring programme will be taken up during construction phase to monitor the movement of the migratory birds. Due to slight increase in noise level during construction phase, the migratory bird colonies/areas will not have permanent shifting effect. It is expected that they may slightly shift, if at all, during construction phase, to avoid any disturbance. It has been observed during the study that during high tide period on the mudflats these birds shifts themselves to other areas and come back again during low tide. Even during movements of boats etc they tend to shift for temporary period. In fact there are few industries very near to these mudflats, which generate typical noise levels due to industrial operations. This level sometime reaches up to 40 to 50 dB but it does not affect these birds. It is expected that construction of this project will not affect the habitation of the migratory birds permanently.

Report on "MTHL Project: Study of flamingos and migratory birds by Salim Ali Centre for Ornithology and Natural History, Coimbatore" December 2008.

Salim Ali Centre for Ornithology and Natural History studied the Flemingos and other migratory birds in the Sewri - Mahul and Nhava Mudflats which will help to take necessary mitigation steps for the protection of birds in the area. Following are some of the observation in the report

- Total abundance of birds in the Sewri-Mahul region was much higher than in Nhava, >53000 birds of 54 species in 2008 in the former and only >2000 of 26 species in the latter.

- The lesser flemingo started arriving in the area during December 2006 in small numbers and increased slowly in March 2007 and in large numbers in April 2007reaching the peak in May 2007. They started leaving the area in June with a few juveniles remaining in June-July 2007.

- Distribution was caused by the ship repair activities at Sewri and tourist going closer to the flamingos by boat. The local people catching crabs did not cause much disturbance. Small construction works by Tata Power caused slight disturbance, but the birds got adjusted and went back to the area after the construction was over. This shows their adjustable nature with local movements as recorded elsewhere in the world.

- Heavy metal contamination in water, sediment and fish samples from the study locations showed high levels were of iron, nickel and copper in the sediment in Sewri and chromium and cadmium in Mahul because of effluents from industry, domestic sewage and ship repair. These would create toxicity to the biota on a long-term exposure.

- Levels of Pesticides, polychlorinated biphenyls (PCBs) and Polyclic aromatic hydrocarbons (PAHs) are higher than the guideline values. It is to be noted that the higher concentrations of Total PAHs found in sediment and fishes are demonstrated to be carcinogenic and mutagenic.

Some of the recommendations of the report are

- Flamingos have moved away from Sewri Port area probably because of the increased activity of ship repair. This also created pollution. Hence this needs to be shifted.

- Tourism has to be regulated and managed in an eco-friendly way to avoid disturbance to the birds. Ensure no or minimum disturbance to the flamingos in the feeding and nesting areas. Construction activities in this area may be restricted to then season when flemingos are not here (or not in larger flocks).

- Contamination by PCBs, oil and grease and PAHs is above the prescribed limits and hence of great concern. Necessary action may be taken with concerned authorities.

- Mangrove restoration programmes may be undertaken in suitable areas. These areas also need to be identified.

- Long term monitoring and detailed studies during the construction work of MTHL.

3.13. CRZ Areas of the Alignment

CRZ Notification dt 6th January 2011 and its implications on this project have been discussed in detail in Chapter 1 of this report.

The CRZ maps in the scale of 1:4000 with the project alignment superimposed on them are prepared by the Institute of remote Sensing, Chennai, which an approved agency by MoEF&CC, New Delhi.

The statement of area for MTHL falling in CRZ is shown in the following table

Table 3.27 Area Statement of bridge/Viaduct in CRZ

Sr No	Zone	Area of Bridge in CRZ in Sqm	No of Piers	Size of Pier	Total area of pier in CRZ in sqm
SEWRI SIDE					
1	CRZ I (including mangroves)	141495	208	3m x 4m	2496
			3	30m x 65m navigational span	5850
	Total CRZ I				**8346**
	Area of Mangroves affected		48	3m x 4m	576
2	CRZ II	8505	60	2.5m x 2.5m	375
			At grade road	8.5m x 135m	1148
CHIRLE SIDE					
1	CRZ (including mangroves)I	112595	212	3m x 4m	2544
			6 nos solid ramps	150 x 8.5	7650
	Total CRZ I				**10194**
	Area of Mangroves affected				9306
2	CRZ II	3440	10	3m x 4m	120
CRZ IV			**354**	3m x 4m	**4248**
			8	30 x 65 navigational span	**15600**
Casting yard on Navi Mumbai side					
	CRZ I (all of Mangroves)				**16.15 Ha**
	CRZ II				**2.82 Ha**
	Grand Total				
	CRZ-I				**17.24 Ha**
	CRZ-II				**2.99 Ha**
	CRZ-IV				**1.99 Ha**

The Coastal Zone Management Plans (1:4000 scale) are enclosed with this report.

CHAPTER 4

IMPACT ASSESSMENT & MITIGATION MEASURES

4.1. General

The construction of proposed Mumbai Trans Harbour Link will result in saving in time, fewer accidents, greater travel speeds, reduced pollution and comfort for drivers/ users of the highway. However, it may have varied impact on the various environmental parameters like water quality and hydrology, air quality, noise levels, ecology, public health and socio-economic structure of the surrounding area. These impacts will be felt during construction and operation stages of the project. The anticipated environmental impacts and the mitigation measures to ameliorate the same are discussed below.

4.2. IMPACTS DURING CONSTRUCTION

4.2.1. Air Quality

Impact on Ambient Air Quality (AAQ) during construction stage of MTHL is anticipated. The adverse impact will be primarily due to transportation of construction material, road construction activities, loading and unloading of construction materials, and plying of construction vehicles along unpaved shoulders of access roads, emissions from asphalt mix plants, casting yards etc. Emission from these sources will have temporary but not significant impact on air quality.

MITIGATION MEASURES

During project initiation and construction period, the adverse impacts on ambient air quality are anticipated to occur mainly due to site clearance activities, construction material movement, and during various road construction activities.

a) For mobile source emissions

- Trucks carrying soil, sand or stone will be covered with traps to avoid spilling and blowing by wind from quarry to the site of construction.

- Fugitive dust entrainment at site and casting yard will be controlled by sprinkling water.

Figure 4.1 Water being sprinkled to control the fugitive dust

- Regular maintenance of machinery and equipment will be carried out.
- Mostly, pre-cast concrete elements will be used for construction. The construction yard will be located at Mumbai and Navi Mumbai on the mainland will be away from the settlements to minimise disturbance to these settlements**.**
- The pre-cast blocks will be transported to the construction sites by barges.
- Latest construction equipment and technologies will be used with arrangements for dust and noise control.
- Regular maintenance of equipment will be ensured.
- Construction materials required at the construction yard will be obtained from the authorised borrow areas and quarry sites and will be transported in covered trucks.

b) For stationary source emissions

- Asphalt hot mix plants will be located at Mumbai and Navi Mumbai on the main land and will be away from inhabited areas.
- All stationary equipment will be located as far away as possible from sensitive receptor locations in order to allow dispersion of emitted pollutants.
- Areas prone to fugitive dust emissions due to activities such as demolition, excavation, grading sites and routes of delivery vehicles across patches of exposed earth, will be frequently watered to suppress re-entrained dust.

- Apart from these, the equipment/ machines and vehicles should be always kept in good state of repairs to minimize emissions. Low emission construction vehicles/ equipment will be used wherever feasible. Construction areas should be enclosed, wherever possible.

- Exhaust and noise emissions of construction equipments will adhere to emission norms as laid out by MoEF/CPCB.

- The concessionaire shall ensure that the batching plant is located away from the residential areas and will be licensed and authorized for operation by the concerned authorities.

- Periodic inspection of the site will be carried out to ensure removal of construction debris to the landfill sites.

4.2.2 Ambient Noise Level

The main sources of noise during construction are construction equipment and the vehicles used for transporting various materials at the construction site. Operation of construction machinery e.g. hot-mixer, bulldozer, loader, backhoes, concrete mixer, etc will lead to rise in noise level to the range between 80-95 dB (A). The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Effect of increase in noise levels will be significant during night time near the residential area located close to the site.

The noise level generated from a source will decrease with distance as per the following empirical formula (inverse square law).

$$SPL2 = SPL1 - 20Log_{10}(r_2/r_1)$$

Where, SPL1 and SPL2 are the sound pressure levels at distance r_1 and r_2 respectively.

Considering the stationary construction equipment as a point source generating 90 dB(A) at a reference distance of 2 m, computed distance require to meet the permissible limits during day time for different land use categories are given below.

Table 4.1 Minimum distance of operation from Stationary Source required for Meeting Standards

Category	Permissible limits in day time (CPCB)	Distance required (m)
Silence zone	50 dB(A)	200
Residential	55 dB(A)	113
Commercial	65 dB(A)	36
Industrial	75 dB(A)	11

From the above table it may be noted that residence within 113m from the road will be exposed to a noise higher than the permissible limit. Therefore the impacts will be significant on construction workers, working close to the machinery.

Mitigation measures

The following mitigation measures are being recommended to control noise level during construction and operation phase.

Site Control

Stationary equipment will be placed beyond the distance indicated in the **Table 4.1.**

Source Control

- All construction equipment will be fitted with exhaust silencer. Damaged silencer to be promptly replaced by the concessionaire.
- Proper maintenance of equipment will be undertaken with the provision of enclosures and intake silencers.
- DG sets, if used, will adhere to the noise standards of MoEF.

Scheduling of Project Activities

- Generally construction activities involving generation of noise will be carried out adhering to the noise standards of MoEF in the residential and sensitive areas.
- Provision of protection devices (ear plug) to be provided to the workers in the vicinity of high noise generating machinery.

4.2.3 Impacts due to "Construction and Labour Camps"

Construction camps include workers' residential areas and the grounds where equipment is stored and serviced and where materials are stockpiled. Careless construction camp design and management can lead to serious environmental degradation including

- sewage and garbage pollution;
- depletion of fauna and flora through illegal harvesting (poaching);
- infrastructure overloading- health services,
- sewage treatment,
- schooling

- law enforcement; and
- Spills from construction equipment operation and servicing.

Mitigation Measures:

The labour camp would be located at Navi Mumbai. All the facilities and amenities will be provided to the labour camps as per the "The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996" and "The Inter-State Migrant Workmen (Regulation of Employment) and Conditions of Service) Act, 1979"

The casting yards will be located at Mumbai and Navi Mumbai side. The 40ha land has been identified for this purpose. These locations are away from the habitation. Temporary Jetties will be constructed to transport the precast segments at the project location through barges. The barricading to the proposed casting yard site will be provided. The proposed location of casting yards and labour camp is shown in **Figure 2.4.**

4.2.4 Impacts due to Siting of Borrow and Quarry Material Areas

Material Source

Construction of MTHL will require transportation and handling of materials in large volumes. The volume of natural materials required is so large that careful consideration needs to be given to identify the sources. The transportation of these materials could severely over load the existing road network. Transportation of other materials like cement, steel will aggravate the situation. Some of the basic materials like aggregates -coarse & fine, murum can be procured locally from the surrounding quarries. The broad quantities of material are given in **Table 4.2.**

Table 4.2 Broad Quantities of Material

Sr.No.	Material	Unit	Quantity (in 000's)	Sources
1.	**Fill Materials**			
	Murum	Cum.	200	Locally available materials at Jasai, Gavhan, Dronagiri etc.
	Sand	Cum.	375	Ulwe, Kharghar, Dharamtar, Patalganga and crushed sand
2.	**Stone Materials**			
	Armour/Pitching	Cum.	50	Dronagiri, Vahal, Ulwe and Kharghar
	Rubble	Cum.	20	
3.	**Concrete Materials**			In bulk from manufacturer by rail at Jasai or Sewri stations or bulk

Sr.No.	Material	Unit	Quantity (in 000's)	Sources
				depot at Ulwe. Crusher at quarry or at site in Nhava. Sand dredged from sea or stone dust aggregate from crusher. Bulk bitumen from refinery in Mumbai.
	Cement Coarse Aggregate Fine Aggregate	MT Cum. Cum.	492 987 492	
4.	**Road Materials** Surfacing Base Course Sub-base Course	 Cum. Cum. Cum.	 300 27 38	From crusher at Trombay and on NH-17
5.	**Steel** Reinforcing rounds	 MT	 105	From manufacturers (SAIL or TISCO) in trucks
	Prestressing	MT	21.4	
	Structural	MT	89	
	Bridge cables	MT	5.2	

It will be ensured that sand (It is proposed to use crushed stone sand instead of dredged sand), aggregates and other quarry material be procured from licensed quarries. It would be ensured that borrow and quarry areas that have been identified are approved and authorized to operate by competent authorities. There are number of quarries available near the project site on Navi Mumbai side. The locations of these quarries are shown in **Figure 2.7**.

Also, during construction phase, the opening up of new borrow pits shall be in accordance with the IRC: 10-1961 specifications. Top soil (upto 150 mm) to be preserved and reused as the resurfacing material for the berms, slopes and central verge of the road where plantation / grasses will be developed.

Mitigation Measures

i) Quarries will be opened from the rear end to keep its unaesthetic, noisy and pollution oriented activities away from the roads and the surrounding communities from where it can be seen.

ii) Collapsing of heavy rocks and boulders. Such a slope is also unstable.

iii) Quarrying will not be done up to ground floor level, as it results in preventing flooding Quarrying will not be carried out with a vertical sheet 90^0 slope, due to damage of and letting the surrounding water into the quarry-pits. It is also

unsafe for the population in the surrounding area who might meet with accidents and may accidentally drown in the collected water.

iv) Quarrying will be done in benches i.e. at an angle and at regular angles. A bench of 5 m should provided before the next higher up slope is cut.

v) The sequence will be from the rear to front from aesthetic point of view.

vi) After the work is over, the quarry site will be planted with shrubs and trees of indigenous variety to merge within the existing landscape.

vii) Huge amount of debris will be generated due to dressing of stones. This material should be used to fill hollows and scars created in the process of quarrying. The material is also ideally suitable as fill material for embankment and can be used for the purpose.

viii) Quarries will be carefully leveled to avoid de-stabilization of slope and the general landscaping will be easier due to rock and soil content.

4.2.5 Water Quality

The major water body concern in the area is none other than the sea. There are no other water bodies and/or resources in the nearby project area. During construction there will be a slight change in the water quality at the construction location because of spillage of oil and grease and increase in turbidity due to the turbulence in water. However it will be insignificant and the change will be purely temporary. No permanent impact is anticipated on water quality due to sea link project. No impacts on ground water quality and its availability are anticipated as a result of the proposed actions at the sites.

MITIGATION MEASURES

- Proper Construction methodologies will be adopted in order to avoid turbidity problem.

- Care will be taken to avoid layer of suspended solids and spillage of oil and grease in the seawater during transportation as well as during shifting of girders.

4.2.6 Topography, Soil and Geology

The construction of roads on either side of the link will require excavation. This cutting material (excavation earth) will be disposed off in a scientific manner at a designated dumping site; thereby preventing the adjoining area from being disturbed. The link is passing through the mudflats area for a length of 2.1 km. (1.5 km at Sewri end and 0.6 km. at Nhava side). Thus to avoid the mudflats being disturbed during the construction, temporary bridge will be constructed for the movement of material and machinery.

Figure 4.2 Temporary Bridge will be constructed for the movement of vehicles and machinery

MITIGATION MEASURES

- Instead of solid embankments, Viaducts are proposed on Sewri and Shivaji Nagar side to avoid disturbance to the mudflats. This will allow vegetation below to maintain continuity and survive. Such phenomenon was also observed during construction of Airoli creek Bridge as shown in the photograph below.

Figure 4.3 Airoli Creek Bridge

- The road and bridge materials will be collected only from selected/approved/licensed borrow area.

- Rehabilitation of borrow pits using appropriate mix of local bushes and trees for vegetation coverage

- Cutting material will be utilized for earthwork filling requirement.

- Debris from cutting materials will be disposed at suitable sites properly, ensuring that it does not affect groundwater quality and soil quality of adjoining land.

- Pre-cast units will be used instead of cast in situ to avoid any adverse effect to mudflat area.

4.2.7 Reserved Forest and Fauna

The project area does not fall under any of the reserved forest area. There are no endangered species of flora and fauna within the project area, neither any endemic flora nor fauna species are found in the adjoining area. Wild life activity is also absent in the area.

4.2.8 Land use

The project area on the land side consists of main & arterials roads including residential and commercial establishments. This is a typical feature in the urban area. As approach roads are taken on viaducts instead of on solid embankment, quantity of filling material is drastically reduced as also the extent of borrow pits. Stone rubble, aggregate etc. is to be procured from existing authorized quarries.

MITIGATION MEASURES

- Development of any land will be in accordance with the government regulations

- Care will be taken to ensure that the construction worker's camp doesn't disturb the surrounding land use pattern which will be located in Navi Mumbai.

4.2.9 Impacts on Utility Services and Community Severance

Utility lines like electric poles, telephone poles, transformers high and low tension electric lines and telephone lines which may be affected by project will be identified with respect to their locations in the project area. Community severance and sensitive receptors like religious places community centers schools, inhabitant centers and cattle crossing location etc. will be taken in to consideration during construction phase.

4.2.10 Fisheries

Although no fishing activity has been observed within the project corridor, sufficient horizontal and vertical clearance have been proposed below the link for the movement of fishing boats.

4.2.11 Ecology and Biodiversity

It has been observed that the creek water has been thoroughly affected and polluted due to industrial and domestic waste water. There is an accumulation of various heavy metals and other organic and inorganic contents near ecological areas of the project including mudflats. There are two locations, Sewri on Mumbai side and Nhave on Navi Mumbai area having mudflats. There is sparsely scattered mangrove species (coastal halophytes) in this places and detail study has been carried out for ecological features and also Biodiversity of various components. The pollution has adversely affected the ecology of the mudflats particularly on Sewri side. At the same time constructive plans have been evolved for minimizing effect of construction activity on mudflats by adopting construction technologies which will not damage mudflat extensively. Following are some of the impacts, though they are of temporary nature

- Release of contaminants from disturbed sediments will result in pulses of contamination in water for a temporary duration
- Increase in turbidity during pile driving.
- Reduced water clarity/ light penetration leading to disturbance in zoo & phytoplankton & benthic biota for a short period during construction
- Zoo-plankton & phytoplankton species would be affected in the immediate vicinity of the link.
- Flamingoes are one of the important migratory bird species found in this area. The Sewri mud-flat areas are habitat grounds for these migratory birds from December to May. Though their stay is only for a limited period, these are of ecological importance. It also attracts nature lovers & tourist population, during their stay. Their habitat would be disturbed during construction phase.
- Generation of employment opportunities and providing short-term socio-economic benefits to the people engaged in the works.

Mitigative Measure

- Construction vessels to be kept at a slow speed to prevent disruption as far as possible to fishes & other marine biota
- Water pollution, dumping of waste, reclamation, are some of the major threats to wetlands which would be strictly looked into. Waste generated during construction phase should be disposed off at approved disposal sites.
- Construction technologies to be adopted in such away to minimize effect on mudflats.(Described in Chapter 2 of this report)

- Pre-cast units will be used to avoid any effect on mudflats during construction activity.

- Mangrove restoration plan will be being initiated in lieu of loss of mangroves.

- Care will be taken to minimize any damage to aquatic flora – fauna etc and to restore biodiversity.

- Pollution prevention plans will be evolved and submitted to responsible authorities to minimize/prevent pollution at source.

4.2.12 Archaeological / Heritage:-

There are 3 archaeological monuments near the project site. It includes Gateway of India (within 7 km), Elephanta Caves (4 km) & Sewri fort (1km). The impact on these monuments due to the air and noise quality during operational stage have been predicted and it was found that there will not be any change in the air and noise quality at these site because of the MTHL. However NOC for the Sewri, Elephanta and Gateway of India has already been obtained from the Archaeological Department.

MITIGATIVE MEASURES:-

- Surveillance monitoring will be carried throughout entire construction period.

4.3 IMPACTS DURING OPERATION

4.3.1 Air Quality

During operation stage of the MTHL major impact will be on the air quality due to the vehicles plying on the MTHL. The impacts have been predicted along the MTHL alignment based on the existing levels of air quality, traffic, meteorology etc. Impacts have been predicted for the year 2017, 2021 and 2031 when the MTHL becomes operational. It is necessary to find out and evaluate these impacts on the surrounding environment including archaeological sites.

Air Quality Prediction Based on Traffic Projections

CO is an important pollutant released due to vehicular emission. Therefore, simulation of air quality in respect of CO based on projected traffic has been made to assess the impact on air quality due to MTHL. Considering the project progress, the impact on air quality is assessed for the year 2017, 2021 and 2031.

Model for Simulation of CO Concentration

A computer model, CALINE-4 is used to assess the impact on air quality in respect of CO due to present traffic at a distance of 50, 100, 200 and 3000m from the MTHL. California Department of Transportation, USA, has developed the model. It is based on Gaussian diffusion equation and uses a mixing zone concept to characterize pollutant dispersion over the roadway.

Inputs to the Model

- Speed dependent emission factors-class wise,
- Hourly traffic data of vehicles (cars, 2/3 wheelers, buses, trucks),
- Meteorological data (hourly wind speed, direction, atmospheric stability, temperature),
- Receptor location (distance from centre line of carriage way) are input parameters, and
- The baseline concentration of CO in ppm.

Output of the Model

Predicted concentrations at downwind receptor locations.

Location Used for Modeling

The predictions have been made at a distance of 50, 100, 200 and 3000 m (Elephanta) and Sewri Fort. The impact is super imposed on the baseline air quality and compared with National Ambient Air Quality Standards for compliance or otherwise. With the available data, the total emission load for each location was computed using the corresponding emission factors. Following tables show the projected daily traffic for the year 2017, 2021 and 2031.

Table 4.3 Projected Daily Traffic

Year	2017		2021		2031	
	Peak Hr	Daily	Peak Hr	Daily	Peak Hr	Daily
Car/Taxi	1784	29725	2175	36250	3213	53550
LCV (Light Commercial Vehicles)	380	6325	543	9050	918	15300
Bus	140	2325	162	2700	215	3575
HCV (Heavy Commercial Vehicles)	314	5225	453	7550	768	12800
MAV	83	1375	119	1975	200	3325
Total (Vehicles)	**2699**	**44975**	**3452**	**57525**	**5313**	**88550**

Source: ARUP-CES STUDY, 2011.

Emission Factors

The emission value for CO for Indian vehicles is used as applicable emission factors for different vehicle types. This value is proposed in the report “Vehicles Emission and Control perspective in India” prepared by Indian Institute of Petroleum (IIP) and is adopted as emission standard by Central Pollution Control Board (CPCB). This standard provides permissible emission levels in terms of mass of pollutant generated per unit distance traveled or per unit engine capacity. **Table 4.4** represents the emission rate of CO for different types of vehicles.

Table 4.4 Emission Rate of Different Types of Vehicles for CO

Emission Rate (g / km)				
2-Wheeler	Auto Rickshaw	Car/Jeep/ Van	Buses	LCV/ Trucks
2.0	2.0	2.72	8.281	6.475

Source: Indian Institute of Petroleum

The results of the modeling are presented in the **Table 4.5.**

Table 4.5 Air Quality Prediction (CO)

Distance from MTHL in m		2017	2021	2031
North of MTHL	50	1.9	1.9	2.0
	100	1.9	1.9	1.9
	200	1.9	1.9	1.9
	3000	1.8	1.8	1.8
South of MTHL	50	1.9	1.9	2.0
	100	1.9	1.9	1.9
	200	1.9	1.9	1.9
	3000 (Elephanta)	1.8	1.8	1.8
North of MTHL	600 (Sewri Fort)	1.8	1.8	1.9

Background CO concentration of 2 mg/m^3 (1.75 ppm) (max recorded in the study area) has been considered in the modelling.

From the **Table 4.5**, it can be observed that there is an increase of 0.1 ppm in the year 2017 and 2021 while it is just 2 ppm in the year 2031 at a distance of 50 m to 200 m from MTHL indicating that there will be negligible impact on the air quality due to the MTHL traffic.

Impact of MTHL at Elephanta

Concentration of CO due to the MTHL at Elephanta has been predicted and it was observed that there will not be any impact on the air quality at Elephanta due to the MTHL when the link becomes operational.(The model has been run for the wind angle producing worst impact on the receptor i.e. Elephanta)

Mitigation Measures

A thick vegetative cover along the approach roads (Sewri and Nhava side) of the sea link will act as a barrier & will help to absorb the emission of the vehicles.

- Road Furniture/Signboards will be put along the approach roads and at project building requesting motorists to avoid idling or/and stoppage of the vehicles at non-designated places.

- Continuous monitoring of parameter such as CO, will be carried out by installing monitoring stations on both the ends of the bridge. A mobile monitoring van will also have a vigil on the bridge for air quality monitoring.

- Micrometeorological station is proposed on the Sea Link which will continuously monitor wind speed, wind direction, relative humidity, and temperature. This will facilitate the knowledge of meteorological factors which are important and have co-relation with the ambient air quality.

In addition to the above mitigation measures, further technical improvement in form of superior engine design in order to meet the stringent Government regulations will also reduce emissions in the years to come. As a mitigation plan, competent authority shall enforce vehicular emission norms of the day.

4.3.2 Noise Levels

Ambient noise monitoring was carried out to know the existing ambient noise levels in the influence zone of MTHL. The analysis of the monitoring is presented in the Chapter 3.

Prediction of Noise Levels

The prediction of noise levels due to the proposed MTHL have been carried out for the year 2017, 2021and 2031 using Federal Highway Noise Model developed based on the guidelines suggested by Federal Highway Administration (FHWA). The background noise levels and the noise generated due to the MTHL have been further added to the predicted noise levels to ascertain the resultant noise levels.

The FHWA Model is based on the following formula for calculating the hourly Leq for each category of vehicle separately. These values are logarithmically added to obtain the overall hourly Leq.

$$Leq\ (hi) = Loe_i + 10 \log (Ni/SiT) + 10 \log (15/D)^{(1+\alpha)} - 13 + \delta$$

Where,

Leq(hi) :Equivalent noise level at the hour (h) for vehicle type (i)

Loei : Reference mean energy level for ith vehicle type

Ni : Number of vehicles of i-th class passing in time T, (1 hr)

Si : Average speed of vehicles of i-th class (kmph)

T : Time duration corresponding to Ni one hour

D : Perpendicular distance (m) from centerline of the traffic lane to observer

α : Factor relating to absorption characteristics of ground cover between roadway and observer

δ : Shielding factor e.g. for barrier

The predicted noise level arising from the MTHL is combined with that of the existing ambient noise level to give the resulting noise level (L_{ATotal}) using the formula:

$L_{ATotal} = 10 \log_{10} (\text{antilog}_{10} (L_{AMTHL})/10) + \text{antilog}_{10} (L_{AAmbient}/10))$

The results of the computations are presented in the **Table 4.6**

Table 4.6 Noise Level Prediction

Distance from centerline of MTHL in m	Year		
	2017	2021	2031
30	75.1	75.8	76.7
50	72.8	73.6	74.4
75	71.1	71.9	72.7
100	69.8	70.6	71.4
200	66.8	67.6	68.4
300	65.1	65.8	66.7
500	62.8	63.6	64.4

All values are in dB (A)

**Background Noise levels 66.6 dB (A) (Maximum recorded in the influence area) have been considered.*

The above analysis shows that the projected noise levels likely to occur in the range of 75.1 to 62.8 dB(A), 75.8 to 63.6 dB(A) & 76.7 to 64.4 dB(A) in the year 2017, 2021 and 2031 respectively for a distance of 30 m to 500 m from the centerline of road. Though the noise levels are above the prescribed standard (55 dB(A)), there is marginal increase in the noise levels for a distance of 500 m in the year 2017 to 2031.

Predicted Noise levels at Elephanta due to MTHL

The Elephanta caves are located at a distance of 3000 m south of MTHL alignment and are a World Heritage Site. Therefore noise levels are predicted at this location using the same methodology as described above and for the same scenario. Background noise level of 53.7 dB(A) have been considered in the

model which is the highest recorded equivalent noise level at this location. The predicted noise levels are presented in the following **Table 4.7**

Table 4.7 Noise Level Prediction

Distance from centerline of MTHL in m	Year		
	2017	2021	2031
30	75.1	75.9	76.7
50	72.9	73.7	74.5
75	71.2	71.9	72.7
100	69.9	70.7	71.5
200	67.0	67.8	68.6
300	65.4	66.1	66.9
500	63.3	64.0	64.8
3000	**57.4**	**57.9**	**58.4**

All values are in dB (A)
**Background Noise levels 53.7 db (A) (Maximum Leq recorded at the Elephanta) have been considered.*

From the above table, it can be observed that the noise level at the Elephanta is slightly exceeding the permissible limit of CPCB. This is due to the fact that the existing noise level is already much higher considering that there is no traffic. However the increase in noise levels at 30 m distance is about 11 dB(A) while it just 3.5 dB(A) at 3000 m distance. Therefore the impact due to noise generated by MTHL at Elephanta would be minimal.

Mitigation Measures

- Appropriate action would be initiated for declaring silence zone for about 2km length of MTHL on Sewri side and near to school/other sensitive receptors on Navi Mumbai side of MTHL.

- With the implementation of the mitigative measures proposed for air quality, the noise level can also be attenuated to acceptable limits by providing barrier of the Sealink (bridge).

4.3.3 Ecology

The sea link construction would lead to significant reduction of travel time, from Sewri to Nhava, i.e. connect the Mumbai main-land to the satellite town near Panvel, where main industrial activity and areas are located. It would further connect to the NH-4 Mumbai- Pune Express highway. This in-turn would have a beneficial impact to reduce traffic congestion, help in conservation of resources, & improve air quality to some extent. Therefore no significant impact is envisaged on

the ecology during the operational stage of the project. Aquatic life of the Thane creek is also not affected when MTHL becomes functional. However certain measures have been proposed to ameliorate the existing environment. These should be seen as measures to enhance the quality of environment.

1) The huge pollution load in the Sewri mud-flat zone inhibit normal development of physiology and morphology of halophyte. Hence the growth and reproduction of the different mangrove species get affected. It is currently dominated by only one species (*Avicennia marina).* This signifies that this mud-flat does not support an ideal mangrove system. The poor biological diversity of fauna can also be correlated with the extremely hostile environmental conditions of the area in terms of presence of heavy metals, bacterial load, and high levels of oil and grease. The sources of pollution are the economic activities on both the adjoining land and the sea water.

3) *It is proposed to construct approach/access road in mudflat on viaduct structure to avoid impact on* sedimentation and erosional patterns or activities. This would allow growth of the coastal halophytic vegetation and revival of the hardier mangrove species.

4) The pillars for the viaduct would occupy small area on the mud-flat and would not cause any serious erosion. Nevertheless, these pillars would alter biological diversity and would invite a large variety of benthic algae. These will, in turn, gradually form a secondary community a result of ecological succession. The water will also be biologically purified by the algae and other benthic organisms that will gradually settle on the pillars as per the law of succession. This will enhance, to some extent, the changes of growth of at least the halophytic vegetation.

5) To remove the circumstances of pollution is in itself a difficult task. As a means to purify environment by bio-engineering, it is useful to consider plantation of *Porteracea coarctata* in this area. It is a good remedial measure to purify the aquatic environment, as this species has a unique capacity for bio-accumulation. *Enteromorpha sp* which already exists in the local substrata in this zone, can also be fruitful if the plantation programme is taken up. This macro algae can accumulate high level of Cu, Zn, Mn, Fe and Pb and charge the system with O_2 during day time.

6) The major repository of pollution is the waters of the Thane Creek in Segment III. Here the MTHL project is designed in the shape of viaducts and bridge. The pillars in the bay region has the potential to adversely affect the benthic bio-mass; but these can also accelerate the biological diversity in the Segment by establishing the benthic algal community followed by animal communities to settle on them. But the need for taking actions to arrest pollution of water is necessary. This would require, *inter alia*, considerable investments on sewage treatment. Prohibition of ship-painting activities together with collection and disposal of bilge water in safer locations would be the other necessary measures.

6) The Shivaji Nagar mud-flat, has relatively less stress in terms of pollution. But the ONGC road has drastically cut off the supply of marine nutrients. Under such circumstances, it is necessary to consider construction of culverts across the ONGC road. In addition, construction of feeder canals with a grid layout in the mud-flat can possibly restore the eco-system. This will assist proper replenishment of the nutrients.

7) Across the Shivaji Nagar mud-flat, a viaduct structure would require a small amount of land and would not impede the flow of marine nutrients into the declining mangrove like eco-system on this mud-flat.

8) Compensatory afforestation would be taken up on 7 ha of land after construction phase. This would be in lieu of loss of 0.117 Ha mangroves that would be cut due to the construction of piers of sea link viaduct.

9) *MMRDA would beautify the area as tourist attraction in form of flamingo park, mangrove park. Certain area along the bridge can be managed as tourist spots and as environmental education centers along with the involvement of local community/NGO.*

10) *A nature interpretation centre would also be developed by MMRDA in the area to create awareness about importance of conservation of flora and fauna.*

The measures suggested above would only enhance the quality of the given environment and could hopefully bring back the mangrove-type eco-system eventually. Without these actions, the sensitivity of the given ecology need not be considered as factors to restrain construction of the MTHL project. To say the least, the existing ecology is either dead or moribund.

4.3.4 Water Quality

There could be occasional oil spills, grease and dirt due to the plying of vehicles on the MTHL, which may enter the creek waters due to surface runoff. However the impact is insignificant. During the monsoon the surface runoff from the road will be collected through the road side drains and will be discharged in to the natural streams nearby.

Mitigation Measures

Storm water drains will be proposed on either side of MTHL and also viaduct. Storm water from the ROB/Viaduct will be collected by spout and will be taken to the Chamber through downtake pipe which will be discharged in to the natural drain/storm water drains. The new roadside drain will also be connected to the existing storm drainage system / drains in the area at appropriate locations.

4.3.5 Solid Waste Management

Solid waste from the project during construction will be mainly domestic scraps & wastes from the construction camp and construction spoils from construction sites.

- The small amount of construction debris will be disposed of in suitable pre-identified dumping areas in tune with the local condition to avoid land degradation & water pollution due to indiscriminate dumping.
- Dumping areas will be biologically reclaimed through top soil cover & plantation.
- Regular inspection of haul roads, construction site & camp will be carried out to ensure regular and timely removal of construction debris to the dumping sites.

4.3.6 Impacts on Quality of Life

Socio-Economic Condition

The socio-economic scenario in the region will certainly change with positive impact on the existing regional socio-economic pattern. Lot of employment opportunities will be created for the local people which will have positive impact on the economic growth of the region and subsequently the increase in living standard of the people of the region. It will have positive effect on industrial sector in Navi Mumbai area. Also it will boost the port related activities as well as rapid growth of Navi Mumbai International Airport & Special Economic Zone (SEZ) being developed in the Navi Mumbai.

Accident hazards and safety

During operational phase accidents / hazards will be greatly minimized and will ensure further safety of the local people.

4.3.7 Aesthetics and landscape

It is proposed to plant avenue trees as well as hedges / shrubs wherever possible within the project corridor on Nhava side of MTHL.

A landscaping will be provided for viaduct and interchange during implementation. Adequate provision is made in the Project cost. The detailed green belt management plan is given below-

DETAILS OF GREEN BELT MANAGEMENT PLAN

(I) Establishment of Roadside Vegetation

OBJECTIVES OF ROADSIDE PLANTATION.

- To conserve the natural Flora and Fauna

- To raise multipurpose plantations along roadside for Economic, Bio-Aesthetic and environmental purpose thereby enhancing the landscape quality.
- Attenuate against fugitive emission & particulate.
- To achieve reduction in noise level.

Species Selection and Composition

The major tree species occurring and flora predominant along alignment have been taken into consideration in selection of Tree species. The species recommended by Forest Department, Maharashtra State for avenue plantations and by C.P.C.B. Delhi in "Guidelines for Developing Greenbelts" have been taken into consideration. The objectives listed above also govern the selection of species and accordingly plan is prepared. Thrust is mainly to plant indigenous variety of species occurring in the region like Mango, Neem, Vad, Pipal etc. predominant in the respective tract from the ecological and environmental point of view.

From the Bio-aesthetic point of considerations, few species, though not indigenous, but have adapted to the climatic and edaphic conditions of the said tract are worth considering for plantation. Due to their variety in foliage and beautiful coloured flowers during different seasons such as, different species of Cassia etc.

The species recommended for Avenue Plantations are grouped into three, such as Tall Evergreens/Semi-evergreens having well defined crown, Fruit and other plants of commercial importance and beautiful flowering ornamental plants. Plantation of these tree species is envisaged proper composition and design in the field to achieve the desired objectives. The various planting designs can be prepared by considering various factors such as, various management aspects, Bio-aesthetic aspect, suitability of site to species or the composition of species, Irrigation inputs extended, and etc. A chart may be prepared kilometer wise for each section after studying field conditions showing the planting design. Accordingly requirement of various species as per the composition may be worked out.

Table 4.8 Species Recommended For Roadside Plantation

Sr No	Botanical Name	Local Name	Description
1.	*Acacia Auriculiformis*	Acacia	Australian acacia, pale green leaves with yellow flowers
2.	*Acacia Mangium*	Mangium	Straight tall growing acacia with leaves like mango tree.

Sr No	Botanical Name	Local Name	Description
3.	*Barringtonia Recemosa*	Samudra Phul	Tree with dark leaves with scented flowers thrives well along sea-shore and salty climatic conditions.
4.	*Bauhnia Verigata*	Kachnar	Bears variegated flowers in profusion in February and March.
5.	*Calophyllum Innophyllum*	Undal	Tree with dark green leaves, suitable to places exposed to sea shore.
6.	*Cassia Fistula*	Amaltas	Bears a profusion of drooping racemes of bright-yellow flowers during April-June.
7.	*Cassia Javanica*	-	The Java Cassia. Bears a profusion of rose colored flowers in autumn.
8.	*Cassia Marginata*	-	The Scarlet Cassia. Scarlet and crimson flowers during monsoon.
9.	*Cassia Siamea*	-	The Siam Cassia. Very fast growing, evergreen tree with masses of yellow flowers in winter.
10.	*Casuarina Equisetifo;la*	Suru	Tall pine like tree with conical shape resembling pine.
11.	*Dalbergia Sissoo*	Sissoo	Tall evergreen to deciduous, on of the Green belt species
12.	*Delonix Regia*	Gulmohar	Fast growing and with a profusion of flaming red flowers in April-May.
13.	*Erythrina Indica*	Pangara	The Coral tree. Bears a profusion of vermilion coloured, elongated bead-shaped flowers in March.
14.	*Ficas Bengalensis*	Banyan tree/ Vad	Very suitable for shady avenues, tall, evergreen.
15.	*Ficus Religiosa*	Pipal	Tall tree, nearly evergreen a good avenue trees.
16.	*Mangifera Indica*	Amba	Evergreen, tall, well-crown avenue fruit tree.
17.	*Millingtonia Hortensis*	Akash Nim	A tall straight tree with handsome foliage & aromatic white flowers.
18.	*Peltophorum Inerme*	Peltophorum	Dense, round, evergreen crown and scented yellow flowers twice a year.

Sr No	Botanical Name	Local Name	Description
19.	*Plumeria Rubra*	Chapha	Evergreen dark green coloured leaves, with scented flowers.
20.	*Pongamia Pinnata*	Karanj	Large , evergreen shade tree
21.	*Samanea Saman*	The rain tree	A spreading evergreen tree suitable for shady groves.
22.	*Spathodea Campnulata*	The Tulip tree	A tall, evergreen tree with large, deep-orange, bell-shaped flowers twice a year.
23.	*Syzygium Cumini*	Jambhul	Evergreen, well-formed tree. Suitable for moist localities.
24.	*Tabubia Rosia*	-	Beautiful medium sized flowering evergreen tree.
25.	*Tamarindus Indica*	Chinch	Giant fruit specie with majestic look.
26.	*Thespecia Populnea*	Bhendi	Evergreen medium size tree with yellow flowering twice a year

Plant Quality:

One of the major reasons for plant failure on roadsides is poor quality plant stock. Because roadsides are often extremely harsh sites and there is generally minimum maintenance, it is essential that quality plants should be selected.

To ensure plant quality and reliability as in such cases, it is recommended that the plants be obtained from known sources of plant origin. In case of high yielding fruit plants required, various varieties can be procured from private reputed Nurseries.

On some sites, it may be appropriate to use larger plant stock. However it is appropriate to plant tall plants having height up to 1.2 m which should have solid stem; plants taller than this require support and much attention till they are established. Many a times such tall plant tends to bending/ drooping, and the growth may be affected due to the same.

Pre-planting operations:

Following pre-planting operations should begin well in advance, to keep the site ready before on-set of monsoon. It is the prime requirement that before pre-planting activity is to start all road construction related works on the either side where planting is to be done should preferably be completed. Works such as side gutters, leveling work and other such works which have direct influence on the planting works, if are completed there will be less chances of damage to the young plants.

ALIGNMENT/ LAYOUT/ SPACING:

The planting activity has to be restricted mainly to the area between Terrestrial as well as Terrestrial & Marine Setting. At certain stretches along length, even no space is available for planting due to embankment or cutting where, planting has to be restricted in one row at the outer edge of the boundary.

It is important that the trees planted should not be the cause of distracting the attention of the drivers, and should not obstruct the clear vision while speeding on bridge. Hence, 'it is recommended that the trees should not be planted to the inner side of the curve, as for the road safety this clearance zone is essential. On roads with high traffic speeds and high traffic volumes, a clear Roadside recovery area of 9 meters from edge of the nearest traffic lane to tree planting is desirable. This is the minimum requirement of all freeways/expressways. It is recommended that such clearance zones should be marked on the ground for the Road Safety.

Digging of pits & size recommended:

Optimum size of pit is proposed as 0.60M X 0.60M X 0.60M (= 0.216 M3). Before digging of pit operation is to take place removal of any metal and murrum present on surface by way of scraping need to be done. At the same time, the work of Gutter on either side needs to be completed side by side.

Refilling with good soil/manure etc.:

It is recommended that the pits of the size 0.60M X 0.60M X 0.60M (= 0.216CM) dug after necessary alignment proposed as above, need to be refilled by good soil and well decomposed manure mixed in 1:1 proportion. It is recommended that 2/3rd volume i.e. 0.144CM of the pit should be filled with good soil/manure and local soil should be used for filling 1/3rd volume i.e. 0.072CM of the pit. Slow-releasing 25gm Phosphatic fertilizer power should be mixed with soil while refilling pits. While doing so, dug it is recommended that all the stones, 0boulders etc should be removed and then only good soil and manure be added and this mixture be used for refilling. The refilled soil in a pit should be kept loose.

Planting operations:

Normally the planting activity is to be scheduled in such a way that the maximum advantage of Monsoon is availed, it means that the planting should be done in second/ third week of June when monsoon is set. However, if the early planting in the 2nd/3rd week of May is done followed by watering by drip irrigation or by other suitable method such as deploying water tankers, this will result in early establishing of the seedling. Thereby the seedlings will be benefited immensely in growth. This should be done in few identified sections where watering is ensured.

Planting plan- Design & layout:

To plan for systematic plantation planting design need to be prepared. The proposed design of planting is to be communicated in the field by preparing planting plan and this must be circulated to the supervisor/worker level. This plan will give the planting details, kilometer wise, which species to plant where. As the design of planting is done with certain objectives, this is very important to achieve desired objectives. This will help in planning for transportation of seedlings to various stretches of different sections of the road.

Transport plan as per design:

Based on the planting plan, transport plan is to be prepared. Actually, transport plan is nothing but the plan of transporting *planting stock* from the nursery to the respective sections for planting. Before transporting the seedlings to the site for plantation, it is very important that thorough inspection of seedlings must be done at Nursery. Only those seedlings should be transported which are healthy and promising one, rest unsuitable for planting must be discarded at nursery only. This is to assured by the responsible supervisory staff. Transport plan will help in ensuring that the only best planting stock is transported to the respective stretches as per the planting design. This will avoid confusion in the field during planting rush and quality work is achieved.

Maintenance operations*:*

Regular tree/plant maintenance is essential to ensure the healthy growth of the trees. Following are the general maintenance operations essential.

Protection of vegetation

Proper watch and ward is essential for looking after the plants and protecting them against stray cattle. The watchmen are essential to take care of plants until they are finally established, i.e. may be for one or two years as per the site conditions. These watchmen can be entrusted with the work of erecting vegetative thorny fence for individual plant. These watchmen should preferably be from the adjoining villages to give them work and to seek their participation in the protection work.

Grass/weed control

Weeds on roadsides are those plants, which have undesirable characteristics and include:

1) Plants with excessive vegetative growth which, can obscure sight lines, block drainage and be a fire hazard in summer.

2) Annual plants that die off in the summer leaving soil exposed to erosion.

3) Pest plants which are harmful to adjoining agriculture, e.g. lantana, mychenia etc.

4) Alien or non-local species which can dominate the local or indigenous vegetation, e.g. Su-babhul, *A. auriculiformis* etc.

Grass cover and other dense undergrowth can successfully compete with newly planted trees for available moisture and nutrients. This can result in stunted growth or early death of young trees. The area around young trees should be kept weed free for the first two to three years. It is recommended that the weed control around young plants should be done manually. As this operation is to be linked with casualty replacement and soil mulching around plants, it is to be done 2 to 3 times during monsoon. Areas other than this where weed invasion is probably the most significant long term threat to roadsides and, is also difficult to reverse because of changes to the environmental conditions which have occurred.

Weed control should aim at reconstructing the ecological conditions that would occur in a natural bush or native grassland situation. Weed control methods preferred are those that minimize disturbance including hand pulling or cutting, selective herbicide application.

Herbicides

Chemical control of vegetation may be used where mechanical methods are uneconomical or impracticable. Herbicides may be used to

- Weed control before and after tree and shrub planting,
- As an alternative to mowing in inaccessible or special situations, e.g. drains and slopes.
- Control specific pest plants (noxious weeds) or undesirable grasses.

The herbicides are classified in to,

1) Foliage contact Herbicides (Fast Knockdown)

2) Foliage absorbed and Trans located herbicides (Slow Knockdown.)

3) Root Absorbed Herbicides (Residual)

Success of weed control program using herbicides requires some knowledge of both herbicides and weeds. Plants may be grouped into annuals, biennials and perennials. Timing of herbicide spraying to suit each type is important to achieve proper control. In simple terms, annuals are best sprayed early in their growth whereas for perennials and when using a Trans located herbicide, application near seeding or flowering is best.

Casualty Replacement

After two weeks of the planting operation is completed it is important to replace the casualties to avoid future 'gaps' in plantation. This operation will be taken up with weed/Grass control operation. While replacing the casualty, care will be taken in selecting plants for planting, which are as per planting design.

Mulching Operations

Mulches are used to reduce loss of soil moisture through evaporation and to suppress weed growth. Generally, mulches will be laid following watering of plants. They will be approximately 50mm to 75mm deep but should not extend right up to the trunk as this can cause a moisture build-up resulting in collar rot. Mulches can be organic (compost, bark-chipping, old Sawdust, etc) or inorganic (gravel, black polythene, etc). Organic mulches are advantageous in having some 'conditioning' effect upon the soil as they rot down, but need to be regular supplemented to maintain their efficiency. The organic material available in situ due to weeding operation can be best utilized as mulch. In absence of the said material simple Soil mulching will be a best alternative. The soil mulching will be done in September/October months and November/December.

Insecticide/Pesticide / Fertilizer Application

A pest is an enemy of plants, which is a living creature like bird, insect, fly, snail, bug etc., and causes damage above a critical level. A disease is a physiological disturbance in a plant cause by fungus, virus, harmful bacteria, deficiency of minerals, etc.

During the early period of the plantation, the plants should be frequently inspected and look for diseases and pests. Preventive measure such as, timely selective spraying insecticide/pesticide saves the plant from major damage, which otherwise will result in its stunted growth, foliage damage and ultimately may result in dying. The measures for control of pests and diseases may be cultural, Mechanical or chemical. Appropriate measures may be adopted to suit the situation specific demand. Certain sites may be infested with white ants, insecticide application will be done at the time of planting. Insecticide such as Neem extract is recommended.

Healthy plants grown with adequate nutrition and water are less susceptible to pests and diseases than the sickly ones grown with little attention. As most indigenous plants are adapted to poor growing conditions and low nutrient levels most of the plants do respond favorably to some fertilizer applied in small quantities. These will be applied as a balanced mixture, preferably in a slow-release form. The fertilizer in the form of organic such as, Bio fertilizers, Neem cake and inorganic form such as, NPK should be applied in low doses. The fertilizer application should be done preferably after the weeding operation is complete, as during this time weed competition for nutrients and water from weeds is not there and plants can be benefited most.

Fire Prevention

Uncontrolled fire along the road can cause detrimental effect on the survival of plants. It may result in to scorching of young plants, loosing growth of a plant, it may fall prey to fungal disease may ultimately result in dying. Fires breaks construction and fuel reduction is proposed for the management of fine fuels less than 6mm in diameter, such as dry grass, leaf litter and flammable shrubs. These fine fuels are mainly responsible for the spread of fire and assist with the igniting of heavier vegetation. These fine fuels are also an important part of the ecosystem and firebreaks should not be excessive in area.

Pruning/ cutting back

Pruning means cutting of certain portion of plant, generally side branches, to improve its vigor. In fruits, it is mainly to stimulate better fruiting. In flowering trees, it may be for better and profuse flowering. It may also be vigorously practiced in hedges, trees, or shrubs to give a graceful shape. Minor or incidental objectives are to remove diseased, damaged or bruised parts of a plant.

Tree pruning within road plantations may be required in certain circumstances. The decision to prune any vegetation may not be taken lightly. Before pruning is carried out consideration may be given to the effect such action will have on the visual, physical, ecological and social environment. The safety of staff, abutting property and road users should also be considered.

During the early phase of plantation pruning is not required. However it is recommended that the pruning should be done with considering situation specific demand of the plantation.

Watering Arrangements

As the plantation is to be taken up during monsoon season, full benefit can be drawn of the water during rainy season. Recommended watering schedule for avenue plantation, based on the Forest Department/ Social Forestry Department norms.

Watering is especially important for newly planted trees. It is better to give occasional deep watering rather than regular watering, as former treatment encourages roots to extend deeper in search of available moisture. Regular light watering encourages root to stay close to the surface which, can prove disastrous if watering has to cease in dry periods for any reason.

Method of Execution of Work

Government Agencies doing plantation works, such as Social Forestry Dept; Forest Dept. & Forest Development Corporation of Maharashtra Ltd may be considered while entrusting the work of Plantations. Depending upon the schedule of completion of road works which allows start of Plantation works, planning for

establishing nursery for raising tall plants should be done. Suitable MOU may be signed with the plantation Agency before entrusting the work.

(II) Development of Median Verge

OBJECTIVES OF PLANTING IN MEDIAN VERGE:

1) *To control glare/reflection.*

2) *To achieve Headlight and Visual screening.*

3) *To beautify median verge by raising multipurpose shrubs and herbs for economic, Bio-aesthetic and environmental purpose.*

Species Selection:

Planting in median verge provide an opportunity to improve the roadside landscape and provide a pleasant driver experience. Planting on median verge can assist safety for the travelling motorist through road delineation, separation, and crash absorption and by screening headlight glare. Planting should not present an unreasonable safety hazard to the road users, and maintenance staff.

Selection of species for Median Verge Development is mainly from the Shrubs and Herbs and also sometimes from small size tree species. Plants, which have dense foliage to ground level, are very useful for screening. However, ***sight distance*** must be considered. Plants, which have a single trunk and a high branching characteristic, contribute to the visual attraction of a road without causing sight distance or traffic clearance problems

Plants which are short lived, require high maintenance (e.g. pruning) or have a spindly growth habit should be avoided. Some plants, which have a very open form, can cause maintenance problems by catching litter, which is unsightly. It also requires maintenance staff to remove this litter which in some cases can be a hazardous task. Therefore planting on these areas must be done with future maintenance in mind.

The shrubs can be planted in various ways, with varying spacing and with economic considerations, planting design will be prepared matching with the most appropriate and economic irrigation design. Depending upon spacing plant number/plant density will vary. Considering above aspects, following species of shrubs are recommended. These are categorized into **five groups**, such as,

1. Grasses and creepers.

In some instances as per the site conditions it may be worthwhile to plant Grass which is a cheap means of providing some form of ground cover and many cases it is easy to maintain. It also has a beautiful landscaping effect.

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
1	*Cynodon dactylon*	Harali	Tussocks
2	*Vetavera zizanioides*	Vala	Slips/Tussocks
3	*Andropogon schoenanthus*	Rosha	Slips/Tussocks
4	*Ischaemum rugossus*	Ber	Seeds/Tussocks
5	*Bacopa monnieri*	Bramhi	Cuttings
6	*Clitoria ternatea*	Gokarni	Poly pot/ RT

2. Crotons & different Varieties of flowering shrubs.

This group includes variety of Crotons having colourful foliage and flowering plants/shrubs generally grow up to 2M height. This group will mainly add 'colour' to the road. These are to be planted in various combinations and patterns. Maintenance wise these plants require frequent pruning and cuttings besides timely watering. Hence these plants are to be planted in such areas of the Median Verge where accessibility and watering is assured.

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
1	*Crotons spps.*	Crotons	Poly pot/ RT
2	*Bougainvilleas spps.*	Bougainvillea	Poly pot/ RT
3	*Aster spps.*	Shevanti	Poly pot/ RT
4	*Allamanda spps.*	Allamanda	Poly pot/ RT
5	*Durranta plumieri*	Durranta	Poly pot/ RT
6	*Mussaenda spps.*	Mussaenda	Poly pot/ RT
7	*Hebiscus spps.*	Jasvand	Poly pot/ RT
8	*Galphmia spps.*	Galphimia	Poly pot/ RT
9	*Ixora spps.*	Ixora	Poly pot/ RT
10	*Jatropha spps.*	Jatropha	Poly pot/ RT
11	*Lagerstroemia indica*	Lagerstroemia	Poly pot/ RT

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
12	*Gardenia spps.*	Gardenia	Poly pot/ RT
13	*Jasminum sambac*	Jasmin	Poly pot/ RT
14	*Cestrum nocturnum*	Night queen	Poly pot/ RT
15	*Oleander spps.*	Oleandar	Poly pot/ RT
16	*Tabernaemontana coronaria*	Chandni	Poly pot/ RT
17	*Amaranthus spps.*	Amaranthus	Rhizomes

3. Medicinal shrubs & herbs.

This group is proposed to have effective utilization of the 'productive' areas of the median Verge by realizing marginal produce obtained from the regular maintenance of the medicinal plants. There are varieties of beautiful and flowering medicinal plants having medicinal value to the different parts of a plant, such as leaves, roots, bark, stem etc. There are perennial and annual types. Hence the choice can be made depending upon the availability of water and site condition.

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
1	*Adhatoda vasica*	Adulsa	Poly pot/ RT
2	*Aloe vera*	Korfad	Suckers
3	*Calitropis gigentia*	Rui	Poly pot/ RT
4	*Hebiscus rosa sinensis*	Jasvand	Poly pot/ RT
5	*Vitex negundo*	Nirgudi	Poly pot/ RT
6	*Withania somnifera*	Ashvagandha	Poly pot/ RT
7	*Woodfordia fruiticosa*	Dhayati	Poly pot/ RT
8	*Murraya koenigii*	Kadhipatta	Poly pot/ RT
9	*Ocimum sanctum*	Tulas	Polypot/ seed sowing
10	*Rauwolfia serprntina*	Sarpagandha	Polypot/ seed sowing
11	*Ricinus cammunis*	Erand	Seed sowing
12	*Solanum xanthocarpum*	Bhui ringni	Seed Sowing

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
13	*Spilanthes acmella*	Akkal kara	Polypot/ seed sowing
14	*Vinca rosa*	Sadafuli	Polypot/ seed sowing
15	*Bacopa monnieri*	Bramhi	Rooted/Clipped cuttings
16	*Gardenia lucida*	Dikamali.	Poly pot/ clipped cutting

4. Xerophytic & Secculants plants like Agave, Aloe & Varieties of Cactai:

These are the succulent plants some are having spines. They have varied shapes but can be best managed and are very much suitable for landscaping and beautification. Their water requirement is very little and they are hardy plants. Moreover, they remain green throughout year and need almost minimum maintenance. Hence these types can be suitably planted in those sections of the median verge where watering is having limitations may be due to some other reasons.

Sr.No	Botanical Name	Local Name	Suggested method of propagation.
1	*Agave americana*	Ghaipat	Nursery raised Bulbils/ Suckers
2	*Agave sislana*	Ghaipat	Nursery raised Bulbils/ Suckers
3	*Aloe vera*	Korphad	Nursery raised Bulbils/ Suckers
4	*Astrophytus spp.*	Nivdunga	Cuttings
5	*Opentia spp.*	Nivdunga	Cuttings
6	*Carrisa grandis*	Karvand	Poly pot/ RT
7	*Carrisa carandus*	Karvand	Poly pot/ RT

5. Shrubs suitable for Topiary

Topiary is the art of giving shapes to the hedge plants. Shrubs planted in a closed spacing can be trimmed and prune to different shapes like Dome, Pillar, Waves, Solid block, and many more. The plants in this group can be easily reproduced from their branches. These shrubs are generally used as a live fencing and need considerable maintenance like trimming and pruning, otherwise it gives shabby

look. Hence as per the site situations these shrubs can be maintained and trimmed to different shapes to get pleasant aesthetic effect.

Sr. No.	Botanical Name	Local Name	Suggested method of propagation.
1	*Murraya exotica*	Pandhari	Poly pot raised
2	*Laowsonia alba*	Mehandi	Clipped/Rooted cuttings
3	*Murraya paniculata*	Pandhari	Poly pot /RT raised
4	*Tecoma stans*	Tecoma	Seed sowing
5	*Dodonia spp.*	Dodonia	Seed sowing
6.	*Casuarina equisitifolia*	Suru	Poly pot /RT raised
7	*Thuja compacta*	Morpankhi	Poly pot /RT raised
8	*Clerodendrum inerme*	Koyanel	Cuttings.

PLANT QUALITY:

The plant quality required for shrubs and herbs is similar to that as in case of Tree species with respect to their health and vigor and known source of origin**.** The shrubs, **which are to be planted, should be at least 30 to 45cm in height.** There are different types of planting material required such as, poly-pot raised seedlings (10 X 20cm or 12.5 X 25cm size poly-bags) and Root trainer raised seedlings, rooted cuttings, clipped cuttings, rhizomes and seed sowing depending upon species to be planted. The species which can be easily produced by way of seed sowing, clipped cuttings, rhizomes planting should not be raised in poly-pots, instead those should be directly sown/planted on median verge in situ. This will help in reducing the expenditure of raising and transporting them to site.

The recent advanced Root Trainer technology for seedling production is the best option to raise shrubs and herbs required for median verge, in place of traditional technology of poly-bag raised nursery plants. Root trainer raised shrubs and herbs are easy to raise in short time, easy to transport in large numbers at a time, and easy to handle during planting. The Root trainer raised plants are found to be superior in quality than the traditional ones, moreover the mortality rate of these plants is also found to be very low when planted at site. This technology was introduced in 1992/93 on a large scale and has been adopted in Maharashtra by Forest Department, Social Forestry Department, FDCM Ltd. and many private nursery entrepreneurs.

MAINTENANCE OPERATIONS:

Successful establishment of plants in median verge requires good maintenance of plantings. The need to water during the first year is minimized if the ground is prepared well, species are selected for the site and planted at the correct time, and weed control is carried out both before and after planting. Weed control after planting can involve use of cultivation, herbicides, and organic and inorganic mulches. Regular trimming and pruning whenever necessary should be carried out to prevent protruding branches of the shrubs obstructing the traffic. Other maintenance operations are similar to those in case of maintenance of tree species. Watering is very critical factor for all type of plantings in median verge.

4.3.8 Benefits of Proposed Development

The benefits of this Project comprise direct benefits associated with usage of the Trans Harbour Link and indirect benefits arising out of contribution towards economic development. The direct benefits of the MTHL project will be:

- Savings in Vehicle Operation Cost (VOC) due to reduction in distance and in congestion level for vehicles that using MTHL as compared to those using the existing transport system
- Savings in travel time
- Improved levels of comfort and accessibility between Mumbai Island and mainland
- Accelerated growth in the area under MTHL influence particularly in Navi Mumbai resulting in new traffic generation

The indirect benefits of MTHL will be:

- Increase in demand for land and improvement in land prices due to improved accessibility in the influence zone
- Accelerated economic development of Navi Mumbai and nearby regions
- Greater economic integration of Mumbai Island with Navi Mumbai and extended regions of Alibag, Panvel, Pune and Goa.
- Decongestion of Mumbai Island and dispersal of population to Navi Mumbai region and beyond
- Environment improvement and reduced pollution levels
- Improved safety due to reduction in accidents
- Improvement in trade and trade competitiveness through faster and improved logistics

Benefit to stakeholders

Apart from the MTHL' s impact on connectivity and savings to commuters, the key beneficiaries include Mumbai Port Trust, JNPT, Navi Mumbai Municipal Corporation, CIDCO, MMRDA, Navi Mumbai SEZ, Navi Mumbai airport and various industries in the hinterland.

Catalytic growth in hinterland

MTHL will also play a catalytic role in boosting the development of Navi Mumbai as it will improve connectivity with Greater Mumbai, resulting in appreciation in land value and associated revenue realization for CIDCO.

Employment growth

For the state government, based on normative parameters, a project of this magnitude can generate direct employment of 17,000 during construction (assuming construction cost of Rs. 27,000 mn and considering a norm of 1 job created per Rs. 1.5 mn investment). By adopting the same norms, the project is also likely to generate indirect employment of 17,000 during the construction period.

Likewise, the capital in circulation during the operation period would generate further direct & indirect employment over the project lifetime.

GDP Contribution

The above when added to the quantified value of savings in Vehicle Operating Cost and Value of Travel Time saving discussed in Section 2.2.3 could potentially result in a contribution ranging from 0.17% to 0.35% the Net State Domestic Product (NSDP) of Maharashtra.

Growth dispersal

Further, the influence zone of the project could cover and extend to the following geographical areas (over 100 sq. km influence area) covering a total population and working population of over 12 million and 3.5 million respectively:

- Greater Mumbai
- Navi Mumbai
- Alibag, Panvel, Pune and Goa
- Golden Triangle comprising Mumbai-Pune-Nasik

The spin-offs of this project will be felt across a wider area, as discussed above thereby contributing to economic development in a significant way.

CHAPTER 5

ENVIRONMENTAL MANAGEMENT PLAN

5.1. Introduction

An Environmental Management Plan (EMP) has been recommended in this chapter. This EMP takes into account all the environmental impacts identified for MTHL and the corresponding mitigation measures to ameliorate the same. The EMP presented below includes:

- Specific actions to be taken vis-à-vis site-specific issues;
- Mitigation measures for abatement of the undesirable impacts caused during construction and operation stages
- Agencies responsible for its implementation & supervision;
- Time frame for implementing these measures;
- Post project environmental monitoring programme to be undertaken after commissioning of the project
- Environmental status reporting frequency; and
- Institutional arrangement, Strengthening of their capabilities, and role.

5.2. Key Performance Indicators

The performance indicators that should be analyzed during construction and operation phase have been provided below.

Key performance indicators during construction phase

Environmental issue	Key indicators	Benchmark values/ standards
Ambient air quality along the MTHL and Elephanta	SO_2, SPM, PM_{10}, CO, NO_x and HC (non-methane);	Baseline values measured during pre-project scenario and corresponding NAAQS standards
Ambient Noise level along the MTHL and Elephanta	L_{eq} day and L_{eq} Night calculated based on hourly equivalent noise levels	Baseline values measured during pre-project scenario and corresponding NAAQS standards
Surface water quality of the creek	pH, TDS, TSS, Turbidity, BOD, DO and O&G	Baseline values measured during pre-project scenario and

Environmental issue	Key indicators	Benchmark values/ standards
		Coastal water criteria SW-III
Soil quality near debris disposal site	Soil contaminants as identified in USEPA or equivalent BIS standards	USEPA soil contaminant threshold limits or equivalent BIS standards
Ground water quality near debris disposal site	Heavy metals and contaminants as per USEPA or equivalent BIS standards	Standards for heavy metals and contaminants as per USEPA or equivalent BIS standards

Key performance indicators during operation phase

Environmental issue	Key indicators	Benchmark values/ standards
Ambient air quality along the MTHL and Elephanta	SO_2, SPM, PM_{10}, CO, NO_x and HC (non-methane);	NAAQS standards
Ambient Noise level along the MTHL and Elephanta	L_{eq} day and L_{eq} Night calculated based on hourly equivalent noise levels	NAAQS standards
Surface water quality of the creek	pH, TDS, TSS, Turbidity, BOD, DO and O&G	Coastal water criteria SW-III
Soil quality near debris disposal site	Soil contaminants as identified in USEPA or equivalent BIS standards	USEPA soil contaminant threshold limits or equivalent BIS standards
Ground water quality near debris disposal site	Heavy metals and contaminants as per USEPA or equivalent BIS standards	Standards for heavy metals and contaminants as per USEPA or equivalent BIS standards
Mangrove Plantation	Survival rate	-
Traffic scenario	Traffic volume and density	Baseline values observed during pre-project scenario

5.3. Environment Management Measures

5.3.1. Construction Stage

The construction stage of MTHL will involve impacts on the different environmental components but would be of purely temporary nature. There will be planning for risks associated with construction activities such as accidental spillages and consequent damage to the surrounding environment in terms of loss of flora and fauna etc. Other possible locations where safety measures will be useful include the locations of Hot Mix plants, casting yard, batching plants, quarries and labour-camp sites. The mitigation measures are proposed in the **Table 5.1.**

5.3.2. Operation Stage

The operation stage will essentially entail monitoring activity along the corridor. The monitoring for pollutants specified in the Monitoring Plan will serve two purposes. In addition to checking the efficacy of the protection/mitigation/enhancement measures implemented, this will help verify the predictions made as a part of the impact assessment. Thus, it will constitute a very important feedback for the MMRDA. The measures adopted and/or to be adopted during the different stages of the project have been detailed in **Table 5.1.**

The mitigation measures recommended will become part of Tender Documents. The major instruments of environmental management will be Tender Document and monitoring performance of the construction by the Environmental Management Cell (EMC), which will be constituted.

Table 5.1 Environment Management Plan

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
Construction Phase:			
Borrow pits and quarry sites development	• Only existing and licensed/approved quarries and borrow areas will be used. • Firm up contract for obtaining the quarry material • Resurfacing and landscaping of the borrow pits.	Contractor	MMRDA
Prevention of erosion and scouring	• Stabilizing embankment with appropriate technique.	Contractor	MMRDA
Water logging and stagnation of water in borrow pits	• Uncontrolled digging of borrow pits will be avoided to prevent water accumulation, which results in breeding of vector disease.	Contractor	MMRDA

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
Drainage system	• Providing adequate drainage structure • Avoiding obstruction of existing drainage during filling	Contractor	MMRDA
Preparation of feasible land acquisition plan	• Initiate and complete the process for land acquisition	Contractor	MMRDA
Site for storage and construction camp	• Casting yard and labour camp will be located on Mumbai and Navi Mumbai side. The mitigation measures would be implemented to ameliorate the impacts.	Contractor	MMRDA
Location of Hot Mix and Batching Plant	• Hot mix and batching plants will be located away from habitation ,agricultural operations and forest area at Navi Mumbai	Contractor	MMRDA
Water quality	• Prior permission of the concerned Engineer and regulatory authorities shall be taken regarding discharging or disposing of any material arising from the execution of works.	Contractor	MMRDA
Air quality	• Vehicles carrying construction material shall be covered to avoid spilling • Asphalt mixing plant shall be over 500 m away from any communities and 300 m from the road as far as possible • Water sprinkling in morning & evening hours at Construction yard and unpaved sections of the road to avoid dust generation	Contractor	MMRDA
Noise level	• Stationary equipment shall be placed as far away as possible from inhabited areas to minimize noise impacts • Construction activities will be scheduled near habitation • Provision of using ear plugs by workers exposed to high noise levels	Contractor	MMRDA

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
Tree plantation and enhancement measures	• Prepare action plan • Budget allocation • Implementation of action plan	Contractor	MMRDA
Basic amenities and sanitation facilities for construction labourers	• Adequate Sanitary facilities will be provided to the workers to avoid health related problem • Periodic health check-up will be done	Contractor	MMRDA
Sewerage & solid waste disposal at construction camp	• Proper sanitation facilities at construction workers camp • Collection of domestic refuse and its suitable disposal	Contractor in consultation with State Pollution Control Board (SPCB) and Public Health Department	MMRDA
Fuel for construction labourers	• Adequate supply of fuel (kerosene) shall be provided to construction labourers to avoid felling of trees for cooking and other household activities	Contractor	MMRDA
Traffic management	• Secure assistance from local police for traffic control during construction phase. • Safety measures will also be undertaken by installing road signs and marking for safe and smooth movement of traffic.	Contractor in consultation with local traffic police.	MMRDA
Occupation health & safety	• Labourers will be equipped with proper safety gears like helmets gloves and gumboot • Periodic health check up of construction worker	Contractor	MMRDA
Construction of approach road in Mudflats	• Temporary bridge would be constructed in the mudflats for movement of vehicles and machinery to avoid the disturbance to mudflats/mangroves	Contractor	MMRDA
Mangrove	• Mangrove plantation program on Navi	MMRDA	MMRDA

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
disturbance	Mumbai side		
Operation Phase:			
Soil characteristics	• Periodic monitoring of soil quality at specified distance from ROW for assessing soil contamination by vehicular emission • Preventing the overflow of spillage from the carriageway.	Contractor	MMRDA
Air quality	• Monitor periodically ambient air quality at suggested locations • Enforcing different control measures to minimize the air pollution	Contractor	MMRDA
Noise level	• Periodic monitoring of ambient noise levels at suggested locations • Erecting signboards at sensitive and residential locations prohibiting use of horns • Growing road side plantation to prevent the noise levels.	Contractor	MMRDA
Maintenance of road side plantation	• Plantation will be undertaken on an aggressive note as per Green Belt Management plan • Employment of people for the maintenance of plantation along the ROW in the initial 3 years	Contractor	MMRDA
Road safety and traffic Management	• Prepare and administer a monitoring system on road accidents • Adequate number of proper signs with clear visibility shall be installed along the road	Contractor in consultation with the State Traffic Police Department	MMRDA

5.4. Environmental Monitoring Plan

It is essential that an effective monitoring plan be designed and carried out. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP

- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in management plan, if required
- To enhance environmental quality
- To satisfy the legal and community obligations

Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters recommended for road transportation developments are Respirable Particulate Matter (RPM), Suspended Particulate Matter (SPM), Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Sulphur Dioxide (SO_2). These are to be monitored at designated locations during the operation phase. Data will be generated twice a week over a fortnight in all seasons (except monsoons) at all identified locations in accordance to the National Ambient Air Quality Standards. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan.

Noise Level Monitoring

The measurement for monitoring noise levels would be carried out at all designated locations in accordance to the ambient Noise Standards formulated by Central Pollution Control Board (CPCB). Sound pressure levels would be monitored on twenty four hour basis. The location, duration and the noise parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan **Table 5.2**.

Water Soil & Ecological Monitoring

Water, soil and ecology will be monitored as mentioned in the **Table 5.2.**

Table 5.2 Environmental Monitoring Plan

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Air Quality	Construction	PM_{10}, $PM_{2.5}$, SO_2, N0x	NAAQS of CPCB	All locations where baseline monitoring was carried out.	Once every quarter –Summer, Winter, post-monsoon	24 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor	MMRDA
		CO, HC (non-methane)	NAAQS of CPCB	All locations where baseline monitoring was carried out.	Once every quarter –Summer, Winter, post-monsoon	8 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor	MMRDA
Air Quality	Operation	PM_{10}, $PM_{2.5}$, SO_2, N0x	NAAQS of CPCB	All locations where baseline monitoring was carried out.	Once every quarter –Summer, Winter, post-monsoon	24 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor	MMRDA
Air Quality	Operation	CO, HC (non-methane)	NAAQS	All locations where baseline monitoring was carried out.	Once every quarter –Summer, Winter, post-monsoon	8 hr/day for 2 consecutive working days per week for 2 weeks.	Contractor	MMRDA

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Noise level	Construction	L_{eq} Day, L_{eq} night, L10, L50, L90 dB(A)	CPCB noise standards	All locations where baseline monitoring was carried out.	Once every quarter during construction period	Continuous 24 hour reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks	Contractor	MMRDA
Noise level	Operation	L_{eq} Day, L_{eq} night, L10, L50, L90 dB(A)	CPCB noise standards	All locations where baseline monitoring was carried out.	Once every quarter after operation starts	Continuous 24 hour reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks	Contractor	MMRDA
Water quality	Construction	pH, BOD, TSS, TDS, DO, Turbidity and O&G	Coastal water quality – SWIII	All locations where baseline monitoring was carried out.	Once every following quarter – Summer, Winter and post-monsoon.	4 grabs samples along MTHL at different locations.	Contractor	MMRDA
Surface Water quality	Operation	pH, BOD, TSS, TDS, DO, Turbidity and O&G	Coastal water quality – SWIII	All locations where baseline monitoring was carried out.	One time after 6 months into operation stage	4 grabs samples along MTHL at different locations	Contractor	MMRDA

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Soil Quality	Construction	Heavy metals and Oil and grease	Contaminant threshold level given by USEPA	-At all stockyard locations set-up by Contractor. Exact sampling spot at the yard as directed by MMRDA -Debris disposal site	At start and end of construction activity.	One time sample	Contractor	MMRDA
	Operation	Heavy metals and Oil and grease		-At accidental spill sites -Debris disposal site	-In the event of an accident -Once during post monsoon season	-One time sample -Annually for three years	Contractor	MMRDA
Ecology	Pre-Construction	Monitoring of tree felling.	As laid out in project detail design.	Along MTHL, if tree felling is involved	During tree felling	During tree felling period	Contractor in consultation with Forest Department	Contractor, MMRDA

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
	Operation	Survival rate of roadside plantation and other compensate mangrove plantation.	Polices/ guideline of tree authority	At locations of compensatory plantation	Annually	For 3 years after operation starts	Contractor in consultation with Forest Department	Contractor, MMRDA

5.5. Environmental Management Cell

The responsibility for the implementation of the EMP will rest with the Promoter and Concessionaire (P & C). An Environmental Management Cell (EMC) will be established by the P &C for implementing the mitigation measures. The environmental officer for MTHL will supervise all activities and accordingly advise the P & C to improve on areas where any short-comings are observed. The EMC will provide all the monitoring results to him who will keep a record of all information and suggest suitable measures to be adopted by the Contractor if any aspect is found to be diverting from the anticipated values/ standards. To mobilize the appropriate expertise to design diverse type of mitigation measures, the P & C need to collaborate with other institutions in the public and private sector like State forest Department, State Public Health Engineering Department, State Traffic Department, State Police Department etc. The EMC will ensure timely implementation of various mitigations measures at different stages of the project i.e. during construction and operation stage.

5.6. Institutional Training

The Environment Management Cell (EMC), in addition to implementing and monitoring different environmental attributes, will also be actively involved in imparting training and raising environmental awareness of the project Construction Engineers and other staff members/ workers so as to enable them take the environmental aspects into consideration as and when required. In the long run, the EMC can impart additional and specialized training in environmental management of the road system.

5.7. Budget for EMP

A capital cost provision of Rs. 4100 lakhs will be kept towards the environmental protection measures in the EMP. The budgetary cost estimate for implementation of the environmental protection measures is elaborated in **Table 5.3**.

Apart from this, the measures/ issues that would form integral part of BOT Bid Document and which the Contractor is bound to provide as part of his responsibility and legal obligations include the following:

- Providing labour camps and all other facilities as laid out in the EMP throughout the pre-construction and construction phase.
- Cost incurred towards maintaining labour camps, sanitation systems, and providing potable drinking water etc.,
- Cost incurred towards providing labourers with safety equipments and appliances during construction phase.

- Cost incurred towards organizing and conducting periodical health camps for the benefit of labourers and their families.

Table 5.3 Budgetary Cost Estimate for Environmental Protection Measures

Description	**Landscaping, beautification, green development plan**	**Pollution monitoring lab equipment etc with micro-met stn, Noise Monitoring**	**Traffic surveillance Monitoring & Control System**	**DMP (Fire Fighting Equipments & Relief operations etc)**	**Additional mitigation measures like septic tanks, sanitation arrangements, vaccination, medical checkup, drinking water etc for the labor camps**
Sewri Interchange	200.00				50.00
Eastern Freeway Interchange	150.00				50.00
NH-4- B Interchange	150.00	80.00 (Lump sum)	3000.00 (Lump sum)	100.00 (Lump sum)	50.00
Green Development	20.00				50.00
Compensatory Mangrove Plantation	60.00				
Pre-casting Yard	40.00				100.00
Total	**620.00**	**80.00**	**3000.00**	**100**	**300.00**

Grand Total 4100.00 Lakhs

CHAPTER 6

DISASTER MANAGEMENT PLAN

6.1. Risk Assessment and Disaster Management Plan

Mumbai Trans Harbour Link would be 6-lane, 22 km long link involving about 16 km bridge with a design speed of 100 kmph. Provision and plan for risks has been made at various stages. The risk may be due to accident, falling of vehicle in to the sea, fire, sabotage, earthquake, collision of ship with the bridge or spillage of oil and chemicals on the bridge and sea. This would, depending upon the type and intensity, involve disasters in terms of loss of life and damage to the bridge apart from disruption of traffic. Therefore to avoid and minimize this, disaster and emergency management plays a very important role.

6.2 Objective of Disaster Management Plan

The purpose of the DMP (Disaster Management Plan) is to identify the roles, responsibilities, and tasks/functions to be performed in all disaster recovery operations. Thus objective is

- To increase awareness among of officials of the project on the issues involved in disaster recovery,
- To provide explanations of roles and responsibilities and
- To provide guidelines for disaster recovery operations.
- To localize the emergency and, if possible eliminate it; and
- To minimize the effects of the accidents on people and property.

Elimination will require prompt action by operators and works emergency staff using, for example, fire-fighting equipment, emergency due to collision and submergence etc.

Minimizing the effects may include rescue, first aid, evacuation, rehabilitation and giving information promptly to people living nearby.

6.3 Risks and Disasters

The project of MTHL consists of bridge and new road in marine and terrestrial settings respectively. Large no. of vehicles will ply across the bridge. In this scenario of vehicular movement, few risks and disasters are involved. This disaster could be natural as well as related to other sources.

6.4 Risk Analysis

Risk may be defined as the potential realization of unwanted consequences of an event (i.e. the product of the probability of an event and the consequences of the event). Both the probability of occurrence of an event and the magnitude of its consequences are thus involved. Acceptance criteria can be established either in the form of a predefined set of “Risk Acceptance Criteria” or in the form of “Optimum cost criteria”.

The Risk acceptance criteria are normally imposed by the authorities to reflect the willingness of people and society to accept risks. Optimum cost criteria are Acceptance Criteria based on cost effectiveness analysis comparing the cost of the bridge strengthening and protection measures against the benefits of risk reduction.

The analysis should take into account consequence of collision, such as

- Damage to bridge
- Damage to the users of the bridge
- Damage to vessel and cargo
- Inconvenience cost of society and business
- Social losses
- Damages to the environment
- Loss of revenue due to possible on-operation of the port

The risk acceptance criteria are intended to cover the aggregate probability of accident due to several types of causes such as fire and explosion, train accidents, etc. in addition of vessel collision.

For this project it is recommended that specific evaluation should be carried out for:

- Importance of the bridge connection to the public and society, to business and industry, to the national defense etc.
- fatality risk in the case of high traffic volume
- cost effectiveness of improving the safety for the bridge.

i) Fatality Acceptance Criteria

The risk categories are

- Individual fatality risk
- Societal risk (i.e. number of fatalities in an accident and the number of events per year)

To achieve low fatality risk

- Ensure a low probability of bride disruption
- Introduce bridge use warning systems on the bridge
- Build deflective type cofferdam systems in forms which would not disrupt the navigational channels.

ii) Optimum and acceptance criteria

a) Damage to the bridge – direction consequences to the bridge owner are:

- Cost of the salvaging the wrecked part of the bridge
- Cost of repair/replacement of the bridge
- Loss of revenue during repair/replacement of the bridge
- Additional costs of repair/replacement due to more strict requirements of the Authorities after the accident

b) Damage to the users of the bridge

- Injuries and loss of lives – cost values for fatalities
- Damage to vehicles and goods

c) Damage to vessel and cargo

Direct consequences to the vessel owner are:

- Loss of lives
- Cost of salvaging the vessel
- Cost of repair/replacement of the vessel
- Loss of income during the period or repair
- Damage to goods carried on the vessel
- Claims for compensation form bridge owner and users.

- Increased insurance costs

d) Inconvenience costs to Society and Business

- Road and rail inconvenience costs, strategic importance of the bridge, Alternative routes available.
- Port interruption cost – blocking of navigation channel
- Business and social loss

e) Damage to environment

- Cost of repair/replacement of the bridge
- Cost of physical restoration
- Ecological problems – immediate/long term.

6.5 Anticipated Emergencies or Disasters

The disasters can be classifieds manmade or artificial and natural. Both type of disasters causes' loss of life as well as properties. The anticipated disasters are:

- Accidents Or Medical Emergencies
- Fire
- Sabotage
- Collision of Ship/barge with bridge
- Explosion
- Bomb Threat
- Chemical Spill
- Local/Civil Disturbance
- Utility Failure
- Violent Crime Or Behaviour
- Health Emergency (Epidemic)
- Weather – Monsoon

6.6 Components of DMP

The efficient and effective Disaster Management System should have following components

- Emergency Response Team
- Public Affairs
- Telephone Services
- Dining Services
- Financial Services
- Planning Section

6.7 Various Scenarios of Risks and Disaster in the Project

Evacuation of passengers

Risk is involved by way of collision and falling of vehicle into the creek. Communication system plays an important role which will be available on the bridge. The Coast Guard will also be intimated about the incident immediately. Early response such as rescue and relief by the rescue team by means of life saving boat will be planned. These rescued passengers will be brought on the coast and given first aid by paramedics and taken to nearby hospital.

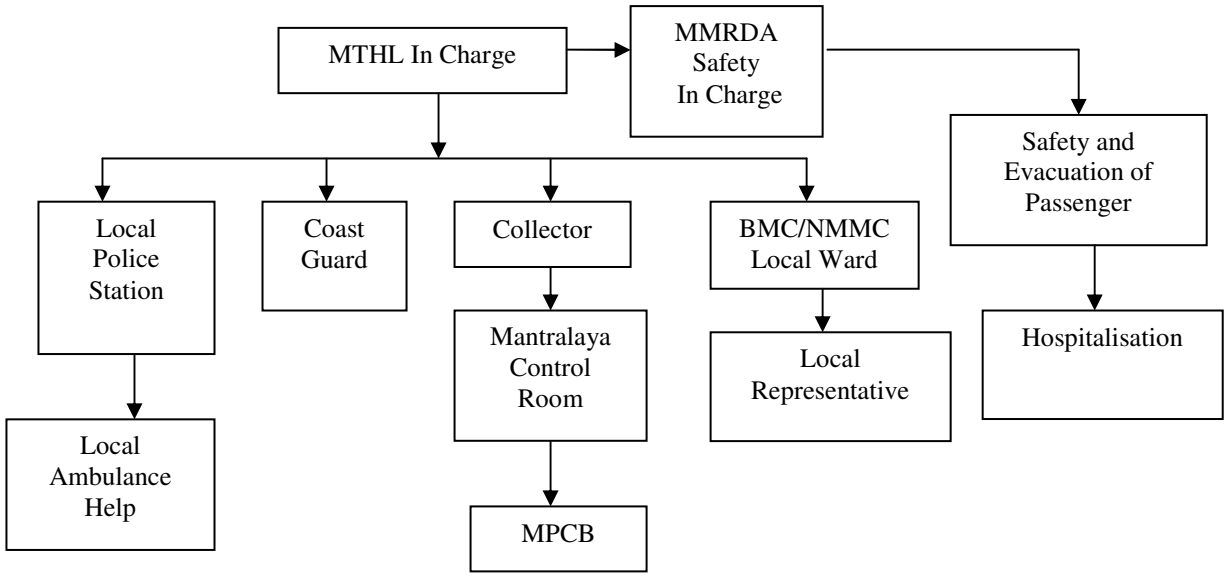
Head-on collision/ vehicle accidents on the bridge

The major risk involved in this type of Disaster is fatal or high degree of injury. Early response will be in terms of well equipped ambulance with paramedical team reaching on the site. This will help in rescue of passengers from the accident site and will be taken to the nearest hospital. If need arises the patient can be taken to one of the major and super-specialty hospital in the area.

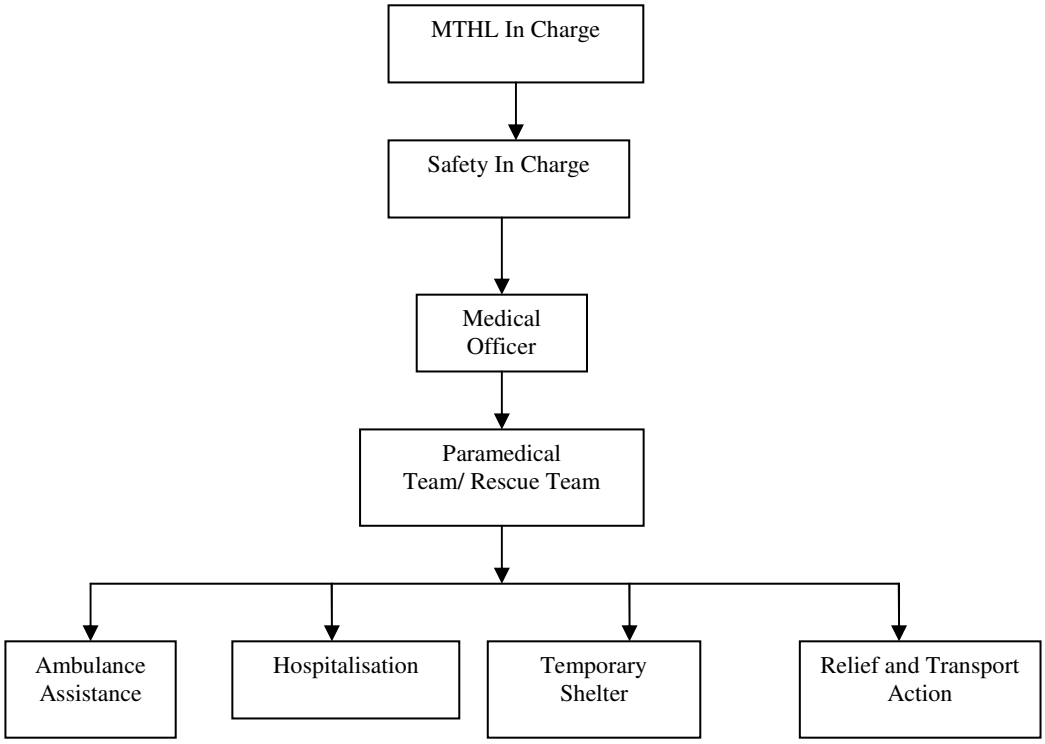
Spillage and leakages of oil on the bridge

This Disaster can occur during a leak or spillages of oil or fuel carrying tankers met with an accident on the bridge. The various risks involved in this includes spillages of oil and fuel into the sea thereby causing marine pollution, danger of skidding of other vehicles due to spillages. Risk of catching fire depends upon the flash point of the material. The early response in this case will be stoppage of vehicular movement immediately by using communication system on the bridge and towing the damaged vehicle in order to make traffic easier. Mopping operations through specialized agencies will be taken to collect oil spilled on the road as well as floating on the marine surface.

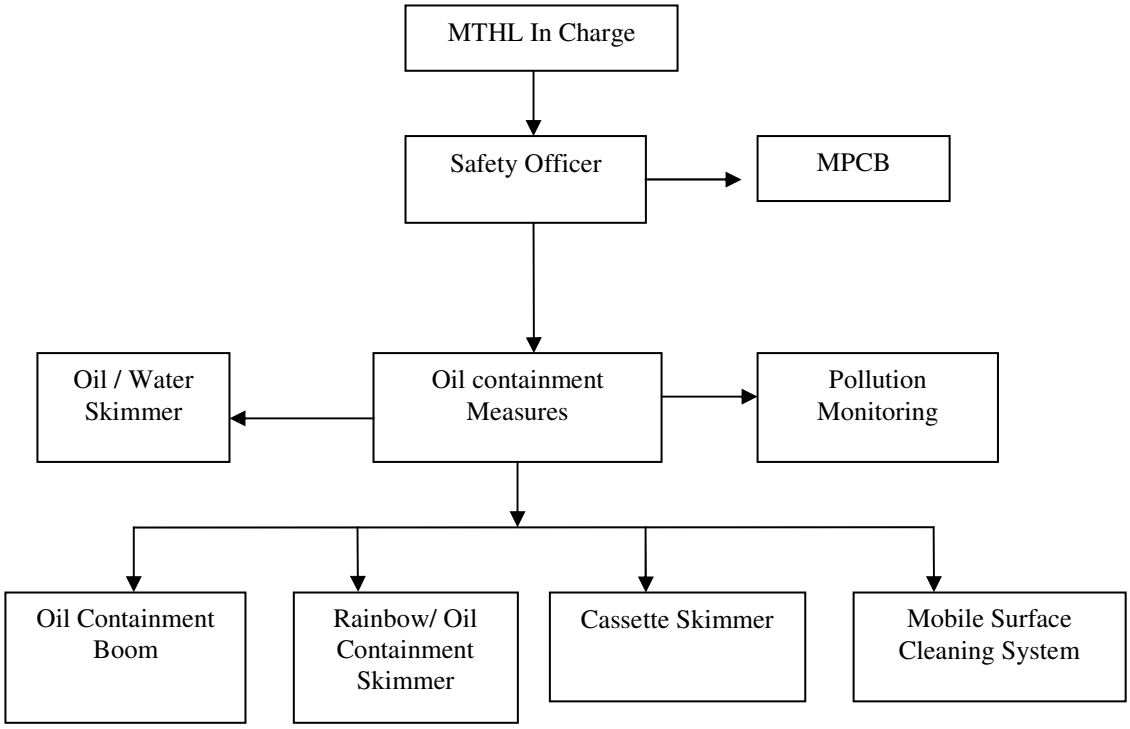
DMP FOR ACCIDENT RISK SCENARIO



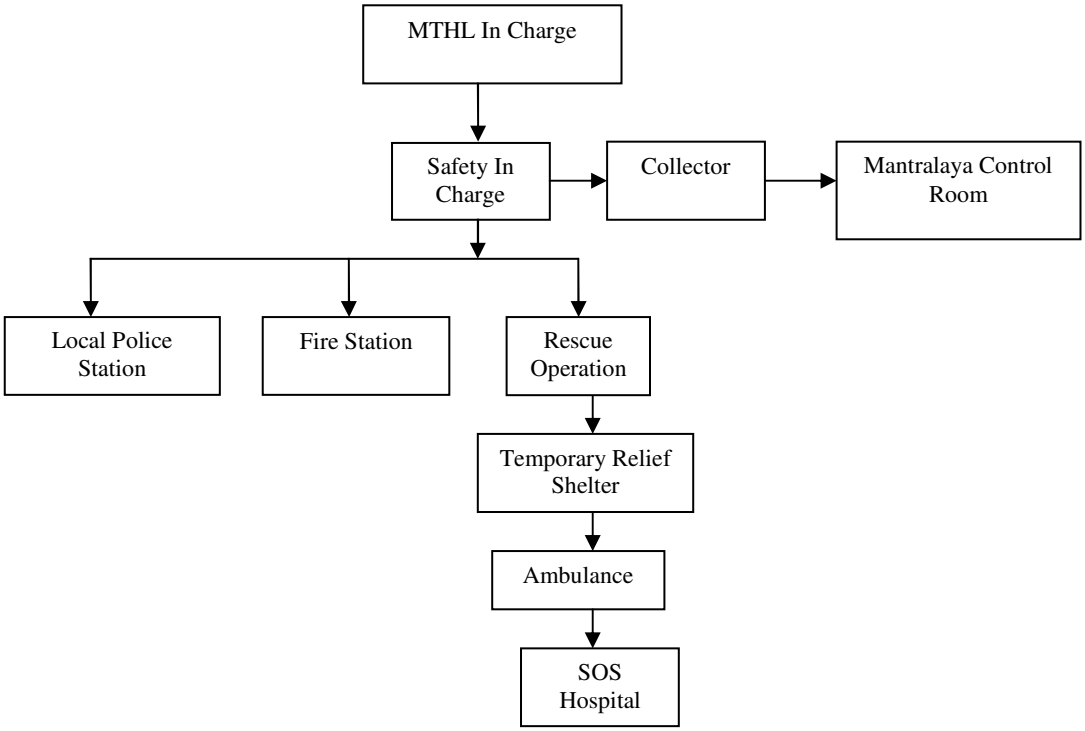
DMP FOR MEDICAL SAFETY SCENARIO



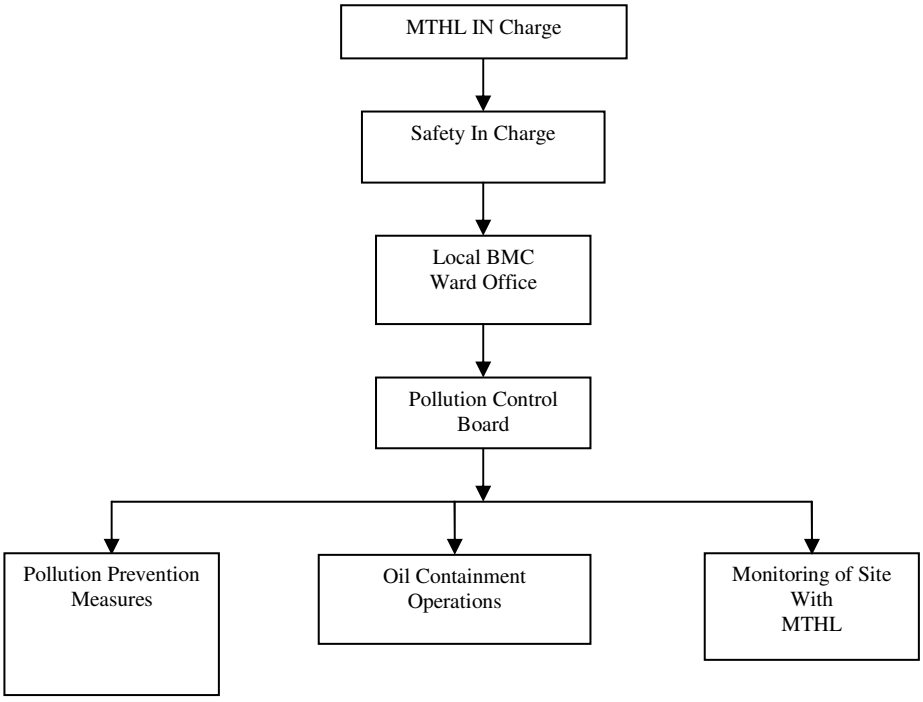
FOR FUEL / OIL LEAKAGE SPILLAGE ON BRIDGE & IN SEA



COLLISION/ ACCIDENT ON THE BRIDGE



POLLUTION RISK/ HAZARD DUE TO VEHICLES FALLING INTO SEA



6.8 Emergency Services needed to meet the disaster

1. Fire fighting – Fire services available in the CIDCO/NMMC and MCGM area

2. Search and rescue – Fire services / Ambulance in CIDCO/NMMC and MCGM area
3. Medical emergency care – Trauma Care / First Aid Centre with additional services from identified hospitals of Mumbai and Navi Mumbai.
4. Facilities Services (public works) – damage prevention, debris, shoring up buildings, custodial, maintenance, and support to other agencies.
5. Scene security and traffic control – Traffic Control Centre
6. Hazardous materials operations – Fire Services
7. Communications Unit – information systems for tactical, regional and national information. Telecommunications, Main Control Centre, Human Resources, etc.
8. Food/Water unit – for emergency workers and patients.
9. Staffing – responsible for operations during the emergency; responsible for normal project operations. Pandemic – should plan that half of the staff will be unavailable.
10. Supply unit – equipment, personnel, supplies, medical supplies,
11. Shelter – Administration Building.
12. Transportation – Project vehicles

In addition to above following equipments are proposed to be stationed at Bridge Control Station on the bridge for disaster management during Fire Fighting

- Foam cum water tender
- Portable fire fighting pumps
- Fire jeeps / vehicles
- Foam fire extinguishers
- Dry chemical powder extinguishers
- CO_2 extinguishers
- Fire protections suits
- Full face and half face mask respirators
- Light water foam AFFF
- Spark proof torch
- Fire alarm system
- Gas measuring meter
- Fire tugs (in the water)

In addition to the above disaster mitigation measures, monitoring and surveillance system proposed for MTHL will greatly help to mitigate the disasters.

LEGEND

- PROPOSED CARRIAGEWAY EDGE
- PROPOSED OUTER EDGE
- PROPOSED MEDIAN
- PROPOSED METRO
- ROAD 3rd LEVEL
- ROAD FROM 3rd LEVEL TO 2nd LEVEL
- ROAD FROM 2nd LEVEL TO 1st LEVEL
- ROAD 1st LEVEL
- ROAD FROM '0' LEVEL TO 1st LEVEL
- PROPOSED LANDSCAPING

NOTE:

3rd LEVEL – 59.95m
2nd LEVEL – 48.95m
1st LEVEL – 39.95m
'0' LEVEL – 28.75 m
ALL LEVLES ARE WITH RESPECT TO TOWN HALL DATUM
0 M TOWN HALL DATUM = 21.95 M CHART DATUM

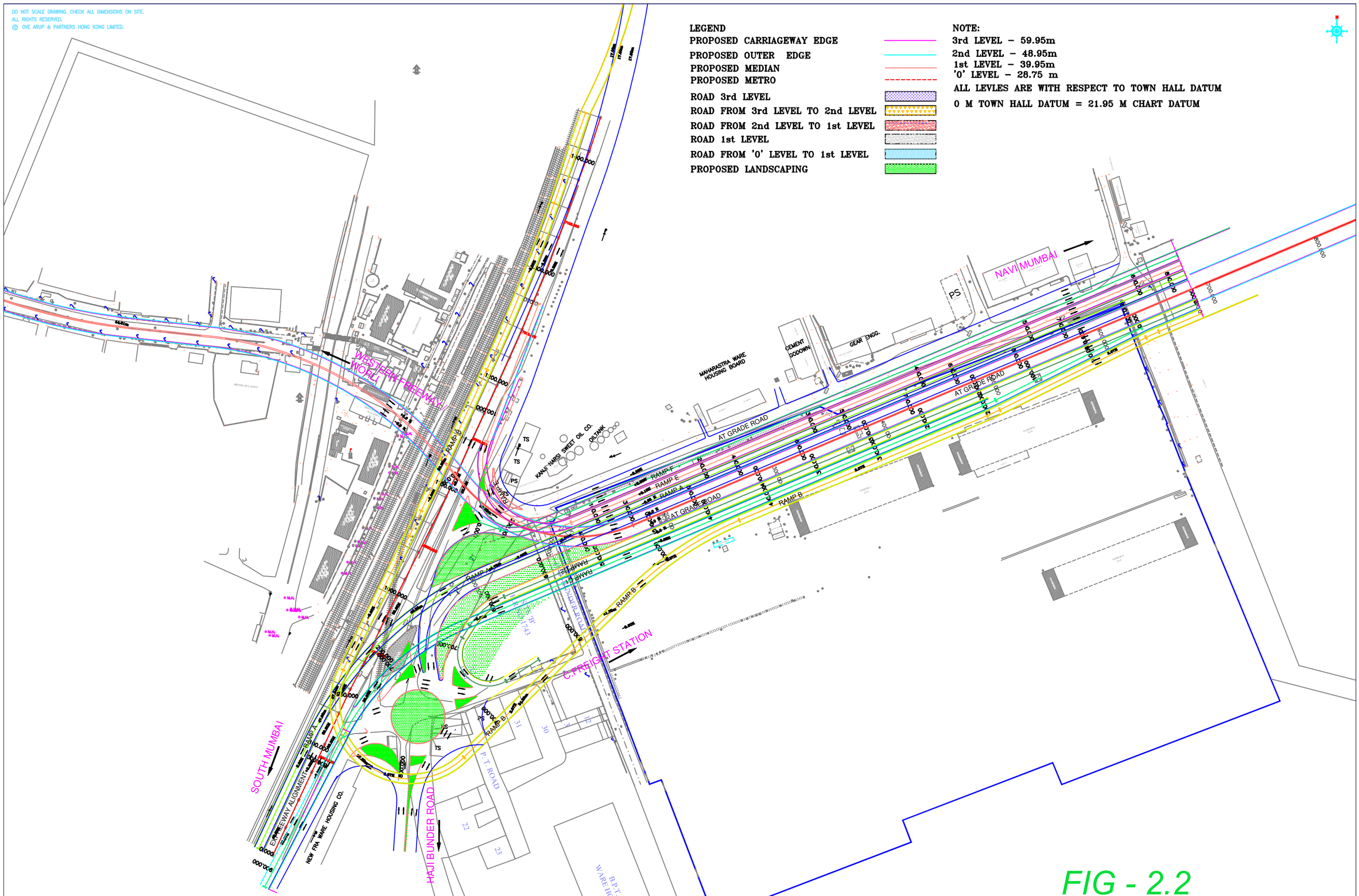


FIG - 2.2

Mark	Date	By	Rev.		

MMRDA
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

MUMBAI TRANS HARBOUR LINK
Contractual Design Drawing

ARUP | HS 40 Years of excellence in knowledge based services | KPMG

Drawing Title: DESIGN LAYOUT AT SEWRI INTERCHANGE

Drawing Status	Scale	Drawing No.	Rev.
PRELIMINARY	1:2000 (HORZ.) 1:200 (VERT.)	218058/H/200	R0

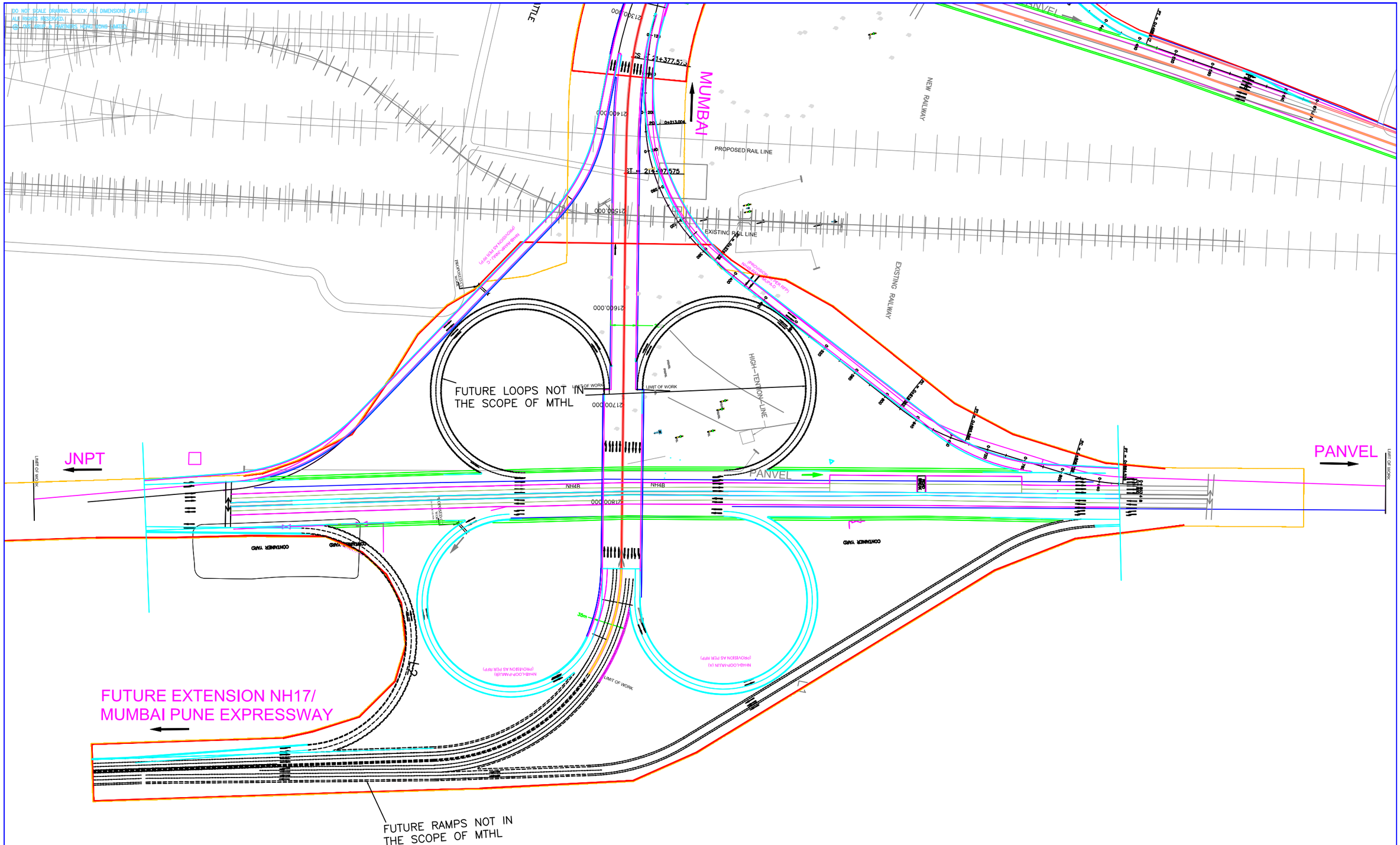


FIG - 2.3

Mark / Date / By / Rev.	MMRDA MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY	MUMBAI TRANS HARBOUR LINK Illustrative Design Drawing	ARUP · HCG 40 Years of excellence in knowledge based services · KPMG

Drawing Title: CHIRLE INTERCHANGE DEVELOPMENT PLAN

Drawing Status	Scale	Drawing No.	Rev.
PRELIMINARY	1:2500 (HORZ.) 1:2500 (VERT.)	2011090/RH/INT-004	R0

FIGURE-2.1 MAP SHOWING ALIGNMENT OF MTHL

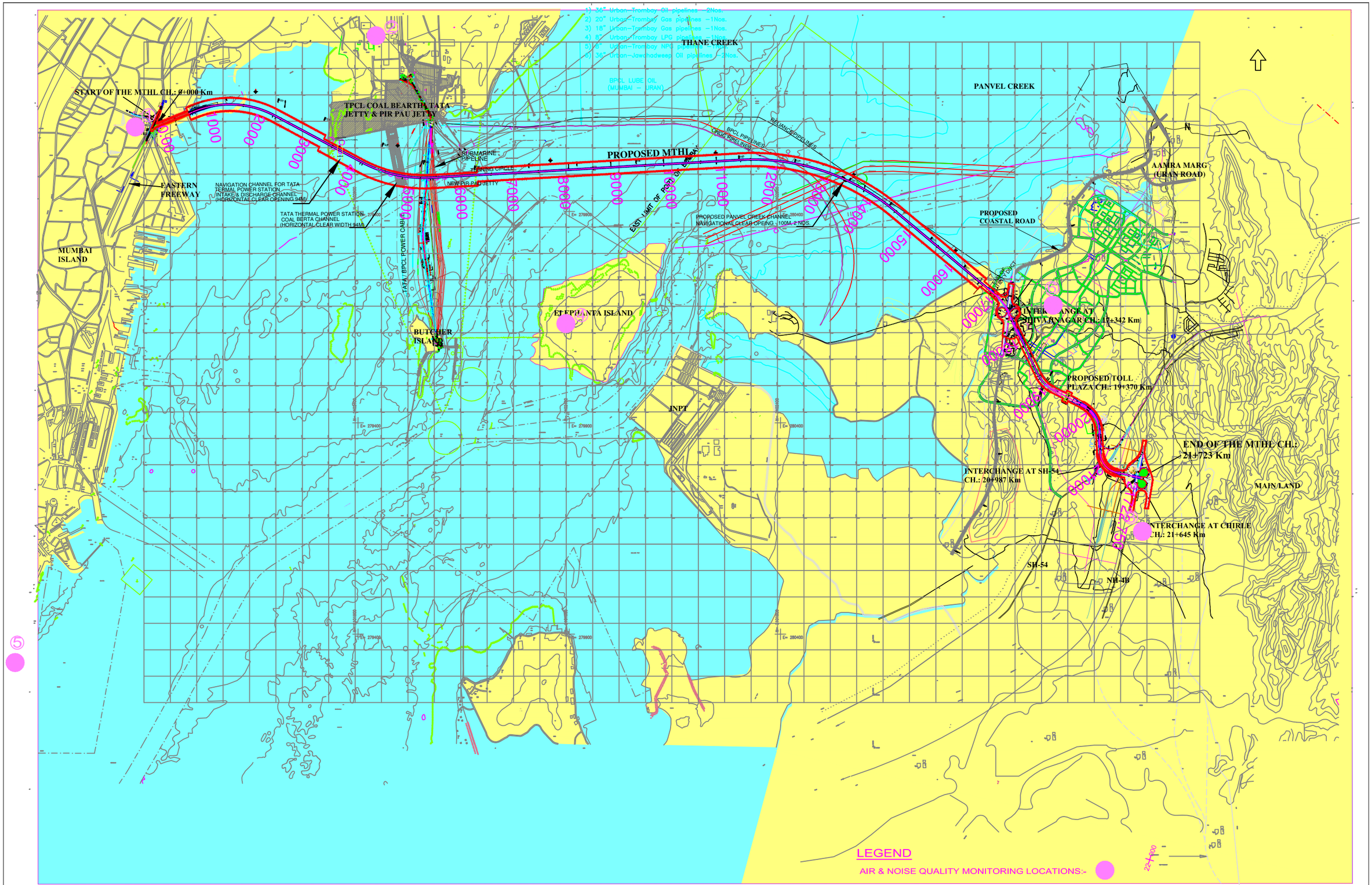
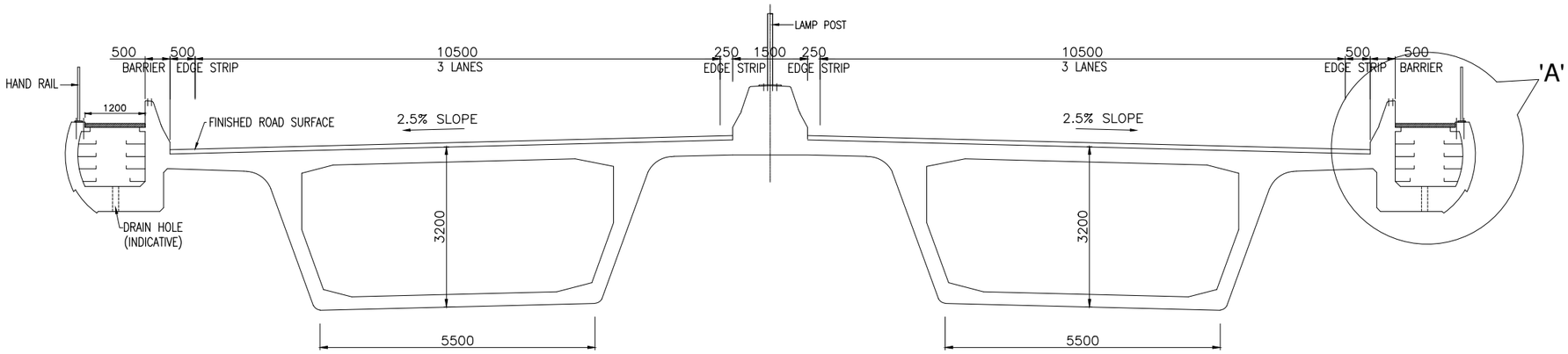
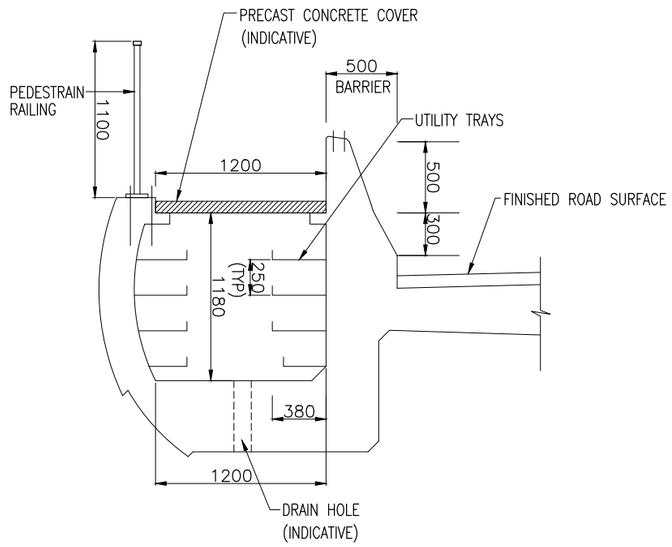


FIGURE-3.2 MAP SHOWING LOCATIONS OF AIR & NOISE MONITORING



TYPICAL CROSS SECTION
0F SIX LANE



DETAIL AT 'A'

FIGURE 2.8

Mark	Date	By	Rev.

MMRDA
MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

MUMBAI TRANS HARBOUR LINK
Contractual Design Drawing

ARUP KPMG

Drawing Title: FUNCTIONAL CROSS SECTIONS

Drawing Status	Scale	Drawing No.	Rev.
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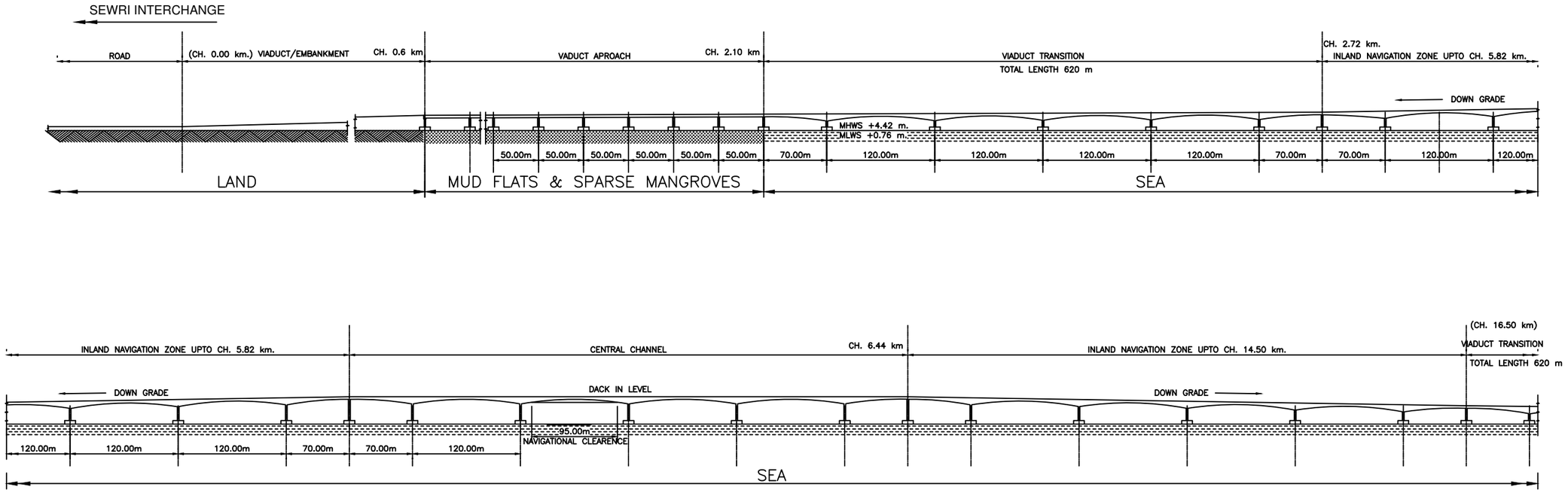

NOTE

1. ALL DIMENSIONS ARE IN METRES.
2. ALL LEVELS ARE IN METRES RELATIVE TO CHART DATUM.
3. VERTICAL & HORZONTAL SCALE ARE DIFFERENT.

LEGEND

MTHL ALIGNMENT ON LAND - (24 %)

MTHL ALIGNMENT IN SEA - (67 %)

MTHL ALIGNMENT IN MUDFLATS - (9 %)

Figure 3.1
ENVIRONMENTAL ZONES OF MTHL ALIGNMENT

‘

CONTENTS

CHECKLIST

Form-1

EXECUTIVE SUMMARY

CHAPTER 1-INTRODUCTION

CHAPTER 2-
PROJECT DESCRIPTION

CHAPTER 3- BASELINE ENVIRONMENTAL STATUS

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CHAPTER 5- ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER 6-
RISK ANALYSIS & DISASTER MANAGEMENT PLAN

ANNEXURE – I (CRZ Clearance of MoEF Dt.19/07/2013)