
CHAPTER 11

11. Executive Summary:

E.S 1. Introduction

Mumbai reckoned as the financial capital of the country, houses a population of 12.4million besides a large floating population in a small area of 437sq.km. As surrounded by sea and has nowhere to expand. The constraints of the geography and the inability of the city to expand have already made it the densest metropolis of the world. High growth in the number of vehicles in the last 20 years has resulted in extreme traffic congestion. This has lead to long commute times and a serious impact on the productivity in the city as well as defining quality of life of its citizens. The extreme traffic congestion has also resulted in Mumbai witnessing the worst kind of transport related pollution.

Comprehensive Traffic Studies (CTS) were carried out for the island city along with its suburbs to identify transportation requirements to eliminate existing problems and plan for future growth. CTS identified requirement of new arterial road along the Western Coast as part of transportation networks. Therefore, Municipal Corporation of Greater Mumbai (MCGM) has proposed to construct a Coastal Road on the western side of the city

The project site is located in the capital city of Maharashtra, Mumbai that lies on the western coast of India by the bank of Arabian Sea. Mumbai is made from the group of seven islands and is thus referred to as the Island city. These islands are Isle of Bombay, Mazagaon, Colaba, OldWoman's Island, Parel, Worli, and Salsette Island.

This island city of Mumbai is divided into two distinct regions, the city and the suburbs. The suburbs have alluvial soil type. The major creeks found in Mumbai coast are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flats and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.



MCGM has appointed consortium of M/S STUP Consultants Pvt. Ltd consultants and M/S Ernst & Young Pvt. Ltd for Preparation of Feasibility Report, DPR Preparation, Environmental Clearance and Bid process management for the proposed Mumbai Coastal Road Project.

Amendment in CRZ Notification 2011

The present CRZ notification issued in January 2011 does not allow coastal roads on reclamation however bridge s and road on stilts are permissible.

MCGM vide letter dated 22.1.2015 made a representation mentioning that it is necessary to amend the MoEF Notification of 2011 for coastal road project as a permissible activity to enable construction of coastal road by reclamation in sea and mangroves. It was further requested to MCZMA to propose necessary amendment to MoEF Notification of 2011 and forward to MOEF at the earliest.

The Authority after deliberation in its 97th Meeting held on 23rd January 2015 decided to recommend the matter to MoEF proposing above said amendment in CRZ Notification, 2011, which are required in order to enable construction of coastal road by reclamation in Mumbai.

The Ministry of Environment, Forest and Climate Change vide S.O No 3552 (E), dated 30th December 2015 made necessary amendments in the CRZ Notification 2011 in Paragraph 3 in sub-paragraph (iv) and Paragraph 4 in sub-paragraph (i) which permits construction of coastal road by reclamation in exceptional cases.

E.S 2. History of Reclamation of Mumbai

It took over 150 years to join the original seven islands of Mumbai. These seven islands were lush green thickly wooded, and dotted with 22 hills, with the Arabian Sea washing through them at high tide. The original island of Mumbai was only 24 km long and 4 km wide from Dongri to Malabar Hill (at its broadest point) and the other six were Colaba, Old Woman's island, Mahim, Parel, Worli, Mazgaon.

After the British arrival, the demand for land steadily increased, and by 1730; it was becoming impossible to accommodate the entire population of Mumbai inside the



Fort. The sea was making inroads at Worli, Mahim and Mahalaxmi, which turned the ground between the islands into a swamp, making travel between Mumbai islands hazardous.

The first major reclamation took place in 1708, to construct the causeway between Mahim and Sion. The second major reclamation took place in 1772, to stop the ingress of water and the consequent flooding of central Mumbai, and to connect Mahalaxmi and Worli. This causeway was named Hornby Vellard, sealing the Great Breach (Breach Candy) between Dongri, Malabar hill and Worli.

At the fortified Dongri hill, an esplanade and parade ground was cleared, from the walls of the Fort to the present day Crawford market. The flat lands from Mahalakshmi to Kamathipura were reclaimed only after the completion of construction at Breach Candy by Hornby in 1784. In 1803, Mumbai was connected to Salsette by a causeway from Sion.

E.S 3 Project Road

The proposed coastal road has a length of 29.20 km which lies in western costal stretch of Mumbai, Maharashtra. The proposed road length is divided in to 2 Parts, from Princess Flyover to Bandra –Worli Sea Link and Bandra –Worli Sea Link to Kandivali Junction.

Project Sections

Part A: South Section (Princess Flyover Road to Worli end of Sea Link)

Section 1: Princess Flyover Road to Priya Darshini Park

Section 2: Priya Darshini Park to Mahalaxmi

Section 3: Mahalaxmi to Baroda Palace

Section 4: Baroda Palace to Bandra Worli Sea Link (Start)

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

Section 5: Bandra Worli Sea Link (End) to Carter Road Mandir

Section 6: Carter Road Mandir to Ritumbhara College

Section 7: Ritumbhara College to Kandivali Junction



E.S.4 Salient feature of the project

- ❖ This project road location is on the western side of Mumbai city, Geater Mumbai district of Maharashtra extending from Princess Flyover to Kandivali Junction link road.
- ❖ The proposed Coastal road has approximate length of 29.20 kms from Princess Flyover to Kandivali Junction link road.
- ❖ The coastal road is proposed on a combination of land reclamation, bridges on sea, elevated roads, and road on stilts and under sea tunnels on western side of Mumbai.
- ❖ There are altogether two tunnels proposed at (i) Princess Flyover to Nepean sea road near Priyadarshani Park Walkeshwar (3.45 km) and (ii) end of Khar Danda village to Ritumbara College near Juhu beach. (5.76 km).
- ❖ The total reclamation area of coastal road is 122 ha
- ❖ The proposed project road falls under CRZ- IA, IB, II, III and IVA
- ❖ Mangrove population of about 33.37 ha would be disturbed.
- ❖ 17 nos. of religious and heritage structures are along the entire project stretch
- ❖ The project will lead to overall development in the region by reducing the travel time and generating green space of 90 ha. These all green spaces along seaside can be developed for public by creating cycling tracks, Promenades, Landscape, Theme parks etc.

E.S.5 Major Findings of the Environmental Assessment

Physiography and Soil Types

The broad physiographic features of are broad and flat terrain flanked by north – south trending hill ranges. The hill ranges form almost parallel ridges in the eastern and western part of the area. The Powai – Kanheri hill ranges are the other hill extending in the eastern and central part running NNE – SSW. The maximum



elevation of the area is 450 m above mean sea level (mamsl) at some of the peaks of hill ranges. Trombay Island has north – south running hills with maximum elevation of 300 m above man sea level (m amsl). Malbar, Colaba, Worli and Pali hills are the isolated small ridges trending north – south in the western part of the district. The Powai – Kanheri hills form the largest hilly terrain in the central part of the Salsette Island and are the feeder zone for the three lakes viz., Powai, Vihar and Tulsi.

There are a number of creeks, dissecting the area. Among them, Thane is the longest creek. Other major creeks are Manori, Malad and Mahim which protrudes in the main land and give rise to mudflangs and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas. Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil. Soil cover in the city region is predominantly sandy due to its proximity to the sea. In the suburbs, the soil cover is largely alluvial and loamy.

Geological Set Up

The entire Greater Mumbai area is occupied by Deccan basalt flows and their acid and basic variants, poured out between the late Cretaceous and Early Eocene time. The basaltic flows are horizontally bedded and are more or less uniform in character over wide areas. Certain extrusive and intrusive mafic types are associated with basalts and are found in Mumbai Island and its vicinity. Further some fossiliferous sediment mainly of tufaceous origin and partly of fresh water origin, rich in fauna are also found in Mumbai area.

Seismic Hazards

Mumbai sits on a seismically active zone owing to the presence of 23 fault lines in the vicinity. The area is classified as a Seismic Zone III region, which means an earthquake of up to magnitude 6.5 on the Richter-scale may be expected



Hydro-geology

The entire area is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occurs as narrow stretch along the major river flowing in the area.

In hard rock areas the ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing etc., of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers.

In soft rock areas which constitutes most the study area, the river Alluvium patches along the course of rivers and Marine Alluvium in the coastal area, are highly potential aquifer but with limited areal extent. The ground water occurs under water table condition in sandy / gritty layers. The alluvial fill of low lying areas underlain by weathered basalt has relatively better ground water potential.

Ambient Air Quality Status of the Study Area

The monitoring of ambient air quality was conducted twice a week at four fixed locations (Nariman Point, Haji Ali, Ram Mandir, Khardanda Village and MCGM Garden, Malad) for 24 hours with respect to Repairable Particulate Matter (RPM10), PM 2.5, Oxides of Nitrogen (NO_x), Sulphur dioxide (SO₂), Lead, CO and PAH.

PM₁₀

The mean ambient PM₁₀ concentration during the monitoring period was 82.3 µg/m³ (Table 4.1) with a range between 70.5 µg/m³ (at Malad) and 100.0 µg/m³ (at Haji Ali). The highest concentration was measured at Haji Ali (115.1 µg/m³) and the least also at Malad (59.4 µg/m³). The average compliance level of four monitoring stations was 75%, i.e 4 measurements are above the NAAQS standard (100 µg/m³).

PM_{2.5}

The mean ambient PM_{2.5} concentration was 47.4 µg/m³ (Table 4.1) with a range between 42.5 µg/m³ (at Malad) and 60.6 µg/m³ (at Haji Ali). The highest



concentration was measured at Haji Ali ($76.5 \mu\text{g}/\text{m}^3$) and the least also at the Khardanda village ($29.7 \mu\text{g}/\text{m}^3$). The average compliance level with respect to National Standard ($60 \mu\text{g}/\text{m}^3$) of all the monitoring stations was 100%.

Oxides of Nitrogen (NO_x)

The mean ambient NO_x level was $18.2 \mu\text{g}/\text{m}^3$ with a range between $13.7 \mu\text{g}/\text{m}^3$ (at Khardanda village) and $25.7 \mu\text{g}/\text{m}^3$ (at Haji Ali). The highest concentration was measured at Haji Ali ($24.4 \mu\text{g}/\text{m}^3$) and the least at Malad ($11.0 \mu\text{g}/\text{m}^3$). The average compliance level with respect to National Standard of all the monitoring stations was 100%.

Sulphur Dioxide

The mean ambient level of SO₂ was $9.9 \mu\text{g}/\text{m}^3$ with a range between $7.9 \mu\text{g}/\text{m}^3$ (at Malad) and 12.6 at Haji Ali. The highest concentration was recorded at Haji Ali ($16.0 \mu\text{g}/\text{m}^3$) and the least at Malad ($6.2 \mu\text{g}/\text{m}^3$). All the stations show 100% compliance level.

Lead

The lead concentration in all the four monitoring station was found below the NAAQS ($1.0 \mu\text{g}/\text{m}^3$). The highest concentration was recorded Khardanda ($0.132 \mu\text{g}/\text{m}^3$) and the least at Nariman Point ($0.009 \mu\text{g}/\text{m}^3$).

Carbon Monoxide (CO)

The carbon monoxide concentrations in all the four monitoring stations were found $<1.0 \mu\text{g}/\text{m}^3$ which is below the NAAQS standard ($4.0 \mu\text{g}/\text{m}^3$).

Hydro Carbon (HC)

The Hydro carbon (HC) concentrations in all the four monitoring stations were found below the detectable limit.

PAH

The PAH concentrations in all the four monitoring stations are below detectable level ($<2.0 \mu\text{g}/\text{m}^3$).



Groundwater Quality

In order to access the groundwater quality of the study area, six groundwater samples were collected from tube wells and dug wells and analysis was carried out as per procedure of APHA. Analysis of the groundwater samples and their comparison with the Indian drinking water Standard (BIS 10500, 2012) reveals the following characteristics:

pH values suggests that the water is alkaline in nature. The total dissolved solids (TDS) in tree locations are above the desirable limit (500mg/l) except at Nibhana Society, Juhu and Kasalbaug, Malad where it is below the desirable limit. However TDS in all samples are well below the permissible limit of 2000mg/l.

Chloride concentration is well below the desirable limit (250mg/l) in all locations. Sulphate and Nitrate concentrations are low and within the permissible limit and thus indicate low degree of organic pollution. Fluoride is present in all the samples and above the desirable limit of 1.0 mg/l.

Concentration of iron is low and below the desirable limit. And thus causes no adverse effect on domestic uses and water supply system and also does not promote growth of iron bacteria.

Groundwater in general is hard in the area and the Total Hardness is above the desirable limit of 200 mg/l but well water sample in Juhu it is below the desirable. It is worth mentioning that groundwater samples are free from heavy metals like cadmium, arsenic, lead, chromium etc.

Bacterial quality of groundwater shows all the samples drawn from both tubewells and wells shows presence of thermo tolerant coliforms or E.coli and hence the water samples are not potable and suitable for human consumption.

Surface Water quality

Samples of surface water were collected from 4 lakes within the project influence zone and one sample from Mithi River. Water qualities were compared with CPCB fresh water classifications.



Comparison of the results with the Indian Standards , it is clear that the in all the locations the water quality is well within the standard prescribed by CPCB for Class B, Class D and Class E type of water for most of the parameters except for DO and BOD. None of the heavy metals are found in the samples and Oil and Grease is also not detected.

Sea Water Quality

Analysis of the sea water samples reveals the following characteristics:

pH values suggests that the water is alkaline in nature. The total suspended solids (TSS) in all samples are low. However TDS in all samples are well below the permissible limit of 2000mg/l.

It is worth mentioning that sea water samples are free from heavy metals like cadmium, arsenic, lead, chromium etc. Oil and Grease is also not detectable in all samples

Soil

The analysis results indicate that soil in the region is moderately alkaline in nature. There is no much variation in the pH range in different sites. It can be inferred that the soil pH is suitable for production of any crop.

The uptake of minerals from soil by plants is directly proportional to the electrical conductivity of soil, which is responsible for plant growth. Conductivity is a measure of evaluating the salt status of soils, the high concentration of which impairs the growth of the plant. Crop plants differ in their tolerance to salinity.

However the levels of conductivity in soil above 2 milimhos, is t affected by salinity effects.

The analysis results indicate that the level of major nutrients and cations present the soil samples are within the range expected in Indian soil.

Bed Sediment Sampling

Three samples were collected to understand the physico-chemical properties of the bed sediment. The analysis results show that there are no toxic contaminations in the samples only Lead is present in higher level.



Noise

Noise levels at Haji Ali, Nariman Point, Mahalaxmi Temple, Carter road, Rizvi College, Poddar Hospital, Varsova and Lokhandwala Complex, are exceeding the limits and at Vir sawarkar Udyan, Malad and Khardanda Gaon are within the limits prescribed under Environment Protection Act (Regulation & Control) rules 2000. Plantation along the road and implementation of the EMP will reduce the noise significantly.

Ecology

- The project site is covering 70% of coastal area and some part of urban settlement area. Coastal area include mangrove vegetation, most commonly seen are
- Avicennia marina, Avicenia marina acuticima, Sessuvium portulacastrum, Salvadora persica, Acanthus iliicifolius. Urban vegetation comprise of gardens, avenue tree, ornamental plants, which grow along the road dividers and traffic island at junctions of crossroads. General urban trees are Acacia arabica, Aalbizia lebbeck, Azadirachta indica, Bambusa vulgaris, Ficus benghalensis, Ficus religiosa, Mangifera indica, Peltophorum pterocarpum, Samanea saman, Schefflera actinophylla. The commonly found shrubs are Carissa carandas, Gnidia eriocephala etc.

E.S. 6 Critical Impacts to be addressed in this project road

On the basis of the assessment of the potential impacts, the critical environmental components that need to be addressed in the Environmental Management Plan have been identified.



Summary of Potential Impacts and remediation measures through EMP

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
1	Air Environment – Construction phase	Movement of vehicles	Increase in PM,CO, NOx and SO2	Not significant due to the temporary nature of the activity	Movement of vehicles will be limited only in the night time. Construction materials will be transported through sea route
		Usage of Construction equipments.	Emission of SO2, NOx, SPM, CO etc.	Not significant due to the temporary nature of the activity.	All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that pollution emission levels comply with the relevant requirements of GOI and the PMU / PMC Trucks carrying construction material will be covered with the tarpaulin sheet.
		Drilling operation	Increase in SPM levels	Not significant due to the	Sprinkling of water can be done



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
				temporary nature of the activity	so as to decrease the suspension of particulate matter in air.
	Air Environment – Operation phase	Functioning of park	Increase in aesthetics due to improved air quality. Less pollution with increase speed of vehicle	Beneficial impact	
2	Noise Environment – Construction phase	Movement of vehicles	Increase in Ambient noise in the area	Temporary nature of the activity, hence not significant	Heavy noise producing equipment and operations should not be allowed in the night time. Their operation will be restricted only in the daytime. If urgently required, noise protection covering shall be provided.
		Usage of construction	Increase in intermittent noise level	Temporary nature of activity	The plants and equipment used in construction shall



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
		equipments			<p>strictly conform to the GOI noise standards.</p> <p>All vehicles & equipment used in construction shall be fitted with exhaust silencers.</p> <p>During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced.</p> <p>Limits for construction equipment used in the project (measured at one meter from the edge of equipment in the free field) such as compactors, rollers, front loaders, concrete</p>



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
					<p>mixers, cranes (moveable), vibrators and saws shall not exceed 55dB(A)</p> <p>Maintenance of vehicles, equipment and machinery shall be regular and to the satisfaction of the PMU and PMC keep noise from these at a minimum.</p> <p>Workers in vicinity of loud noise, and workers working with or in crushing, compaction, or concrete mixing operation shall wear earplugs</p>
	Noise Environment – Operation Phase	Functioning of road	Noise level will increase due to increased human activities	Not significant, the green zone will help in reducing noise from present levels.	Proper management plan is adopted for developing the green zone within the site



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
					which will act as a buffer to check the noise
3	Water Environment – Construction phase	Usage of construction materials	Could lead to possible contamination of sea/lake water by throwing debris	Effect is temporary	The construction activity will not be carried out in the rainy season
		Usage of construction equipments	Accidental spillage of oil and grease from machinery in surface and groundwater	Effect is temporary	Careful handling of the construction equipments and creating awareness among the labour using it
		Usage of construction material	Surface runoffs could lead to possible contamination	No offsite impact	Ready Mix Concrete (RMC) will be used.
		Setting up of garden and transportation of red earth	Leakage of red earth through run off water leads to contamination of water	Effect is temporary	Onsite diversion ditches will be constructed to control any surface runoff during site development



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
	Water Environment – Operation phase	Accidental spillage and solid waste dumping	water contamination	Offsite impact can be minimized through proper management plan	Oil & Grease separator will be provided for the collection and treatment of surface runoffs The treated water will be recycled for gardening use.
		Accumulation of non biodegradable solid waste due to human activity	Throwing of garbage in the leading to contamination of water	No offsite impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the road
		Accumulation debris	Likely chance of throwing of garbage debris in water affecting aquatic flora and fauna	No offsite impact	Onsite vermin-composting facility will be provided and the compost will be used as a manure for gardening purpose



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
4	Land Environment – Construction phase	Drilling operations	No effect on loss of productive soil	No impact	
	Land Environment – Operation phase	Human activity	Generation of solid waste	No significant impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the garden
5	Traffic Pattern – Construction phase	Blockage of the road due to the operation onsite	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of vehicles to the site for carrying the construction material	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of labours and staff around	Negative effect on the existing traffic	No significant impact due to the temporary	Effective traffic diversion and management will



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
		the construction site and on the existing road	pattern	nature of the activity	be undertaken
	Traffic Pattern – Operation phase	Movement of vehicles coming to the site	Create an increase in the number of vehicles	Impact minimized through implementation of EMP	Adequate parking lots will be provided
6	Ecology – Construction phase	Constructing activity	Accumulation of dust particles on the surrounding vegetation result in the decrease of the growth rate of the trees and cutting of trees	Impact minimized through plantation programe	Compensatory afforestation programme will be implemented through EMP
			Decrease of the number of visiting faunal species like butterflies, birds etc. due to vibrations and increased noise levels	Temporary impact	Biodiversity will increase once the road is constructed and adopting EMP guidelines.



Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
	Ecology – Operation phase	Operation of road and	Increase in the green cover have positive impact		

E.S. 7 Environmental Enhancement and Project Benefits

The environmental enhancement measures are intended to provide value addition to a proposed project. These are considered in addition to the specific impact mitigation measures proposed. Environmental enhancements therefore are measures aimed at improving the project surroundings, increasing its user-friendliness and improving the services to the local inhabitants.

In this project, the environmental enhancement measures will include:

- BRTS as one of the dedicated lane of both carriageways to attract commuters to reduce private vehicles.
- At each bus stop proper entry/exit and connectivity on both carriageway through subway or aesthetically pleasing foot over bridges to be proposed.
- The toilet and drinking water facilities should be made available at suitable distances along the promenade.
- Extension of existing subway at Haji Ali chowk is proposed .Also a connectivity from coastal road to existing approach road of Haji ali Darga is proposed
- The garden and promenade spaces being very important recreational space, suitable design landscapes, illumination and street furniture is provided.
- The coastal erosion protection measures by providing tetra pods/sea walls at the end of sea side promenade.
- Proposed Connectivity to Madh island



- Protection Wall (Break water wall) :Considering the storm surge impacts a well designed Break water wall on sea word side of proposed coastal road is planned with an elevation above HHTL
- Road level is planned in such a way that it will not impact aesthetic and sea side view of commuters
- Providing information boards for important tourist and pilgrimage locations
- Promenade with Cycle track and Seating Decks.
- Landscape areas with jogging track, kids play area, Public toilets.
- Open air museum.

E.S.8 Environmental Monitoring Program

Monitoring Program

The purpose of the monitoring program is to ensure that the envisaged objectives of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program 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.

Performance Indicator

The physical, biological and social components identified as of particular significance in affecting the environment at critical locations have been suggested as Performance Indicators (PIs), and are listed below.

- Air quality
- Water quality



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- Noise levels around sensitive locations.
 - Plantation success / survival rate
 - Soil contamination
 - Erosion indices
 - Restoration of borrow pits
 - Sedimentation rate in the downstream where bridges, culverts, etc are built
 - Vital statistics on health
 - Accident frequency

Selection of Indicators for monitoring

The environmental parameters that may be qualitatively and quantitatively measured and compared over a period of time, due to their importance and the availability of standardized procedures and expertise, have been selected as Performance Indicators (PIs).

- Air Quality
- Noise levels
- Water Quality
- Flora
- Soil Contamination

Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters recommended for monitoring road transportation developments are Particulate Matter (PM), Carbon Monoxide (CO), Oxides of Nitrogen (NO_x), Hydro-Carbons (HC), Sulphur Dioxide (SO₂) and Lead (Pb).

These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance to the National Ambient Air Quality Standards 2009.



Water Quality Monitoring

The physical and chemical parameters recommended for analysis of both surface and ground water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan in Chapter 8

Noise level Monitoring

The measurements for monitoring noise levels would be carried out at all designated locations along all contract packages in accordance to the Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989. Sound pressure levels would be monitored on twenty-four hour basis.

Plantation

To ensure the proper maintenance and monitoring of the compensatory afforestation being carried out, a regular maintenance and monitoring of the survival rate of the planted trees is being proposed upto a period of 3 years from the operation of the project. The responsible institutional arrangements are presented in the Environmental Monitoring Plan

Soil Contamination

Contamination of the soil, especially due to increased levels of Pb, Cd and Cr are likely due to the increased traffic movement on the project corridor. The comparison of the concentrations of these parameters before and after the project coming up would aid in arriving at the increase in concentrations of these heavy metals, if any.

E.S 9 Environmental budgets:

Total cost of environmental improvement plan has been estimated as **1.89 crores**