MMRDA

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

SURYA

REGIONAL WATER SUPPLY SCHEME FOR WESTERN SUB-REGION OF MMR

DRAFT

Principle Investigator

Prof R.Nagarajan

CSRE Centre of Studies in Resources Engineering of IIT Bombay

INDEX

VOLUME I

LIST OF TABLES

LIST OF FIGURES

VOLUME II

Chapter 1

Introduction

India has a highly seasonal pattern of rainfall, with 50% of precipitation falling in just 15 days and over 90% of rivers flow in just four months. Over the past 150 years India has made large investments in large scale water infrastructure, much of which bring water to previously water - scarce areas. This has resulted in a dramatic economic shift, with once-arid areas becoming the centers of economic growth, while the historically well-watered areas have seen much slower progress. The poor have benefited hugely from such investments. There are regions of India that can benefit greatly from increased investment in water infrastructure, of all scales. India can still store only relatively small quantities of its rainfall. Whereas arid rich countries (such as the United States and Australia) have built over 5000 cubic meters of water storage per capita, and middle-income countries like South Africa, Mexico, Morocco and China can store about 1000 cubic meters per capita, India's dams can store only 200 cubic meters per person. India can store only about 30 days of rainfall, compared to 900 days in major river basins in arid areas of developed countries. A compounding factor is that there is every indication that the need for storage will grow because global climate change is going to have major impacts in India – there is likely to be rapid glacial melting in coming decades in the western Himalayas, and increased variability of rainfall in large parts of the subcontinent.

Safe drinking water is one of the basic necessities of life and is an essential precondition for improvement of health and well being of the community. Community water supply is a basic human need and access to safe drinking water is basic human right. The water resources in India are sufficient for the water supply in whole of India only if proper & efficient water supply management is adopted. Over the years, India's water resources have been depleting and the demand for water from various sectors of the economy is rapidly rising. The water demand is growing at the rate of 12 per cent per annum.

Generally, the bulk water transferred from the source to the delivery point is done by pipelines, including Mumbai Municipal corporation. The 530 km Goldfields Water supply scheme in Western Australia using 750 mm pipe and completed in 1903 was the largest water supply scheme of its time. Morgan - Whyalla Mannum-Adelaide (completed 1955) pipelines. The Great Manmade River of Libya supplies 3,680,000 cubic metres of water each day to Tripoli, Benghazi, Sirte, and several other cities in Libya. The pipeline is over 2,800 km long, and is connected to wells tapping an aquifer over 500 metres underground.

1.1 Mumbai Metropolitan Region

Mumbai Metropolitan Region (MMR), the largest metropolitan region (4350 sq km) in India has a population of 19 Million **(Census, 2001).** It comprises of 7 municipal corporations and 13 municipal councils - Mumbai city district, Mumbai suburban district, parts of Thane district, comprising Thane, Bhiwandi, Kalyan, and Ulhasnagar tehsils and part of Vasai tehsil, parts of Raigad district, comprising Uran tehsil and part of Panvel, Karjat, Khalapur, Pen and Alibag tehsils (**Figure 1.1**). Mumbai Metropolitan Region Development Authority (MMRDA) is the nodal planning and implementing agency for all infrastructure development projects such as road widening, new roads, bridges, flyovers, Road Over Bridges, subways, elevated roads, Metro-Monorail Projects, Water Resource Development and other related works for the MMR. MMRDA has decided to take up the development of water resources and supply systems to meet the growing demand for drinking water supply in the Region.

Figure 1.1 Administrative units in Mumbai Metropolitan Region

1.1.1 Vasai-Virar Sub-region

It is located on northern boundary of Mira-Bhyandar and on Western side of Mumbai-Ahmedabad National Highway (NH-8). The Sub-region includes Vasai–Virar Municipal Corporation (VVMC) and other 27 villages. The Vasai-Virar Municipal Corporation (VVMC) was formed in the year 2010 covering an area of 105 sqkm, by merging of Nallasopara, Vasai, Virar and Navghar Manikpur towns and 49 urbanised villages (Out of total 76 villages in Sub-region). 27 villages were not merged in the corporation. The Sub-region has annual composite growth rate for the decade 1951 – 2001 for 4 towns stated above was 10.92%. The growth rate has further increased in the decade 2001 – 2011. The population of VVMC as per Census 2011 is 12.21 Lakhs. As per provisional reports of Census India, population of Vasai Virar in 2011 is 1,221,233; of which male and female are 649,535 and 571,698 respectively. The sex ratio of Vasai Virar city is 880 per 1000 males. The decadal growth rate in population has been 58% and

70% during the last two decades i.e., 1981-1991 and 1991-2001. As per census 2001, the population of Vasai Virar was 702723. The projected population is 22.23 lakhs during 2021.

The existing water supply to Vasai-Virar is from 14 MLD from Pelhar (Old Scheme), 100 MLD from Maswan, 24.5 MLD from Usgaon and 1.5 from Papadkhind. Irrespective of these supplies unsustainable urban growth and unplanned development over the years have created scarcity of drinking water. Most population is dependent on tanker fed water supply. It is expected that the water demand at the rate of 135 lpcd would be 235, 400, 600 and 750 MLD and the deficit would be 105, 270, 470 and 620 MLD in the years 2011, 2021, 2031 and 2041 respectively. It is planned to bridge the gap in demand by schemes from water sources such as Surya (2011), Wandri and Ghateghar (2021), Karnan, Kholsapada, and Rajiwali-Sativali (2031) and Pijal (2041).

A low cost housing project is also proposed for the urban poor in this region. It is also proposed to develop the Heritage installations and create recreational hubs for Tourism development in addition to shore line suitable for water sports in the shoreline area.

1.1.2 Mira Bhayandar Municipal Corporation (MBMC)

Mira Bhayandar Municipal Corporation (MBMC) formed in 2002 covers an area of 89 sqkm. It had a population of 5.20 lakhs in 2001 (2,86,391 males and 2,33,997 females), which has increased to 8.15 lakhs in the 2011 census. It is projected that population would be about 14.74 lakhs, 22.11 lakhs and 28.55 lakhs in 2021, 2031 and 2041 respectively. The annual growth rate is 4.6%. The Eastern part Mira road has developed into residential area and the western portion of the railway is mostly covered by salt pans and mangroves. Bhayandar on the western side of the railway line is traditionally residential, and the Eastern was predominantly commercial and industrial activities. The population water demand was 72.8, 101.92 and 137.62 MLD in 2001, 2006 and 2011 and projected to be 206.36 and 509.54 MLD in 2021 and 2031 at the rate of 85lts/day/person. The existing water supply is of 86 MLD from STEM (Shahad-Temghar project) and 5 MLD from MIDC sources.

1.1.3 Rental Housing Projects

The Govt. of Maharashtra has appointed MMRDA as the Implementing Agency for Rental Housing Projects towards the Slum Prevention Programme in the MMR in 2008. It is proposed to construct or procure 5,00,000 self contained Rental Housing units of minimum 160 sqft carpet area within 5 years. The complex will have all basic required infrastructures such as internal roads, storm water drain, sewer lines, water supply lines, electricity etc. MMRDA till date has granted local clearance to 39 Rental Housing Proposal at various locations in MMR which will generate Rental Housing stock of about 2.58 Lakh Rental housing units in next 3 to 4 years. Some rental housing projects are located in Vasai-Virar sub-region and Mira – Bhayander Sub-region.

1.2 Surya Integrated Water Supply Scheme

The Surya Integrated Water Supply Scheme proposed by MMRDA is proposes to lift water from Kawadas Weir located across the Surya River and on the downstream of the Surya Dam, transport the same to the water treatment plant for quality treatment and supply to 1) Vasai-Virar Municipal Corporation (VVMC), Mira Bhayander Municipal Corporations (MBMC), 2) 27 villages in Vasai – Virar Sub-region which are not merged in VVCMC and 3) for proposed rental housing projects of MMRDA and deliver it to Master Balancing Reservoirs, positioned at strategic locations for distribution.MMRDA has accorded an administrative approval for estimated cost of Rs. 945.00 Crores towards expenditure of proposed 303 MLD project. Government of Maharashtra has allocated 67.18 Mm^3 of water to Surya Integrated Water Supply Scheme of MMRDA as per Government R (Water Resources Department) dated 07.12.2011. The proposed distribution of water from Surya project is shown below:

Table 1.1. Proposed distribution of water from Surya project

Administrative units	Allocation(in MLD)
Vasai-Virar Municipal Corporation area including 49 Villages merged in VVMC	170
MMRDA‘s proposed Rental Housing Project in Vasai– Virar Sub-region	
27 villages in Vasai - Virar Sub-region not merged in VVMC	15
Mira – Bhayandar Municipal Corporation including MMRDA‘s special planning areas at Uttan and other 5 others	118

MMRDA's Proposed Rental Housing Project in Mira - Bhayander Sub-region	
Total	**303**

Further, it has also appointed Consultants to collect data required from the site and formulate suitable water supply scheme indicating the locations of plant structures pipe lines etc. from source to all supply points. The requirements of infrastructure facilities for plants and operation maintenance also will be included and the total project cost will be worked out. Consultants will also study the present water supply arrangements of different ULB's and the groups of villages and the augmentation pattern required as per the population growth tendency of each for the further period up to 2021. M/s Shah Technical Consultants Pvt. Ltd. and Tandon Urban Solutions Private Limited (TUSPL) have been appointed for providing consultancy services for planning, designing and implementation of Surya integrated water supply scheme for bulk water supplies to the Western Sub-region of the MMR.

1.3 Objective

The purpose of this study on Environmental Impact Assessment is to investigate and assess the potential impacts on the existing environment in achieving the goal. The scope of the work is to:

1) Assessment of Alternate routes and justification for selecting present scheme
2) Legal Status of proposed project site with respect to applicable environmental laws
3) Evaluate the Baseline Environmental Conditions
4) Identify environmental parameters that would be impacted during the construction and operation phases
5) Environmental Management plan.

1.4 Methodology

The nature and magnitude of impact on different components of the environment depends on the nature and size of project as well as location of the proposed project site and steps taken for mitigating the environmental impact. The final net impact due to the proposed project on environmental components can be evaluated through Environmental Impact Assessment (EIA) studies within the study zone prior to its implementation. The results of EIA Studies form the

basis for preparation of a viable Environmental Management Plan (EMP). The EIA Studies are broadly divided into three phases.

 First phase involves identification of significant environmental components and assessing their baseline (Pre-project or existing) status within the study zone.

 Second phase involves prediction of impacts and hurdles on various identified significant environmental parameters due to proposed project. Data regarding the proposed construction activities, Planning, design and Implementation capacity for bulk water supplies to western sub-region of MMR, Flora and fauna, water consumption, sewage generation, characteristics of disposal medium and topography of the impact zone is also assessed to evaluate project related environmental features.

 Third phase includes the evaluation of final impacts and delineation of an Environmental Management Plan to mitigate adverse impacts on the quality of surrounding environment.

The base line studies are conducted and the predictions of impacts made & mitigation measures suggested on the basis of the above are presented in the EIA report.

1.5 Policy and Legal frame work

The project will be implemented under the applicable Indian legal framework. The applicable legal and policy framework related to environment is described below.

 Environmental (Protection) Act, 1986 and applicable prescribed Rules and Notifications under the Act.

 Environmental Impact Assessment Notification Sept 2006 (S.O.1533)

 The Maharashtra (Urban Areas) Preservation of Trees Act, 1975.

 Coastal Regulation Zone Rules, 2011 (S.O.19(E))

 Indian Forest Act, 1921

 The Wildlife (Protection) Act, 1972, Biological Diversity Act, 2002 and other State Forest Acts, as notified by the State/Union Territory Government.

 Hazardous Wastes (Management and Handling) Amendment Rules, 2000

Legislation related to Resettlement and Rehabilitation:

 Land Acquisition Act 1894 (LA Act)

 Maharashtra Regional and Town Planning Act, 1966 (MR&TP Act).

 R & R Policy of Govt. of Maharashtra

Following table presents the applicable rules and regulations and how they are applicable in implementation of this project.

Table 1.2 Rules and regulations in implementation of project.

Applicable Regulations	Status of compliance
Environmental (Protection) Act, 1986 and applicable prescribed rules and notifications under the Act	This is an umbrella act for environment protection. Various standards in terms ambient air, noise are prescribed under this act.
The Maharashtra (Urban Areas) Preservation of Trees Act, 1975	As per this act no tree can be felled without the permission of local tree authority. Trees in the RoW can be removed with the permission of tree authority which may prescribe transplanting or compensatory plantation
Land Acquisition Act 1894 (LA Act)	Land acquisition required for the Project will be carried out as per this act.
Maharashtra Regional and Town Planning Act, 1966 (MR&TP Act).	The act provides for preparation of regional plan for the MMR as a whole and preparation of Development plans for the local jurisdiction of individual municipal authority. All the components of project are planned in accordance with this act and Development Plan.

Chapter 2

Surya Integrated Water Supply Project

The water supply system envisages abstracting raw water from the river Surya at suitable location, treating the water by adopting appropriate process in water treatment plant and transmitting to master balancing reservoirs to be located at outskirts of the two ULBs. The MBRs shall be bulk supply points and destinations for the water supply system. The water availability in many of the reservoirs that are located on the western region of the MMR committed and is operation. Even though water in the Surya Reservoir is committed to Tarapur and Reliance's Patalganga project, 303 MLD water could be sparred for the urban demands. The water supply system envisages abstracting raw water from the river Surya at suitable location, treating the water by adopting appropriate process in water treatment plant and transmitting to master balancing reservoirs to be located at outskirts of the two ULBs. The MBRs shall be bulk supply points and destinations for the water supply system.

The integrated water supply scheme considered the following components such as – 1) Intake and raw water pumping station; 2) Raw water pumping main; 3) Water treatment plant; 4) Clear water pumping station at WTP; 5) Clear water pumping main to break pressure tank (BPT); 6) Break pressure tank; 7) Clear water transmission main; 8) Tunnel crossing at National Highway; 9) Master Balancing Reservoirs (MBR) and en-route River and creek crossings.

2.1 Selection of Source, WTP& MBR

The Surya Dam and reservoir upstream, the Kawadas pick up Weir and the Maswan weir provide the MMRDA with three alternatives for the project water source. After having studied the pros & cons of these options with respect to :-

1. Location of the raw water intake & pumping station as the same has to be in impounded storage at weir either existing or new. Also Water Treatment Plant as land for WTP needs to be at appropriate elevation as well as adequate to accommodate all plant units.

2. Possibility of Minimum 3 days storage of Raw Water available at site which is considered necessary for reliability of water supply.

3. If weir level is raised to obtain 3 days storage, then will submergence exceed beyond banks, is foundation adequate, will stability of weir affected by raising height

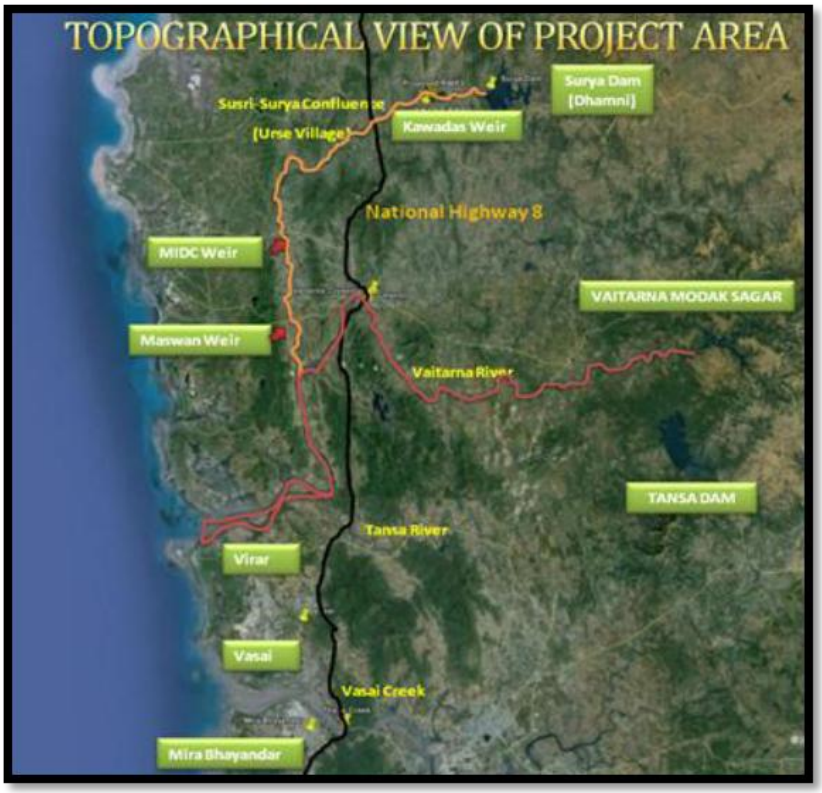
4. Submergence of land due to raise of weir level (ha).

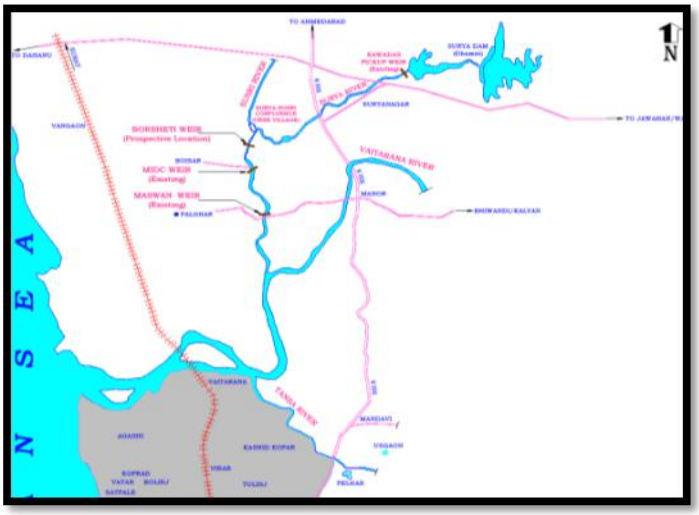
5. Ownership of the land if land acquisition is necessary for components of water supply project & conveyance of water to ULBs. Cost of acquisition of land

Three alternate routes were studied at Techno-economic feasibility level of the project. Detailed study was then initiated for the following two routes for the water supply scheme. Satellite image showing the project area and the reservoirs in the western region is presented below (**Figure 2.1**). The water availability at the Dhamni dam ensures that water will be available for supply to the VVCMC and the MBMC as per the established norms of dependability from the above sources. The water off take shall be 303 MLD.

- Kawadas Pick-up Weir as the Source
- Maswan Pick up Weir as the Source

Figure 2.1 Satellite image showing the project area and reservoirs in western region





2.1.1 Supply Source

Kawadas Pick-up Weir is located about 5.6 km downstream of the Surya Dhamni Reservoir. There are three existing intake wells belonging to the MJP and Reliance Industries abstracting about 36 MLD water from this source. The bed level of the reservoir is 60. Adequate area is

available on the upstream side of the weir to design and develop another intake well for abstracting 303/403 MLD water from this weir without affecting other daily abstractions. The width of Dam is 648.93 m and height is approximately 3.5 m. The abstracted water is proposed to be pumped to the proposed WTP site at Suryanagar for treatment.

After treatment the treated water shall be pumped to the break pressure tank at the WTP (which also happens to be the highest point) and then by gravity from the WTP site of Suryanagar to the VVCMC MBR proposed at Kashid Kopar. The quantity allocated for the MBMC shall be conveyed by gravity main to the proposed MBMC MBR at Ghodbandar.

Maswan weir is located about 40.6 km downstream of the Kawadas Weir. The bed level of the impoundage is about 7 m. The river bed is narrow and there are apparent limitations to increasing the impoundage upstream of the weir. There will be the requirement of additional water storage upstream.

The MJP intake well at Maswan abstracts about 100 MLD water and pumps it to the Duktan WTP located about 5.5 km away. After treatment the treated water is stored in the ground storage and pumped to another balancing reservoir about 1 km away at a level of about 90 m. From this storage the water is taken by gravity mains (27 kms) up to the Kashid Kopar MBR located at a level of about 57 m. It is then distributed by gravity.

Using the Maswan weir as the source will involve construction of another intake well of 303/403 MLD capacity, Pumping mains up to the WTP site through 2.5 km distance. In case the land available at the WTP is not adequate, some adjacent land acquisition may be necessary.

After treatment and storage, the treated water shall be pumped to about 90 m for storage and downstream gravity conveyance to the Kashid Kopar MBR of the VVCMC and to Ghodbandar MBR (proposed) for the MBMC.

2.1.2 WTP Sites

The water abstracted from any of the above sources has to be treated before it reaches the consumers. It is therefore necessary to design and construct a water treatment plant for the defined capacity of 303 MLD. It is anticipated that the plant shall require about 12 to 15 ha land depending on the treatment process alternatives available. These alternatives were studied in detail during the feasibility stage. The possible location alternatives studied are described below.

The **Surya Nagar Colony** located about 5.54 km from the Village Kasa Khurd and about 2 km from the Kawadas weir at an average level of about 80 m. The colony covers an area of about 20 Ha. The colony is inhabited by a few employees of the Irrigation Department, Govt. of Maharashtra and houses some offices as well.

Most of the old quarters of temporary specifications in the colony are in a very poor state of repairs. It should be possible demolish the part of the colony which is not in use and make the area available for the construction of a 303/403 MLD water treatment plant even with the provision for future expansion. Since the land belongs to the Govt. it was considered as the best option to avoid land acquisition. This site was therefore selected as the best alternative for two source alternatives of the Surya Dam at Dhamni and the Kawadas weir.

The water intake at the Maswan weir supplies about 100 MLD water to the WTP located at Duktan (5.5 km away). Large area is available within the WTP complex. Depending upon the treatment process and methodology, it should be possible to accommodate the new WTP of 303/403 MLD capacity.

In case more land is needed, the contiguous land acquisition may be proposed to fully accommodate the new WTP. This alternative will be useful for the Maswan weir intake alternative. Its usefulness for the Susri-Surya (new) weir alternative was also examined in detail. However was not found to be feasible. As Maswan pick up weir option was not chosen Duktan WTP site was not selected.

2.1.3 Mass Balance Reservoir Site

The Kashid Kopar MBR supplies water to the VVCMC. The land availability at this location and in possession of the VVCMC has been selected for locating the 303/403 MLD WTP. This alternative has the advantage of the fact that the raw water is being brought very close to the consumer distribution locations as compared to the other locations which are comparatively very remote. Better control over the water treatment plant is therefore more likely. This alternative shall be useful for all the proposed sources including Surya (Dhamni), Kawadas, Susri-Surya and Maswan weirs.

2.1.4 Pressure and Gravity water conveyance lines

The alignment options for the conveyance of bulk water under pressure or by gravity are several and will essentially depend on the source chosen for lifting water. The Surya Dam source and Kawadas weir source are connected with well developed roads. It should therefore be feasible to follow the road alignments and also keep the conveyance mains within the ROW of the roads. In this context the Guidelines of the Govt. of India, MoEF issued vide letter No. F. No. 8-66/2009-FC-pt dated 30th September 2009 on the subject of Re-diversion of Forest land under the Forest (Conservation) Act, 1980 will be followed during the project development for selection of alternatives for the alignment of water transmission mains. Based on the constraints and advantages described above, the following identifications were made:

2.2 Surya Dam

It is a multipurpose stone masonry dam is located at Dhamni (19^0 55‘N and 73^0 03‘ E) is built across the Surya river that originates from Sahyadri mountain in Mokhada Tehsil of Thane District. Susri is an important tributary of Surya River. The total length of the river course 55 Km before it reaches the Arabian Sea. The tidal water reaches upto Maswan. It has total storage of 299.01 MCM; 12.69 MCM dead storage from average annual rainfall of 2216mm. The submerge area of the reservoir is 355.60 sq km. 215.84 MCM is allocated for total irrigation capacity is 14696 ha of agriculture land and the presence use is 62.856 MCM. 24.557 MCM and, 47.835 MCM of water are allocated for drinking water and industries respectively. 6.75 MV of electricity is generated from the storage. Water from the dam is released through the tail race

of the hydroelectric power house located at the foot of the dam. Water pick-up weirs are located at Kawadas, MIDC and Maswan situated at 5.5km, 29.7 km and 40km downstream of dam.

2.3 In-take and Pumping station

Kawadas pick-up weir is weir across the Surya River about 5 km downstream of the Dhamni Dam. It has a total storage of 13.70 MCM and 3.74 MCM of dead storage. The length of the right and left canals are 28.5km and 47mm respectively. Discharge to left canal is 10.78 m^3 / sec. 36 MLD of water is drawn for Tarapur Atomic Power Station and Reliance industries.

Maswan pick-up weir is situated 40.6 km from the Kawadas weir near the Mano-Palghar road. 100 MLD from water is being lifted for Vasai –Virar City Municipal Corporation.

It is proposed to lift water at Kawadas weir and transport to Surya Nagar where it will be treated in Water treatment Plant prior to transmission Master Balancing Reservoirs (MBRs) for bulk distribution. It was decided based on the 1) proximity of raw water intake location and pumping station, 2) land for Water Treatment Plant units and its elevation, 3) 3 days of storage of demanded water for reliable water supply, 4) weir foundation and stability in raising the weir height for additional storage and 5) issues related to submergence of land due to raise in weir level. It was found that there is an adequate area available on the upstream side of the weir to design and develop another intake well for abstracting 303/403 MLD water from this weir without affecting other daily abstractions. The width of Dam is 648.93 m and height is approximately 3.5 m. Intake location is proposed 140 m inside the river.The abstracted water is proposed to be pumped to the likely WTP site at Suryanagar for treatment.

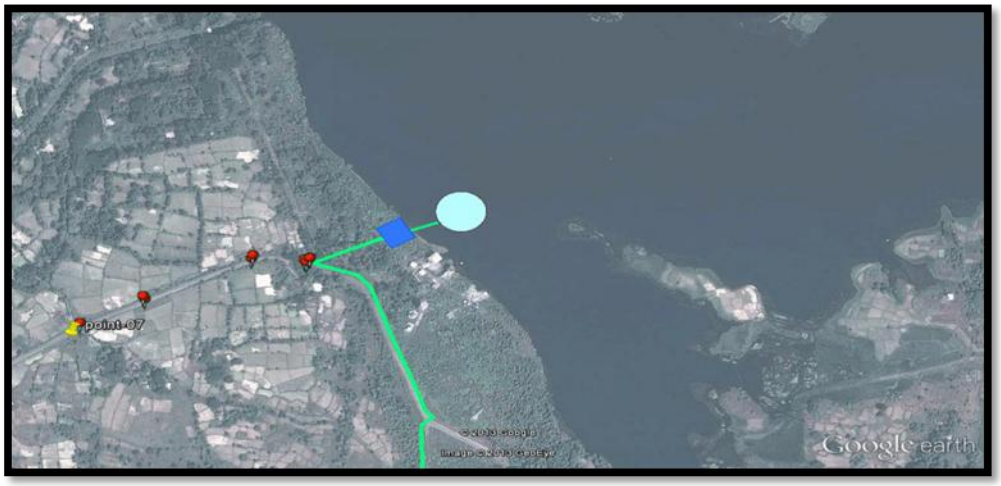
The constraints from the Maswan weir is – distance (40.6 km downstream of the Kawadas Weir), the bed level for the impoundage is about 7 m, and river bed is narrow and there are apparent limitations to increasing the impoundage upstream of the weir.

Intake and raw water pumping station: Water released from the Surya dam and impounded by the Kawadas Weir will be the source of intake. A jack well exclusively for this project will to lift

be a capacity of about 350 MLD through effective pumping mechanism to the water treatment plant. The pumping station and adjoining functional space required is 1 Ha.

Raw water pumping main: about 2.030 m diameter, made of MS lined and externally coated from the raw water intake to the WTP, length about 2.00 km.

Fig 2.2 Intake Location



2.4 Water Treatment Plant (WTP)

Water abstracted from the above said sources need to be treated. It is necessary to design and construct a water treatment plant for the defined capacity of 303 MLD. It is anticipated that the plant shall require about 12 to 15 Hectares of land depending on the treatment process alternatives available. These alternatives were studied in detail during the feasibility stage.

Surya Nagar Colony, inhabited by employees of the Irrigation Department, Govt. of Maharashtra is 2 km from the Kawadas weir at an average level of about 80 m above MSL, covering an area of about 20 Ha.The activities and residential requirements for Surya dam has substantially decreased over the years. Hence, the developed land could be used for this purpose. However, the facility at Maswan-Duktan WTP plant is located 5.5 km away and land acquisition is required to accommodate the new plant.

For treatment of about 350 MLD raw water and having aeration fountain, flash mixers, clari-flocculators, rapid sand filters, chlorine contact tanks and treated water storage. It is proposed to

be located at the Surya Nagar Irrigation Colony spread over an area of about 20 Ha including treated water storage, pumping station and Break Pressure Tank (BPT).

Pressure and Gravity water conveyance lines - The conveyance of bulk water under pressure or by gravity will depend on the source chosen for lifting water. The Surya Dam source and Kawadas weir source are connected with well developed roads. It should therefore be feasible to follow the road alignments and also keep the conveyance mains within the ROW of the roads. Further, the Guidelines of MoEF (vide letter No. F. 8-66/2009-FC-pt dated 30th September 2009) on the Re-diversion of Forest land under the Forest (Conservation) Act, 1980 will be followed during the project development for selection of alternatives for the alignment of water transmission mains.

Clear water pumping station at WTP: It will be located at the WTP complex and treated water shall be pumped locally to the overhead break pressure tank.

Break pressure tank: This will be located at the hill top in the WTP complex at Suryanagar. Treated water will be pumped through a 240 m long rising main of MS, 2000 mm dia.

Clear Water Gravity Transmission Main: From the BPT to the VVCMC and MBMC master balancing reservoirs with a total length of about 89 km. made of MS sheet, internally lined and externally coated, diameter varying from 2.03 m to 1.4 m.

2.5 Pipeline alignment

Tunnelling*:* En-route crossing of NH by tunnel at Medhwan Khind with 3.6 m diameter, 2.1 km long and bored using tunnel boring machine.

River Crossings*:* Crossings across the Vaitarana and Tansa Rivers parallel to the NH Bridges and buried under the river bed for smooth and uninterrupted water supply across all seasons.

Creek crossings*:* Under the tidal Ulhas creek by underwater tunnel about 2.60 m in diameter and about 750 m long.

2.6 Master Balancing Reservoirs (MBR):

Master Balancing Reservoirs (MBR): One each for the Vasai-Virar City Municipal Corporation located at Kashid Kopar near the existing MBR and covering an area of about 5 Ha. The second

MBR for the Mira-Bhayandar Municipal Corporation shall be constructed at Ghodbandar on MBMC land.

2.7 Land requirement

The land requirement for the scheme for all the alternatives has been indicated below. This indication covers the project execution as well as the operations and maintenance phases. The requirement may vary significantly depending on the final alternative / alternatives selected. The same shall be refined in the subsequent detailed project reports. In the planning of the project and location of components all due care shall be taken to ensure that the land and property belonging to the indigenous and tribal population shall not be proposed for the development of project. The land requirement for the project (**Table 2.1)** is given below**.**

Table 2.1 Land requirement for the project

Project component	Location	Land requirement
Intake Works and Pumping Station For 440 MLD	Surya Dhamni Dam/ Kawadas Weir/ Maswan Weir	1 Ha
Raw Water Rising Main about 2500 mm dia.	From the Pumping station to WTP site with 3.6 m wide service road	12 m wide strip for the entire length of the rising main
Water Treatment Plant for 420 MLD output	Suryanagar / Duktan / Kashid Kopar	10 -12 Ha
Treated Water Rising / Gravity Main about 2500 mm dia.	From the WTP to BPT/Tunnel at 115 m on NH8 and beyond up to VVCMC MBR at Kashid Kopar	12 m wide strip for the full length including 3.6 m wide service road
MBR for VVCMC of 25 ML capacity	Kashid Kopar	5 -6 Ha
Gravity Main of about 1500 mm dia for MBMC	Kashid Kopar to Ghodbandar MBR site	10 m wide strip including 3.6 m wide road for full length
MBR for MBMC of 25 ML capacity	Ghodbandar at about 40 m RL	5-6 Ha

2.8 Water allocation

Raw water will need to be abstracted at a suitable location upstream of existing weir (or new weir) rendering adequate raw water storage. The raw water will have to be pumped and conveyed to water treatment plant located at appropriate location and elevation. The raw water and pure water will have to be lifted by pumping and conveyed through transmission mains to the WTP at its selected location and the MBRs respectively at the service limit of the local bodies. The system shall also include crossings over rivers, creek, railway line and roads.

The allocation of 303 MLD Bulk Water Supply shall be - i) 97 MLD to VVMC and 76 villages (49 villages were merged with VVMC & 27 villages are separate) in the area; 2) 106 MLD to MMRDA's proposed rental housing project (proposed to be in VVMC & MBMC) and iii) 100 MLD for MBMC including MMRDA's special planning areas for Uttan and other 5 villages. The basis of allocation is as follows:

a) **Vasai-Virar Area** – 1) Total quantity as per TOR allocated is 97 MLd for the Vasai-Virar area including 76 villages. Out of above 76 villages, 49 villages are merged in VVMC and separate allocation for remaining 27 villages need to be allotted. 2) Population of 27 villages as per year 2011 census is 60560. Water requirement for these villages is about 15 MLD. 3) Balance 82 MLD is to be allocated to VVMC. 4) 88 MLD shall be allocated from 106 MLD earmarked for rental housing project in Vasai-Virar area

b) **Rental Housing Projects** - Total 106 MLD is earmarked for the rental housing project. The rental housing units are proposed in areas of both ULBs i.e. VVMC and MBMC. i) 137214 Units Vasai-Virar area, ii) 28652 Units in Mira Bhayadar area. It is proposed to allocate 106 MLD in proportion of housing units in two ULBs, as supply allocated for rental housing will be given as bulk supply to the two ULBs. Hence, 88 MLD is allocated to VVMC and 18 MLD to MBMC.

c) **Mira Bhayandar** - total bulk supply to MBMC shall be 118 MLD. Allocation for MBMC including MMRDA's special planning areas for Uttan and 5 villages is 100 MLD. Proportional allocation for rental housing unit is 18 MLD

2.9 Electrical and Power requirements

Electric power supply and electrical equipments are required for raw water pumping station, water treatment plant and clear water pumping station. It shall be necessary to provide substation at raw water pump house site and WTP with clear water pump house site. Estimated power requirement shall be around 4000 to 6000 KVA depending upon the location of RWPS and WTP with CWPS. Maharashtra State Electricity Distribution Co. Ltd. Would supply voltage for the power supply shall depend upon the availability of power from nearest receiving stations.

It is proposed to provide double circuit power transmission lines for reliability of power supply. Metering shall be on H.T side and metering system shall be as per the requirement of Supply Company in separate room. **Operating Voltages -** a) HighTension: Pump motor rating shall be 500 kW to 700 kW, hence operating voltage for motors shall be 3.3 kV or 6.6 kV. b) L.T. load: 3 Phase – 400 Volts. Single phase – 230 Volts. c) Control Circuit Voltage: 230 V a.c., 110 V D.C. for other circuits, 24V D.C. for Instrumentation

2.10 Estimate Project cost

Schedule of rates adopted by Maharashtra Jeeven Pradhikaran (MJP) were considered for **pipeline**, WTP, BPT and MBR. Rates for **tunnel** are determined on basis tendered rate for tunnel in Bruhanmumbai Municipal Corporation area. For pumping machinery, the rates are based on average rate for complete installation of pumping machineries including H.T. substation in respect of few schemes. For **construction of offices**, quarters and road, prevailing market rates are adopted. **Land acquisition**, rates are adopted on basis of local enquiry in the project area. The rates are as under: Area in Mira – Bhayander Rs. 2.4 Crores/ha; Area in Vasai Virar, Boisar MIDC Rs. 1.2 Crores/ha; Kawadas, Suryanagar Rs. 0.25 Crores/ha. Rates for **utilities, power supply** line etc. are based on the broad judgment. **Physical contingencies** at 3% and administrative/ miscellaneous charges at 0.5% are added. 0.5% of cost is added for **capacity building**. The individual cost estimate is given in **Table 2.2**.

Table 2.2 Physical Infrastructure cost estimate

Activities	unit	Quantity	Rate (Rs)	Cost (Rs. Crore)
Survey & Investigation including Geo technical investigation	LS	LS	19620763/-	1.96
Carrying out Environmental impact assessment study	LS	LS	2500000	0.25
Raw water intake including pumping station suitable for assumed 4 (W) + 2 (S) plus space for 2 future pumps	LS	LS	LS	23.25
Raw water pumping Machinery (including substation)	kW	2160.00	60000	12.96
Raw water rising main 2032 mm OD x 12.5 mm thick & cement mortar lineing	Rm	1760	62255	10.96
Water hammer control device for raw water pumping main	LS	1	7000000	0.70
WTP at Surya nagar 342 MLd + Add 10% for facilities for future expansion inlet works, sump & pump house filter house.	MLd	342	1258694.27	43.05
Treated water pumping Machinery (including substation)	kW	1452.00	55000	7.99
Instrumentation, SCADA, Fire detection & IT	LS	LS	55500000	5.55
Treated water rising main 2032 mm OD x 12.5 mm thick	Rm	200	60000	1.20
Water hammer control device for Clear water pumping main	LS	1	3000000	0.30
Break pressure tank (2.5 ML capacity)	LS	2500000	2.87	0.72
Gravity main from BPT to Tunnel outlet 2032 mm OD x 12.5mm thick	Rm	17800	62255	110.81
Tunnel at 37 m depth	km	2.0	600000000	120.00
Gravity main from Tunnel outlet to Junction on NH near Kashidkopar 2032 mm OD x 12.5 mm thick	Rm	40900	62255	254.62
Gravity main from Junction on NH to Kashidkopar MBR 1626 mm OD x 10 mm thick	Rm	1000	39853	3.99
At MBRs at Kashid Kopar				
Vasai Virar City (Total 31 ML capacity)	Lit.	31000000	2.07	6.42
Gravity main upto Ghodbander from junction near Kashidkopar (1626 mm OD x 10 mm thick)	Rm	27000	39853	107.60
MBRs at Ghodbander (Total 20 ML capacity)	Lit.	20000000	2.11	4.22
Pipe line Crossings				
Vaitarna Crossing below bed/Scour level (Open Excavation)	Rm	200	78900	1.58
Tansa Crossing below bed/Scour level (Open Excavation)	Rm	250	78900	1.97
Vasai Creek Crossing (Tunnel)	km	0.75	600000000	45.00
Vasai - Panvel Railway line crossing by jacking & pushing through embankment	LS	LS	5000000	0.50
Minor crossings	No.	LS	2500000	5.00
Approach road at intake, WTP, BPT & MBR's	LS	LS	LS	2.00
Office and residential quarters	LS	LS	LS	3.10
33 kV incoming Power supply (30 km approximately)	LS	LS	LS	16.18
Shifting of utilities	LS	LS	LS	41.00
Road Reinstatement	Sq m	265980	750	19.95

Total	852.82
Add 3% contingencies	25.58
Add 3 % for Consultancy services	25.58
Add 0.5 % Administrative charges	4.26
Sub Total	**908.25**
Add 0.5 % for capacity Building	4.54
Total Cost	**912.80**

Chapter 3

Baseline Environment

Baseline environment information is used in the assessment of impact from the proposed activities in planning and implementation of mitigation measures. Baseline data on various environmental parameters was collected and the same is presented here. As, the pipeline is a linear activity, information on the 100m width of the alignment is considered. However, the regional information on the –

1) Air & Noise environment,
2) Water environment including surface and ground water,
3) Land environment
4) Biological environment/Ecosystem (Flora/Fauna), and
5) socio-economic aspects

were assessed through primary surveys, field monitoring and existing secondary data / information. Integration of these parameters gives an overall perception of positive and negative impacts due to construction of integrated water supply scheme for bulk water supply

3.1 Air Environment

This region has a tropical monsoon climate that borders on a tropical wet and dry climate. Overall climate is equable with high rainfall days and very few days of extreme temperatures. The temperature varies from 22°C to 36°C. In winter temperature is between 12°C to 20°C while summer temperature ranges from 36°C to 41°C. Out of total rainfall, 80% rainfall is experienced during June to October. There are basically three seasons, with a transitional period of about 15 days between each season. **Winter** extends from October to January with the mean maximum temperature of about 28^0 C. and the mean minimum temperature of about 16^0C with relative humidity of about 77-85%. **Summer** season starts from February to May with the mean maximum temperature of about 34^0 C. and the mean minimum temperature of about 26^0 C. with relative humidity of about 60%. **Monsoon rainy season** begins from June to September. The south-west monsoon begins in the first week of June. 95% of the annual rainfall is recorded

during this period. The annual average rainfall is about 2200 mm. During this season, the mean maximum temperature is about 30^0 C. and the mean minimum temperature is about 24^0 C. with relative humidity hovering around 80-85%. The wind direction and speed are determined by temperature and pressure conditions over land and sea. Predominant wind direction is north-west or west. During the monsoon season, the wind direction is north-east or east with a high velocity.

The **rainfall** is usually experienced from the beginning of June to the end of September with annual mean rainfall of 2200-2500 mm. The maximum rainfall is in the month of July averaging to 800 mm. The **humidity** ranges from 49% to 85% with the highest humidity in the month of July. The **wind direction** is predominately from, west and southwest for a major period of the year. The mean wind speed is 16.52 km/hr. The maximum speed varies from 15 to 19 km/hr from June to August. However, the velocity gradually increases reaching its peak in the month of July with directions from the southwest and west. Mean Maximum and minimum temperature and rainfall events of 1950-1980 is shown below.

Table 3.1 Temperature and rainfall events of 1950-1980

Months	Mean Temperature (^{9}C)		Mean total Rainfall (mm)	Mean number of rainy days
	Daily (Min)	Daily (max)		
January	16.4	30.6	0.6	0.1
February	17.3	31.3	1.5	0.1
March	20.6	32.7	0.1	0.0
April	23.7	33.1	0.6	0.1
May	26.1	33.3	13.2	1.0
June	25.8	31.9	574.1	14.9
July	24.8	29.8	868.3	24.0
August	24.5	29.3	553.0	22.0
September	24.0	30.1	306.4	13.7
October	23.1	32.9	62.9	3.2
November	20.5	33.4	14.9	1.1
December	18.2	32.0	5.6	0.4
Annual	22.1	31.7	2422.1	80.6

(Source: India Meteorological Department 1950-1980)

The entire western region MMR is on the western side of the Sahyadri ranges and possesses more or less occupied by hill. Besides agriculture, forests occupy a considerable geographical area in the district, viz., 43.1% which is higher than 33% as prescribed by the national forest convention.

3.1.1 Air quality

Air pollution problems are quite severe in urban area of MMR and are mainly compounded by the transportation sector, industrial sector & domestic fuel consumption. However in rural areas due to large green area the air quality is generally good. The current pipeline project being near the National Highway the contribution to air quality will be from transport sector before, during and operational stages of the project besides the impact of construction activity. As the core transportation sector presently consists mainly of petrol and diesel driven vehicles, the major air pollutants contributed by the automobile exhaust emissions, consist of; Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Oxides of Nitrogen and Sulphur dioxide, Carbon Monoxide etc. Presently many of these air pollutant concentrations are being monitored by the Maharashtra State Pollution Control Board (MSPCB) at some locations in urban area and by the Central Pollution Control Board (CPCB) at some selected important intersections of the city. However there are no sampling stations in this rural area. The baseline air quality was therefore carried out at locations where construction activity for Intake well, Pumping Stations, Water Treatment Plant & MBR are expected there monitoring was done by using high volume sampler The Sulphur dioxide was analyzed using waste and gaeke method and Nox using Jacob and Hochheiser modified method and RSPM by gravimetric method.

Table 3. 2Ambient air quality

Location	Station	SO_2	NOx	RSPM
1	Kawdas (Pick-up zone)	8.50	25.23	63.28
2	Maswan weir	12.08	35.13	56.05
3	MIDC weir	13.03	38.63	64.68
4	Borsheti (Tranportation zone)	8.95	30.43	60.03
5	Manor (Tranportation zone)	12.02	37.13	56.91
6	Ghodbundar (Mira-Bhayandar) (Delivery zone)	16.08	26.30	53.23
7	Kashin Kopar (Delivery zone)	6.58	13.36	44.10

3.1.2 Noise level

It affects the serenity of the environment and poses health and communication hazards. The intensity of noise is measured in decibel (db). The intensity of more than 65 db becomes alarming from pollution point of view. At the construction sites, the intensity of noise usually

will be much higher for which safeguard measures will be adopted so that the noise pollution could be controlled. In order to collect the base line data on noise pollution various landuse pattern were chosen such as hill section, Clear Zone, bridges, Toll naka, Chowk. Noise levels are monitored by using Skypac decibel meter. Noise level monitored along the pipeline is presented in **Table.3.3**

Table 3.3 Noise Levels Monitoring

Sr No.	Chainage No. From	Chainage No.To	Location	Average Reading
1	85200	85100	Ghodbunder Chowk (LS)	75
2	85200	85100	Center point of Ghodbunder Chowk (LS)	88
3	85200	85100	South side of Ghodbunder Chowk (LS)	75
4	85200	85100	North side of Ghodbunder Chowk (LS)	85
5	85100	85000	Ghodbunder bridge starting point	85
6	84800	84700	Bridge Center point	86
7	84500	84400	Bridge End point	91
8	80400	80300	Hill zone	87
9	80300	80200	Hill zone	91
10	78100	77900	Kaman greek bridge	88
11	77900	77800	Center point of bridge end point	88
12	77800	77700	Bridge End point	84
13	77400	77300	Juchandra Railway Bridge	93
14	76200	76100	Bapape Chowk Naigoan (Road)	80
15	73600	73500	Chincholi Chowk Bhiwandi	82
16	72100	72000	Vasai naka hill zone	83
17	70100	70600	Tungareshwar chowk vasai	80
18	69800	69700	Tungareshwar naka	80
19	67400	67300	Vasai naka	82
20	66200	66100	Nalasopara chowk	84
21	62900	62800	Wras naka	83
22	61900	61800	Vajrehwari naka	88
23	59400	59300	River bridge starting point	89
24	58700	58600	Khaniwadi chowk	58
25	58600	54500	Khaniwale toll plaza	60
26	54500	50400	Darshet Village boundary	54
27	50400	46200	Vandri lake road	54
28	46200	41800	Varai Naka	48
29	41800	37500	Kude Village	49
30	37500	31800	Padaspada	53
31	31800	26800	Kumar Park Hotel	52
32	26800	22800	Boisor road chillar fhata	60

33	22800	16900	Medwandkhind	58
34	16900	12600	Sonte Village	54
35	12600	8500	Tawa Village	50
36	8500	4600	Varoto Village	55
37	4600	100	Kawdas	52

Noise Map attached in Volume II as Annexure - I

3.2 Water Environment

VASAI-VIRAR CITY MUNICIPAL CORPORATION (VVCMC)

Vasai Virar city is adjacent to the Mumbai municipal corporation limits. At present water is supplied to the four Municipal areas nearly of 33.00 MLD from the Usgaon Scheme (26 Km from city), Papadkhind dam and 0.9 MLD from Pelhar Dam (12 kms from city). The rural area gets water supply of 7.00 Mld from Pelhar Dam. Water supply of nearly of 30.00 Mld. is being supplied through tankers from various sources to the sub-region population (15.00 Mld to four Municipal areas) which include wells, tanks and bore wells. There are 34 tube wells at Vasai and 15 tube wells at Virar. In addition, there are 275 bore wells at Vasai. Besides, there are about 20 private tube wells (10 to 35 m. deep) at Vasai and around 220 private tube wells at Virar. The over drawal of water from underground is resulting into the ingress of salinity over the years. As a result potability of water is adversely affected.

TABLE 3.4: PRESENT SOURCE OF WATER SUPPLY VVCMC

Area	Usgaon Scheme	Pelhar Dam	PapadKhind Dam	Surya Dam	Well/Tanker Water Supply
Vasai Town	2.50 Mld	-	-	10	-
Navghar-Manikpur Municipal Area	4.00 Mld	3.50 Mld	-	25	6.00 Mld
Nallasopara Municipal Area	4.00 Mld	3.50 Mld	-	35	9.00 Mld
Virar Municipal Area.	14.00 Mld	-	1.50 Mld	30 Mld	-
Green Zone (East) (Rural)	-	7.00 Mld	-		2.00 Mld
Green Zone (West) (rural)	-	-	-		13.00 Mld
Total existing water supply	24.50 Mld	14.00 Mld	1.50 Mld	100 Mld	30.0 Mld.

Table 3.5 Water Demand as per Population Projection

Year	Population (Lakhs)	Present Water Supply (MLD)	Water demand in MLD	Demand Supply Gap
2001	7.02	130		
2011	13.07	130	235	105
2021	22.23		400	270
2031	33.34		600	470
2041	41.67		750	620

Mira Bhayandar Municipal Corporation (MBMC)

Mira Bhayandar city is adjacent to the Mumbai municipal corporation limits. The population of Mira Bhayandar in 1981 was 6,732. From 1987-88, Maharashtra Jeevan Pradhikaran supplied 21 MLD Water. Now Mira Bhayandar municipal corporation limit covers around 79.40sqkm and occupies 5,20,301 lakhs of people (census 2001).

To fulfill the water requirements of increasing population, 10 MLD extra water pipeline was sanctioned from 1995-96 onwards. Accordingly, 110 crore project was carried out under Maharashtra Jeevan Pradhikaran for 100 MLD additional water supply. This project was implemented from 2002. The project is now looked after by STEM Pradhikaran. The present water supply to MBMC is

STEM Pradhikaran - 86.0 MLD
BMC - 0.5 MLD
The MIDC covers water to Mira road – Shanti-Nagar area where 50,000 people consumes approximately 5 MLD water. The project is transferred under MBMC.

Table 3.6: Water Demand as per Population Projection

Year	Population (Lakhs)	Present Water Supply (MLD)	Water demand in MLD
2001	5.20	86	72.8
2006	7.28	86	101.92
2011	9.83		137.62
2021	14.74		206.36
2031	22.11		309.54

As the population is assumed not to go beyond 22 lakhs due to land constraint, the water demand is calculated 309.54 MLD.

3.2.1 Rivers

The two main rivers, which join the sea on the West coast, are Vaitarna and Ulhas. The Vaitarna River rises in the hills near Trimbak in the Nashik district and flowing South wards takes a Westwards turn entering Thane district at Vihigaon in Shahapur tahsil. It is further passes across

northern boundary of Shahapur tahsil to enter Wada tahsil near Nishet village and then taking East-West course through the middle of Wada tahsil. It enters Palghar tahsil near village Vasuri (Bk.) and runs in North-West direction upto Manor, where-from it turns South-West and Southwards upto village Navghar forming Vaitarna creek at the south of Palghar tahsil. The important tributaries of Vaitarna are:- 1) Pinjal, which rises in the mountains in the South of Mokhada tahsil, joins it at Aleman village in Wada tahsil. 2) Daherja, which rises in the mountain in Jawhar tahsil, joins it at village Durvas in Palghar tahsil. 3) Surya, which rises in the mountains in Mokhada tahsil and taking south West and southwards course joins it near Sakri village in Palghar tahsil. 4) Tansa which rises in the mountains in Shahapur tahsil and joins it near Chirman village in Vasai tahsil. It is navigable upto 25 km from the coast.

All along the coast there are number of small creeks, in which tidal waters flood upstream and inundate much low ground; human interference in many cases has helped in converting them into mud flats such as Bhiwandi, Chinchani, and Dahanu creeks. The Sopara creek was an important artery of sea-traffic bringing Arab dhows and Greek sailing vessels to Sopara port. The survey shows all existing site conditions and features (drains, watercourses, land boundaries etc.) such that the effects of any work proposed under the project may be identified.

3.2.2 Surface Water quality

Water quality at the intake points (Surya dam and weir) and other surface water bodies near construction sites (treatment plants), pipe alignment, pump houses etc. were carried out. The water quality monitoring of the source and the storage points need to be carried out. The area is free of industrial pollutants as the industrial base is none existent. The water quality results shows (**Figure 3.7**) that all the parameters (physical and biological) are within the permissible limit of Drinking Water Standards (IS: 10500), except the bacteriological parameters. The discharge in the river is more in monsoon season and the water quality is also better as compare to post monsoon season.

Table 3.7. Water quality analysis

Parameter	Surya dam			Maswan intake			MIDC weir		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
pH	8.7	8.3	8.5	8.2	8.4	8.3	8.2	8.8	8.5
Dissolved Oxygen,	6.9	7.2	7.05	6.9	7.3	7.1	5.8	7	6.4
Biological Oxygen Demand, mg/l	3	3.8	3.4	3	3.8	3.4	3.6	7	5.3

Chemical Oxygen Demand, mg/l	20	24	22	20	28	24	28	128	78
MPN	-	-	-	-	-	-	-	-	-
Total Coliform	-	-	-	-	-	-	-	-	-

(Source: Maharashtra Pollution Control Board)

Table 3.8. Physical and Biological parameters

	Acceptable	Kawdas	Maswan weir	MIDC weir	Borshetti
Physical					
pH	7 to 8	7.1	7.3	7.4	7.4
Turbidity (NTU)	1	1.8	2.4	2.6	3.2
Dissolved Oxygen, mg/l		5	4.7	4.8	217
Total hardness mg/l	200	156	223	217	201
Total suspended solids mg/l		20	35	41	78
Total Dissolved Solid, mg/l	500	165	232	237	221
Biological					
MPN 10/100ml		10	21	18	16
E Coliform		+ve	+ve	+ve	+ve
F coli		+ve	+ve	+ve	+ve

3.2.3 Ground water

This region is covered by Mesozoic and early Tertiary volcanic rocks, characterized by a thick sequence of a multi-layered, hard, compact basalt (Deccan Trap), often crossed by dykes and sills and intersected by deep faults. Its thickness is around 2000 meters in the Bombay area, The most promising groundwater conditions are in depressions; stream banks; inter-lava flows; in areas where basalt is intersected by dykes; and wherever the rock is deeply weathered or highly fractured. Ground water development took place in the past 40 years with nearly two hundred thousand of low yielding boreholes drilled by the government and by the private sector. In addition, there are several hundred thousands of large diameter hand-dug wells used mainly for irrigated agriculture. The high density of these water sources indicates the existence of a huge shallow groundwater body actively recharged during the monsoon time by direct rainwater percolation and by infiltration from small and large water courses.

The ‘Pahoehoe’ flows consist of highly vesicular bottom layer having closely spaced horizontal joints but the thickness is generally less. The vesicles are generally filled with secondary minerals and green earths. In such cases, they do not serve as aquifer. However, such vesicular zones are weathered in most part of the area, thus, making them moderately permeable. But if, vesicles are not filled, they act as highly permeable aquifers. The simple and compound

"Pahoehoe" flow comprises a basal vesicular zone, middle relatively massive portion followed by a vesicular top. The vesicles of "Pahoehoe" flows are generally not interconnected and thus there is a variation in water holding capacity from the base to the top of the flow.

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. Generally the phreatic aquifer range down to depth of 15 m bgl. The water bearing zone down to depth of 35 m bgl forms the semi confined aquifer and below this deeper aquifer down to depth of 60 m bgl is observed. The yield of the dugwells varies form 10 to 1000 m3/day, whereas that of bore wells ranges between 50 and 1000 m3/day. It is expected that the potential of deeper aquifers would be much more limited as compared to the unconfined/phreatic aquifer.

Aquifers are generally shallow, represented by weathered and fractured basalt located mainly in depressions, riversides, and flat areas. Deeper aquifers may occur; they are in most cases connected with inter-lava flows and exceptionally with granular rock type, faults and dykes. The transmissivity, storage co-efficient and specific yield of the aquifer varies between 20-325 m^2/d; 0.005-0.04 and 0.5-7% respectively. Groundwater availability has increased in many places thanks to the construction of numerous "percolation tanks" and other water holding structures. Much attention is now being paid to recharge augmentation by introducing appropriate technology for watershed management. In several areas, low yielding boreholes and seasonal open hand dug wells located in hard rock terrain are now supplying permanent water for human consumption and for irrigation of cash crops. The importance of hydro-fracturing and borehole blasting to increase storage capacity of poorly fractured basalt is gaining momentum in region. The intensive groundwater development of the past decades has surely alleviated the widespread.

3.3 Land Environment

The preliminary information regarding topography of the study area, location aspects of site, land usage pattern, development pattern and landscape features within study zone were collected through reconnaissance survey and review of available data & literature.

- Delineation of land use pattern and practices in the vicinity of water pipeline including establishment of land holdings through remote sensing in the area.
- Prediction of impacts on forests
- Estimation of changes in flora and fauna in the area.
- Prediction of loss of agricultural production if any
- Design of a scheme for rehabilitation of displaced population if any

From the steep scarps of the Sahyadri in the-east, the land of the Thane district falls through a succession of plateaus in the north and centre of the district to the Ulhas valley in the south centre. These lowlands are separated from the coastal fiats by a fairly well-defined narrow ridge of hills that runs north-south to the east of the Thane creek, maintaining a remarkable parallelism to the shores at a distance of about six to ten kilometres from the shores. A number of isolated hills and spurs dot the entire district area so much so that the district as a whole in its aspects is hilly.

A number of spurs shoot off from the Sahyadri westwards into Thane lowlands and plateau. Most of them are narrow, rarely more than two kilometres wide, with steep slopes on either side and often rising to considerable levels, rather abruptly, above the floor level of the plateau. Many of them carry on their crests, small plateaus, often forest-clad and of difficult access. This type of a hill range country, with intervening deep gorges of stream valleys, is at its best seen in the central parts of Wade and Jawhar talukas; it presents a memorable picturesque landscape, clothed in green soon after the monsoon.

Besides the main range and the western spurs of the Sahyadris, a number of hills and isolated peaks dot the whole countryside. The long axes of most of these ranges run north-south; they appear to be the erosion remnants of dyke ridges which have withstood the denudation processes

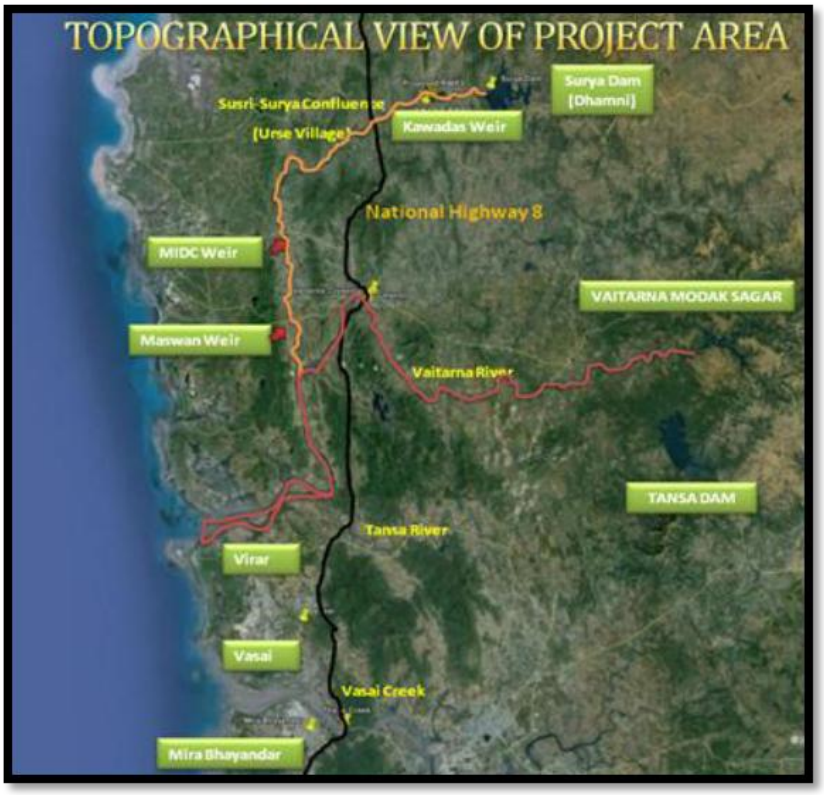
that have planed the rest of the region. None of these outlying spurs and ranges rises higher than the main Sahyadri.

Coastal range: The most rugged terrain of the district is a belt about 15.25 kilometres broad that runs parallel to the coast at a distance of 15-20 kilometres from the shore. In the south of these tracts are the hills of Salsette island that form the core and rise to the highest elevation of 462 metres at Kanheri and Avaghad and further north in Kamandurg and Tungar hills of Bassein.(Bassein is now known as Vasai.) North of Tungar is a duster of hills of which Baronda, Jivda and Nilemore are the most marked peaks and on an offshoot of Takmak range to the east of Tense are two heights known as Kaland Dhamni. To the north-east across the Tense rises the steep peak of Takmak with its two fine basaltic horns.

Parallel to this western coastal range that, runs from Kanheri to Takmak, about fifteen kilometres further east, runs another line of hills front Bhivandi, north-west almost right up to the Manor on the Vaitarna and is breached into two by the Tansa river. To the west, between the railway line and the Surya river, the unbroken chain of hills whose chief peak is Kaldurg, stretches about twenty-five kilometres parallel to the coast carrying on its top three hill-forts: Tandulwadi at the extreme south, Kaldurg opposite to Palghar railway station and Asava near Boisar. In the south-west of the Palghar taluka is the Pophli hill. The coastal range continues north into Dahanu taluka as far north as Vasa ; here the highest peak is Barad. This range slopes relatively gently on the west face but falls sharply to the east with steep slopes and sheer rocky cliffs. North of Varoli, there are only a few hills of moderate heights, the chief of them being Indragad in the extreme north, Near Mokhada and Jawhar there are few hills of considerable size of which the Mahalaxmi and Gambhirgad are the highest

Satellite image showing the project area and the reservoirs in the western region is presented below –

Satellite image showing the project area and reservoirs in western region



3.3.1 Agriculture

Settlement pattern of this sub-region is such that larger villages are located along the coastal belt to the west of the railway line. The villages in this belt have good agricultural, horticultural and fishing base and therefore, they are distinct from the villages in the eastern part of railway line situated along and near the National Highway. Population in coastal belt is mainly engaged in agriculture, horticulture and fishing activities i.e. in primary sector, whereas, that residing near the suburban railway stations viz. Virar, Vasai-Road and Nallasopara is mainly engaged in tertiary sector. The Vasai Virar Region is a narrow coastal belt fringed with dense thickets of cocoanut groves with a near pastoral ambience. Although on Arabian coast this land known as ‘uthalpat’to the locals in richly fertile with fresh, sweet water sources. This area is famous for Bananas & beetle leaves. Strip of land along Arabian Sea coast known as ‘Kharpat’ runs from Chikkal-Dongri in North to Naigaon in the south. Railway line divides this belt which is hardly 3 to 4 Ft. above sea level. Further east is ‘Junglepat’ the rising hills of the Western Ghats with two thirds of the area covered by Forest and inhabited by tribals.

There are two agricultural seasons in this district, viz., kharif and rabi. However the district has a negligible area under cultivation inrabi season. Kharif is the main season of this district and stretches from June to October. Paddy is the principal crop while Ragi, Kodra, Vari, Kulith, Udid are also grown in this season. Owing to the inadequate irrigation facilities, most of the crops are dependent on monsoon. The first showers of rain in June help the cultivators to proceed with sowing of paddy for its seedlings. Cultivators begin to prepare the soil for transplanting the paddy seedlings in the month of July. Harvesting of paddy commences in the last week of October and is continued till the end of November. Rabi season commences from October and continues till the end of January. Pulses such as wal and gram are sown in October and harvested in February-March. Rice in summer is grown in very small area. Vegetables are grown throughout the year as when the irrigation is available.

3.3.2 Soils

The soils that are present in the region are - black soils, occurring on plains, light colored coarse soils occupying hill-slopes (also known as *varkas*) and black soils along the coast in the district. The coastal soils are further divided into sweet lands supporting the garden crops and the khar or saline lands which grow coarse varieties of paddy after partial reclamation. The soil of the district in general is almost neutral in reaction, free from calcium carbonate and is sandy in texture. The colloid complex is low in bases and divalent ions account for more than 90 per cent of the total exchangeable bases. The soil is fairly well supplied with nitrogen but is low in phosphate and potash contents.

Major portion of the project site as per the above map falls under Category 063 which is described as - Shallow somewhat excessively drained. Loamy soils on moderately steeply sloping dissected hills/narrow valleys with severe erosion and moderate stoniness; associated with shallow somewhat excessively drained clayey soils. The taxonomy can be described as Loamy-Skeletal mixed, isohyper-thermic, shallow, ustorthents. Clayey – Skeletal mixed, isohyper –t hermic, Shallow and typinc Ustorthents.

The Geo Technical survey has been conducted at Surya Nagar. The details of the survey showing soil profile is shown Table 3.2.

Table 3.9: The visual classification of soil profile and description

Borehole	Depth level	Description
1	0.50m -6m	0.50m - Brownish silty soil with gravel
		1m - 1.50m -Very stiff yellowish sandy clay
		1.50m -3.50m- Hard Brown Sandy Clay with gravels
		3.50m-4.50m-Highly weathered grey basalt
		4.50m-5.50m-Highly weathered brown basalt
		5.50m-6.50m- Slightly weathered grey basalt
2	0.50m-13.50m	0.50m - Brownish silty soil with gravel
		0.50m - 3m -Very stiff brown sandy clay
		3m -4.50m- Medium dense brown silty sand with gravels
		4.50m-7m-Medium dense brown silty gravels
		7m-8m-Very stiff brown sandy clay with gravels
		8m-10.50m- Very stiff to hard brown sandy clay
		11m-13m-Hard brown clay
		13m -13.50m- Very Stiff brown clay
3	0.50m -11.50m	0.50m - Brownish silty soil with gravel
		0.50m - 4.50m -Stiff brown sandy clay
		4.50m -6m- Stiff brown silty clay with gravels
		6m-7.50m-Stiff brown silty clay
		7.50m-11.50 m-Highly weathered brownish grey basalt
4	0.50m-10m	0.50m - Filling Material
		0.50m - 3m -Stiff brown sandy clay
		3m -10m- Very stiff brown sandy clay
5	0.50m-10m	0.50m - Filling Material
		0.50m -7.50 m -Medium dense brown sandy clay
		7.50m -10m- Stiff brown sandy clay
6	0.50m-10m	0.50m - Filling Material
		0.50m -2 m -Loose brownish grey silty sand
		2m -7.50m- Very stiff brown sandy clay
		7.50m-9m-Brown sandy clay
		9m-10m-Hard brown sandy clay
8	0.50m-5m	0.50m-1.50m - Moderately weathered green basalt
		1.50m -2.50 m -Silty weathered green basalt
		2.50m -5m- Fresh grey basalt

10	0.50m-7m	0.50m - Yellowish brown silty sand with gravels
		0.50m -2 m -Medium dense brown silty sand
		2m -3m- Highly weathered grey basalt
		3m-4m-Moderately weathered grey basalt
		4m-5.50m-Slightly weathered grey basalt
		5.50m-7m- Fresh grey basalt

The soil all along the coast and particularly in parts of Dahanu, Palghar and Vasai talukas, is blackish and contains sand. It is very suitable for garden crops. Towards the east the soil is red and brown. It is not very deep but is suitable for rice. Further east on the hill-slopes, the soil is poor and is used only for growing grass and coarse grains, *viz., nagli* and *vari.* In the valleys there are patches of black soil in Bhiwandi, Kalyan, Mokhada and Shahapur talukas where rice is grown in ample quantity.

For agriculture purpose, there are three classes, *viz.,* coastal soils, mid-plane soils and **varkas** type soils. Coastal soils are further sub-divided into **bagayat**, sandy loam and salt paddy soils near creeks. Mid-plane soils are mainly derived from the trap rock and are sub-divided into late soils and mid-late soils. *Varkas* soils are mostly found in the far eastern part of the district.

3.4 Biological Environment

3.4.1 Flora and Fauna

The flora/fauna that are reported from Tungareshwar Forest, Jowahar Forest, mangroves habitat, Sanjay Gandhi national park, and Virar. The common species found are as follows:

Flora - Kadamba, Teak, Karanj, shisam, and species of Acacia, Ziziphus, Euphorbia, flame of the forest, red silk cotton and a number of other varieties of flowers. Karvi or Karvy, a flowering plant that flowers once in seven years, can be found in the Park. The utility trees and plants found in the Thane forests, in order of their importance, are : - **Teak (Tectona grandis)** is used in buildings, industries, furniture-making etc. **Ain (Terminalia tomentosa)** is tall, and durable and hard wood, is used for building and fuel. The bark is much valued in tanning and its sap yields a gum which is largely eaten. **Khair (Acacia catechu)** is a valuable tree both for timber and fuel. **Apta (Bauhinia racemosa)** is a small fibrous tree whose leaves are used for making cigarettes. **Hed (Adina or Nauclea cordifolia)** is more than 35 feet long. Due to their durability

in water and length, the logs are much prized for fish stakes. **Kalamb (Stephegyne or Nauclea parvifolia)** is used like*hed* for making fish stakes. *Bibla* (*Pterocarpus marsupium*) is a large tree yielding gum. **Palas (Butea frondosa)** is not used much for building. Its flowers yield a dye and the roots, a fibre. A watery fluid gathered from its roots is considered a cure for fever, and its seeds, for worms. **Karvi (Strobilanthus grahamianus**) bears a cone-shaped, mass of calices from which beautiful blue flowers appear. After the flowers fall, the cones become covered with a sticky exudation called *mel.* The seeds remain in the cones till they become dry and fall out. The stems are largely used as wattle for huts and cottage. **Dhavada (Anogeiessus latifolia)** is a valuable fire-wood tree producing a gum. Besides fuel, its strong and tough wood is used for cart axles, poles and also in cloth printing. The leaves yield a black dye and are usedl in tanning. **Savar (Bombax malaburicum)** is the well-known silk cotton tree has very light wood which is hollowed for canoes and water troughs. It is used as tinder.

In the project area of 8 metres from highway in the ROW of State & National Highway there are no rare & endangered species of economic significance which require management.

Fauna: The forest cover provides the ideal habitat for many wild animals. Chital (or spotted deer), Rhesus Macaque and Bonnet Macaque are some of the wild mammals that can easily be spotted roaming inside the park. Other large mammals found in the park are: Black Naped or Indian Hare, Muntjac (Barking Deer), Porcupine, Asian Palm Civet, Chevrotain (Mouse Deer), Hanuman or Gray Langur, Indian Flying-fox, Sambar Deer and Leopard. One can also spot hyena or four-horned antelope. 172 species of butterflies has been reported here, of which the spectacular ones are Blue Mormon, the phenomenal artist of camouflage the Blue Oak leaf, the bright jezebels and Large Yellow and White Orange tips, Tigers, Egg flies and Sailers.

Avian Fauna : Some of the birds one may see in the park are: Jungle Owlets, golden orioles, racket-tailed drongos, minivets, magpies, robins, hornbills, bulbuls, sunbirds, peacock, and woodpeckers. Migratory and local birds such as paradise flycatcher and various species of kingfishers, mynas, drongos, swifts, gulls, egrets, and herons have also been spotted.

In the project area of 8 metres from highway in the ROW of State & National Highway there are no rare & endangered species of economic significance which require management.

3.5 Socio-Economic Environment

The 27 villages along route of the pipeline have been identified. The land and existing structures in the 8 metres ROW that may be affected during construction have been identified along the route of the pipeline through survey. The details are given in Annexure II. These can be easily rebuilt/ replaced after construction. However R&R Policy will have to be followed.

List of Villages

Sr. No.	Name of Village	Sr. No.	Name of Village	Sr. No.	Name of Village	Sr. No.	Name of Village
1	Sasunaghar	8	Pelhar	15	Bhoerale	22	Chillar
2	Juchandra	9	Shirshad	16	Dhekale	23	Wade
3	Bapane	10	Mandvi	17	Warle	24	Somte
4	Kolhi	11	Kashidkopar	18	Kude	25	Tawa
5	Chinchoti	12	Kunkwade	19	Halode	26	Varoto
6	Sativali	13	Bhativali	20	Durvesh	27	Veti
7	Waliv	14	Sakwar	21	Awadhan		

The vacant land in the Surya Nagar is proposed to be used for WTP & pumping station. However in Surya Nagar where WTP, Pumping station are proposed to be located there are at present buildings of school, Community Center, Ladies Hostel which are not in good condition and also not fully utilized. Although these installations are not proposed to be demolished as community social service it will be beneficial if these installations are reconstructed.

Fig 3.1 Socio Economic Environment

1 Road side shanties and temporary parking

2 Bushes and mango tree

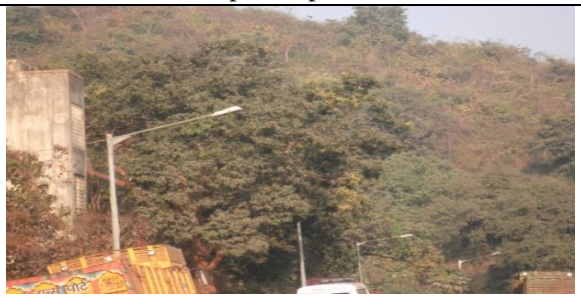
3 Hill cuttings and shrubs

4 Bridge crossings

5 Small scale establishment

6 Electric and Telephone poles

7 open areas



8 Tree cover

3.5.1 Archaeological Locations & places of Worship

There is only one small temple and compound wall of other temple in the ROW. There are no Archaeological Locations within project area.

Landuse Plan Plan showing land use plan of proposed pipeline alignment **(77 Maps)** attached in **Volume II as Annexure - II**

Chapter 4

Environmental Impacts and Mitigation

Environmental Impact Assessment focuses primarily on impacts over the natural or biophysical environment (such as effects on air and water quality, flora and fauna, noise levels, climate and hydrological systems). The effects on 1) biological diversity, 2) soil, water, air, climate and landscape, 3)use of land, natural resources and raw materials; 4) protected areas and designated site of historical and cultural significance, 5) heritage and 6) livelihood, life style and well being of project affected people are included. EIA should be considered as an *investigation into*, rather than a *determination of impacts* (Holling 1978). At present, an EIA is one of several considerations leading to a decision making process to implement a proposed action. Studies provide an organized approach for predicting these impacts. It can aid in identifying data needs and planning special studies and evaluation of mitigation measures that will minimize the environmental impact. Further it provides a summary form for public participation. The impact analyses are required to ensure compliance with the spirit and intent of MoEF

An Environmental impact is defined as any change in the physical-chemical, biological, cultural and/or socioeconomic environmental system that can be attributed to human activities relative to alternatives under study for meeting a project need. Impact identification is to take all the important environmental / project impacts and interactions and make sure that indirect and cumulative effects which may be potentially significant are not inadvertently omitted.

4.1 Project activities

The water supply system envisages abstracting raw water from the river Surya at suitable location, treating the water by adopting appropriate process in water treatment plant and transmitting to master balancing reservoirs to be located at outskirts of the two ULBs. 305 MLD water from the weir is pumped and transported to the Water Treatment Plant. Treated water is dispatched to the Mass Balancing Reservoirs for storage and distribution to allocated members.

	Purpose	Area	Activities
Land requirement	Pumping station	1 ha.	Leveling, foundation requirement, approach roads
	Water Treatment plant	20 ha.	
	MBR @ Kashid Kopar	5 ha.	
	MBR @ Ghodbandar	5ha	
Pipeline	Raw intake to WTP	2.00 km	Trenching (5 X 5 X m)

	Gravity transmission line	89.00 km	& sealing
Tunnel	Land tunnel at Medhwan khind	2.1 km	Usage of Tunnel Boring Machine
	Ulhas Creek crossing	0.750km	
River crossing	Tansa & Vaitarna rivers		Trenching & sealing

The existing land use will not be changed due to this project. But the temporary impact on land is expected during the construction phase. During construction the area required for the project would be cleared for laying pipeline may result in – 1) removal of trees along the pipeline alignment; 2) river crossing; 3) effect on Forest area along the route, 4) Water bodies required to be crossed, 5) Villages nearby, 6) Tunnels / bridges to be constructed and Area of Intake & pumping station, WTP, BPT, MBR etc where construction activity will be undertaken.

Various land cover and utility that are observed along the pipeline is shown in **Figure 4.1**.

The construction impacts are primarily on land, human habitats, farmlands, water bodies and streams, canals and highways. Temporary removal of Structures during construction phase is shown in **Table 4.1** and Removal and transplantation of trees in **Table 4.2**. As a general project planning philosophy, the consultants shall endeavor to locate the project critical components on lands and areas currently in physical possession of the government departments, VVMC and MBMC. All possible efforts will be made to align the transmission lines along the Major District Roads and national Highways within their ROW. During pre-construction and construction phase of the project, construction related activities shall be preferably restricted within project ROW.

Table 4.1 Temporary removal of Structures during construction phase

Structure	Affected
Boards	112
Dhaba	68
Shops	162
Compound walls	376
Bus stops	92
Garage	24
Electric poles	40
Huts	75
Petrol pump	16
Street lights	44
Tabela	2
Toilets	4
Total	1015

Fig 4.1 land cover and utility along the pipeline

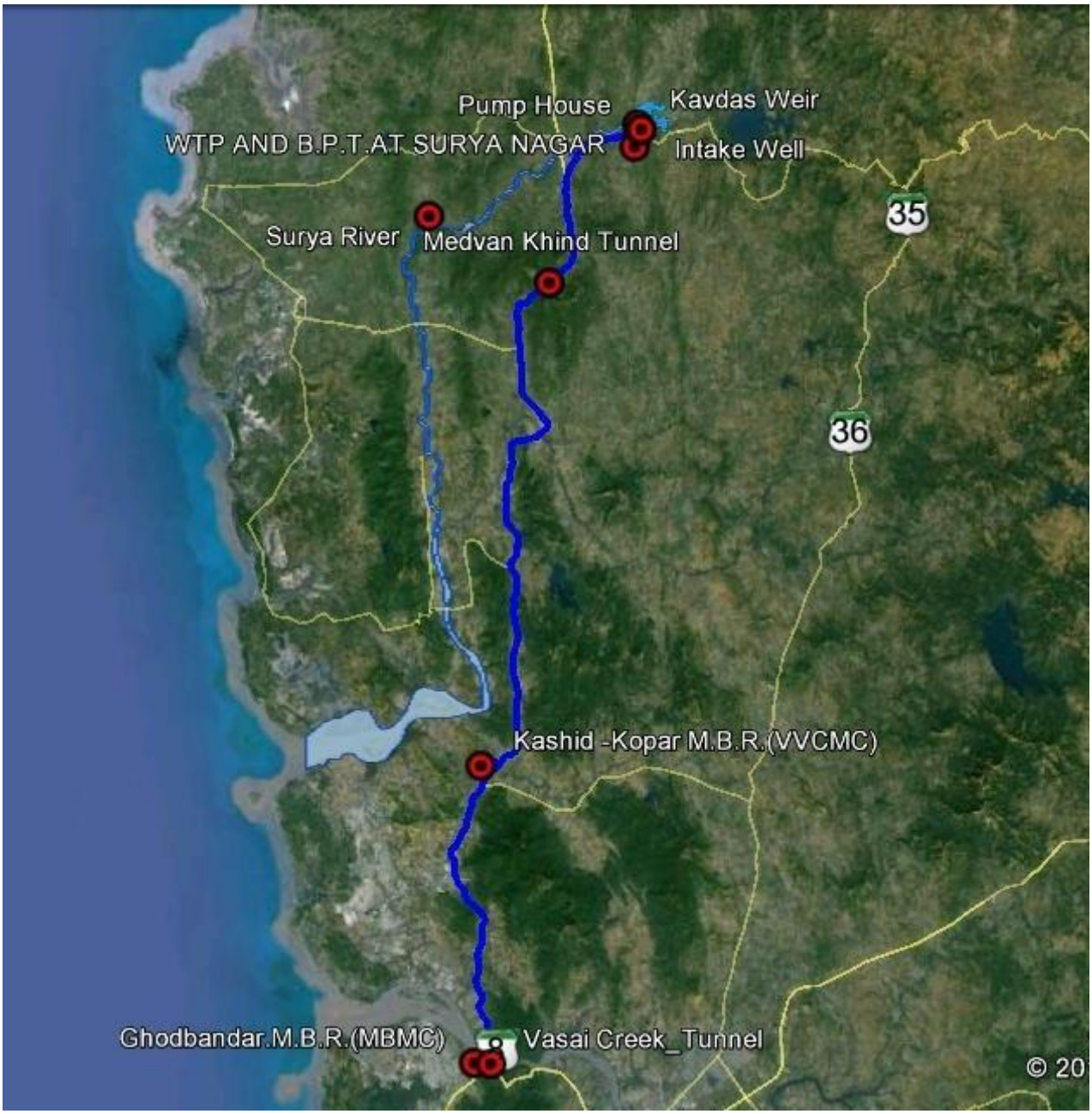


Table 4.2 Removal and transplantation of Trees

Tree type	Qty
Babool	40
Taad	6
Mango	1
Neem	6
Peepal	6
Badam	1

Sagwan	10
Nilgiri	3
Patches tree	108
Unidentified trees	295

Permission and clearances required from following Agencies will be taken from 1) NHAI for taking pipeline through their RoW, 2) Forest department, Government of Maharashtra for clearing of trees coming in pipeline route Compensatory Tree Plantation Plan shall be submitted to them, 3) Maharashtra Coastal Zone Management Authority for crossing the Vasai Creek if mangroves are affected and 4) Irrigation department for WTP location at Surya Nagar.

4.2 Land Environment

91 km of pipeline need to be buried and covered. The cut and fill method will be used. There are two Tunnels & 121 Underpasses (including small bridges/ nallas) proposed to be constructed during the pipeline installation. The details are as under. The excavated material generated in the above construction will be reused to maximum extent and remaining will be disposed off.

Discussions above shows that this is not River Valley project which involves construction of dam and hence there is no submergence of land. There is no impact due to irrigation induced salinity & water logging, soil erosion & inundation of mineral resources.

4.2.1 Tunnel crossing - National Highway

Size of gravity main crossing NH is 2032 mm diameter. It is proposed to provide tunnel of suitable size such that the pipeline can be laid in the tunnel. Considering 2032 mm diameter of pipeline, 450 mm saddle at bottom of pipe and requirement of about 800 mm for air valve, minimum size of tunnel required works out 3282 mm. Considering the margin, size of tunnel is proposed 3500 mm. The tunnel shall be horse-shoe shaped. Tunnel boring machine is proposed to be used.

4.2.2 River and creek crossing

Vaitarna River will be crossed by providing pipeline 5 m below the bed level / scour level of river by doing open excavation. Pipe will be encased in rich concrete in river section. Open excavation is feasible and economical option.

Tansa River crossing is by providing pipeline 5 m before the bed level / scour level by doing open excavation. Working is to be restricted in low tide period. Pipe will be encased in rich concrete in river section. Open excavation is feasible and economical option.

Vasai Creek crossing is proposed to provide tunnel for crossing which will be feasible and less time consuming. Vasai Creek Bridge is having exact length of 486.93 Mtrs. and two parallel bridges having width of 10 m each total width is 20 m. The tunnel is proposed on the west side of bridge nearly 40 m away from bridge having proposed dimensions of 2.0 m. and proposed length is 700 m below 6m in hard rock. Bathymetric Survey has been therefore conducted about 1000 m on left side of bridge and 300 m right side of bridge along the creek to finalize exact location.

Fig 4.2 Vasai Creek Crossing

There is major pipeline crossing at Vasai Creek where the width of river is around 500 mtr. This necessitated conducting a bathymetry survey of the river/ Creek bed to identify the appropriate location of the Tunnel for crossing Vasai Creek. A Vasai Creek bathymetric chart is the

submerged equivalent of an above-water topographic map at Vasai Creek NH-08 Bridge. These Bathymetric charts of Vasai Creek are designed to present accurate, measurable description and visual presentation of the submerged terrain and under water land profile.

Vasai - Panvel **railway line crossing** will be done by jacking and pushing method through embankment. Other minor crossings will be executed laying pipeline below the bed level / ground level by doing open excavation which will be feasible and economical. The pipe sections shall be encased in rich concrete.

Major impact on land environment due to implementation of Surya water supply project will be because of the quantum of earthwork involved in the construction phase, the sub-grade soil is residual soil over lying weathered basalt at shallow depth.

During **operation phase** of the project, the soil erosion does not take place, as the embankments and cut sections will be protected by constructing retaining wall. And hence during operation phase, the impact may become insignificant.

Mitigation Measures

- The quantity of sub-stratum removed during building foundation will be used for backfilling to bring the entire plot to a formation level of 1 ft above road level
- Construction related activities shall be restricted within the proposed project site during pre-construction and construction stage.
- Care should be taken to ensure that the construction workers camp does not disturb the surrounding land use.
- For siting of contractors' facilities and yards select land areas wherein minimum conversion of land will be required from the present land use
- Squatter development along the project shall be strictly avoided by proper regulation and vigilance.
- Debris generated due to dismantling of existing pavement/structures shall be suitably reused in proposed construction. Un-utilizable debris shall be suitably disposed either as fill material or at dump locations authorized by MMRDA and or as directed by

engineer. Care will be taken that the material does not block natural drainage or contaminate water bodies.

4.3 Air Environment

Airborne emissions are generated by combustion of fuel in vehicle engines. The main source of emissions during operation will be from fuel combustion in vehicles approaching and passing through the tunnel and trenching. Emissions from vehicles in the tunnel will be collected by the ventilation system and emitted as point sources via the ventilation shafts at each end.

The principal air quality concern during construction will be dust. Impacts arising from dust generation and deposition will be minimized and managed through the use of good construction practices and procedures. Short term impacts could occur at slightly greater distances (40-70 metres) when unfavorable meteorological conditions combine with peak traffic flows.

Construction heavy good vehicle traffic and construction equipment will contribute less than 1% to the traffic flow on the European side on average. As a result emissions may temporarily and locally be increased by 5%. The impact on ambient air quality will be small. For the Asian side, the projected traffic will have no significant effect on traffic related air quality on the D100.

Construction Phase

The deterioration of air quality depends on the construction practices that would be adopted at the site. Air quality could be deteriorated due to: 1) Exhaust emissions from various construction equipment, vehicles and engines, 2) Fugitive dust emission from construction areas, operations and traffic allowed carriageway and 3) Gaseous emissions from on-site trolley mounted, mobile asphalt/ bitumen mix equipments. They are expected during – 1) Clearing and grubbing, 2) On site storage and transport of waste, 3) Providing and laying concrete, 4) Construction activities and 5) Maintenance and use of storage yards. These construction activities will contribute to increase in SPM to a nominal level for temporary period.

Operation Phase

The proposed project pertains only to construction of water pipeline project .Impact on air quality will be only during construction phase & not operation phase.

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.

For mobile source emissions

1) Dust covers should be provided on the vehicles to be used for transportation of materials prone to fugitive dust emissions.
2) Construction requiring street closings should be carried out during non-peak hours.
3) Idling of delivery trucks or other equipment should not be permitted during periods when they are being unloaded or are not in active use.
4) Construction site should be sprinkled with water to minimise the fugitive dust.
5) Trucks carrying cement, gravel, sand will have to travel to site and may cause dust emission. Therefore ready mix concrete carried in enclosed container may be better option as compared to on site batch mixing.

Stationary source emissions

1) All stationary equipment should be located as far away as possible from sensitive receptor locations in order to allow dispersion of emitted pollutants.
2) 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, should be frequently watered to suppress re-entrained dust.

3) 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 should be used wherever feasible. Construction areas should be enclosed, wherever possible.

4) Exhaust and noise emissions of construction equipments shall adhere to emission norms as laid out by MoEF/CPCB.

5) The contractor shall ensure that the batching plant is located away from the residential areas and shall be licensed and authorized for operation by the concerned authorities.

6) Periodic inspection of the site shall be carried out to ensure removal of construction debris to the landfill sites.

4.4 Noise and vibration

During operation of the tunnel, traffic flows will increase on the approach roads causing increased sound emissions and additional noise in the neighborhood. In order to obtain local data for the environmental noise background, a baseline monitoring survey was undertaken at nine locations along the route and in its vicinity in February 2013.

The propagation of sound into the built-up areas is limited by sound shielding effects from buildings in the first rows and levels at second rows of buildings meet the standard unless there are spaces in the first row buildings enabling the sound wave to propagate through.

4.4.1 Construction noise

The noise levels created by construction equipments will vary greatly depending on the type of equipment, the specific model, the operation being formed and the condition of the equipment. The magnitude of off-site noise impact associated with construction will be dependent on: The intensity and location of construction activities; type of equipment used; existing background noise levels; intervening terrain and structures and the prevailing weather conditions. The equivalent sound level (L_{eq}) of the construction activity depends on the fraction of time that equipment is operated over the period of construction.

Noise from construction equipment and operations

The dominant source of noise from the construction equipment is the diesel engine, without sufficient muffling. Stationary equipment operates in one location for one or more days at time with either a fixed power operation (pumps, generator, compressors) or a variable noise operations. Mobile equipment moves around the construction site with power applied in cyclic fashion (bull dozers, loaders) or to and from the site (trucks). The movement around the site is handled in the construction noise prediction procedure. Typical noise levels from representative equipments that are likely to be used in the project are given below:

Equipment	Noise level (dBA) from 16m from source	Equipment	Noise level (dBA) from 16m from source
Air compressor	81	Jack hammer	88
Backhoe	80	Loader	85
Concrete mixer	85	Paver	89
Concrete pump	82	Pneumatic tool	85
Concrete vibrator	76	Rock drill	98
Crane mobile	83	Roller	74
Dozer	85	Shovel	82
Generator	81	Truck	88

4.4.2 Airborne noise

Construction over the length of a project can take place 24 hours a day. Construction equipments need to operate in very close proximity to residential and commercial (and even industrial) premises. Many items of equipment can be found operating at any time throughout a project. Equipment types range from mobile cranes, pile drivers, jackhammers, dump trucks, concrete pumps and trucks, backhoes, loaders, dozers, rock-breakers, rock drills, pile boring machines, excavators, concrete and chain saws, and gas and pneumatically powered hand tools. An additional factor of great importance is the presence of low frequency noise (< 200 Hz) in the source sound spectra of many items of equipment for which the 'true' annoyance capability at sensitive receptors is not reflected either in the measurement or prediction using the overall A-weighted sound pressure level, or dB(A). LAeq noise levels in general cannot exceed baseline (preconstruction) LAeq noise levels by more than 5 dB at identified noise sensitive receptor locations. While an increase of 5 dB may be noticeable, it should not present an unacceptable noise hardship condition.

Mitigation of construction noise

The noise control approaches are listed:

1. Design considerations and project layout: - construct noise barriers such as temporary shields between noisy activities and noise-sensitive receivers.
2. Sequence of operations: Avoid nighttime activities in residential neighborhoods and combine noisy operations to occur in the same period.
3. Alternative construction methods: use specially quieted equipment (quiet and enclosed air compressors, mufflers on all engines) and quieter demolition methods.

Mitigation construction noise at the Source

Source control is, in general, the most effective form of noise mitigation and involves controlling a noise source before it is able to emit potentially offensive noise levels. Construction noise (exclusive of blasting) is typically generated by two source types:

- Stationary equipment; and Mobile equipment.

Noise levels from both types of noise sources are dependent on equipment characteristics and their operation.

The following aspects will be considered irrespective of it movement (stationary and mobile):

Less noisy & newer equipment: Newer equipment is generally quieter than old equipment for many reasons, including technological advancements and the lack of worn, loose, or damaged components. The types of engines and power transfer methods also play a significant role in achieving lowered equipment noise. The use of electric powered equipment is typically quieter than diesel, and hydraulic powered equipment is quieter than pneumatic power. By specifying and/or using less noisy equipment, the impacts produced can be reduced or eliminated. Source control requirements may have the added benefits of promoting technological advances in the development of quieter equipment.

Mufflers: The construction noise originates from internal combustion engines. A large part of the noise emitted is due to the air intake and exhaust cycle. Specifying the use of adequate muffler systems can control much of this engine noise.

Shields: Employing shields that are physically attached to the particular piece of equipment is effective, particularly for stationary equipment and where considerable noise reduction is required.

Dampeners: An Equipment modification, such as dampening of metal surfaces, is effective in reducing noise due to vibration or redesign of a particular piece of equipment to achieve quieter noise levels.

Aprons: Sound aprons generally take the form of sound absorptive mats hung from the equipment or on frames attached to the equipment. The aprons can be constructed of rubber, lead-filled fabric, or PVC layers with possibly sound absorptive material covering the side facing the machine. Sound aprons are useful when the shielding must be frequently be removed or if only partial covering is possible.

Enclosures: Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. The walls could be lined with sound absorptive material to prevent an increase of sound levels within the structure. They should be designed for ease of erection and dismantling.

Blasting Mats: These mats are typically made with layers of used tyres cabled together. They are commonly used as blankets for blasting operations to control and confine debris. These mats also provide a degree of noise attenuation from the blast. However, they do not mitigate vibration, which is usually more of a concern than noise.

Maintenance Programs: Poor maintenance of equipment typically causes excessive noise levels. Faulty or damaged mufflers and loose engine parts such as screws, bolts, or metal plates contribute to increased noise levels. Removal of noise-reducing attachments and devices such as mufflers, silencers, covers, guards, vibration isolators, etc., will, to varying degrees, increase noise emission levels. Old equipment may be made quieter by simple modifications, such as adding new mufflers or sound absorbing materials. Loose and worn parts should be fixed as soon as possible.

Equipment Operation Training: Careless or improper operation or inappropriate use of equipment can increase noise levels. Poor loading, unloading, excavation, and hauling techniques are examples of how lack of adequate guidance and training may lead to increased noise levels.

Positioning of stationary noise sources such as generators and compressors as far away as possible from noise sensitive areas should be considered. Temporary barriers can be employed and/or enclosures can be built around noisy equipment. These techniques can significantly reduce noise levels and, in many cases, are relatively inexpensive. These barriers can typically be constructed on the work site from common construction building material (plywood, block, stacks, or spoils). Enclosures are often constructed from commercial panels lined with sound absorbing material to achieve the maximum possible shielding effect.

To be effective, the length of a barrier should be greater than its height, the noise source should not be visible, and any barrier should be located as close as possible to either the noise source or the receiver. In addition, providing increased distance between a noise source and a noise receiver can also be considered a form of abatement.

Other temporary abatement techniques include the use of temporary and/or movable shielding for both specific and nonspecific operations. Some mobile shielding is capable of being moved intact or being repeatedly erected and dismantled to shield a moving operation. An example of such a barrier utilizes noise curtains in conjunction with trailers to create an easily movable, temporary noise barrier system.

Mitigation Measures

This can typically be accomplished by identifying all feasible measures that could be used, in selecting the most suitable techniques, and assembling them into a final mitigation strategy.

Some of the factors that influence this identification process are:

- Amount of reduction needed;
- Local sentiment toward the proposed project;
- Local noise ordinances;

- Length of the construction period;
- Effectiveness of control strategies; and
- Cost of control strategies.

Based on these and other factors, various noise mitigation strategies can be examined to determine what measures are best suited for implementation on a specific project. Factors influencing this selection include:

- Cost;
- Practicality;
- Achievable noise reduction; and
- Effect on overall project operation.

Mitigation Strategies involves the selection of a reasonable control strategy from the methods examined in the identification stage. The measure or measures chosen should be weighed as to their benefits compared to their adverse effects. This weighting should take into consideration:

- Monetary costs involved;
- Feasibility of carrying out the mitigation techniques;
- Problems with implementation of the method;
- Ability to enforce any requirements of the strategy;
- Degree of noise reduction achievable;

  Gauging the sensitivity of the receptors in the area; and
- Evaluation of the strategy with regard to any adverse impact on the overall operation of the project caused by delays or disruption of critical construction scheduling.

Monitoring Noise Levels during Construction

Regardless of the types of noise abatement strategies and techniques employed on any particular project, successes or failures are ultimately determined by resultant effects on noise levels at sensitive sites and the adherence of the resultant noise levels to the stated construction noise level criteria. An adequate program requires:

- Properly trained staff for the task of monitoring noise;
- Equipment sufficient to properly monitor noise levels and operations;
- Well-written specifications to avoid misinterpretations;
- Well-defined goals that can be achieved and measured;
- Knowledgeable and properly trained operators and contractors who have an

understanding of what has to be achieved, why it has to be achieved, and how to achieve it; and

- Clearly defined chain of responsibility to ensure compliance in a timely and proper manner.

4.4.3 Construction vibrations

Construction activities result in varying degrees of ground vibration, depending on the equipment and methods employed. Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following: The efficiency of the energy transfer mechanism of the equipment (ie impulsive; reciprocating, rolling or rotating equipment); frequency content; impact medium stiffness and the type of wave (surface or body) and ground type and topography. Operation of construction causes ground vibrations which spread through the ground and diminish in strength with distance. Ground vibrations, very rarely reach the levels that can damage structures, but can achieve the audible and feeble ranges in buildings very close to the site. Blasting and pile driving generate the most severe vibrations. Construction vibration is assessed in terms of peak particle velocity (PPV). It is a typical factor of 1.7 to 6 times greater than root mean square (rms) vibration velocity; a factor of 4 has been used to calculate the approximate rms vibration velocity levels. Various types of construction equipment have measured under a wide variety of construction activities with an average source levels reported in terms of velocity levels is shown below:

Equipment		PPV at 25ft (in/sec)	Approximate L_v @ 25 ft
Pile driver (impact)	Upper range	1.518	112
	Typical	0.644	104
Pile driver (sonic)	Upper range	0.734	105
	Typical	0.170	93
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded truck		0.076	86
Jack hammer		0.035	79
Small bulldozer		0.003	58
RMS velocity in decibels (VdB) re 1µinch/second			

Construction vibration assessment

The vibration assessment during activities such as blasting, pile driving, demolition and drilling or excavation in close proximity to sensitive structure is recommended.

The mitigation of construction vibration requires consideration of equipment location and processes such as:

1) Design consideration and project lay out: route heavily loaded trucks away from residential areas and operate earthmoving equipment away from the vibration-sensitive sites.
2) Sequence operations: phase demolition, earthmoving and ground impacting operations so as not to occur in the same period.
3) Alternative construction method: avoid impact pile driving where possible in vibration-sensitive areas and avoid vibratory rollers and packers near sensitive areas.

4.4.3.1 Ground vibration

The total attenuation of vibration from an item of construction equipment to a receptor is estimated from the spreading loss, a value dependent on whether the source of vibration is considered a point, line or planar source, attenuation due to internal losses in the soil and rock, being a function of loss factor η, velocity of propagation c, frequency of the vibration and distance to the receptor and attenuation due to changes in soil or rock along the propagation path, being a function of mechanical impedances of individual differing rock components.

Mechanical impedance is derived from the density of the various media and longitudinal wave speeds for each media. Wave propagation is usually surface or Rayleigh (or R-wave) type. Here again the perception of ground-borne vibration outside and especially inside premises is of a low frequency character.

Construction noise and vibration issues must be considered an essential part of the assessment of the development of any transportation facility. Road and tunnel construction is often conducted in close proximity to residential and commercial premises and associated noise and vibration should be predicted, controlled and monitored in order to avoid excessive noise and vibration impacts. Construction noise and vibration can threaten a project's schedule if not adequately analysed and if the concerns of the community are not addressed and incorporated.

In general a project's schedule can be maintained by balancing the type, time of day and duration of construction activities: adhering to local or state noise control requirements and being proactive to community concerns.

4.4.4 Construction Methods –Tunnel

Tunnel Boring Machine (TBM) is proposed to be used for excavating tunnels. An effective TMB method requires the selection of appropriate equipment for different rock mass and geological conditions. The TBM may be suitable for excavating tunnels which contain competent rocks that can provide adequate geological stability for boring a long section tunnel without structural support. TBM specification that is likely to be used in this project has cutter head diameter of 8.28m; 60 cutter discs and 55 effective cutter with 17" disc size. Rotation power 9 X 375 kW (3375kW); motor supply voltage of 690 volts, motor maximum global current of 1800 amps; maximum thrust of 28MN for TBM hydraulic system, 15MN set as allowable limit for discs and rotation speed 0-8.4RPM (Wilson Acoustics Ltd). The ground borne noise level will ~ 65 to 75 dB(A; ~ 55 to 70 dB(A); ~ 40 to 60 dB(A); ~ 30 to 50 dB(A); and ~ 25 to 45 dB(A) at 5, 10, 20, 30 and 50 M distance from TMB location.

As theTunnel Boring Machine (TBM) is used for unrestricted 24-hour tunnelling in shortening Construction Programme. It not is advised in areas where it is difficult to restart TBM, water leakage and ground collapse. When TBM passing through a sensitive area, it is desired to minimize the ground borne noise is demanded by reducing the advancing speed of TBM. A prolonged tunneling program may eventually increase the overall exposure of noise and vibration dose. TBM induced ground vibrations are generally lower than building vibration criteria and not a concern for most cases. Critical frequency is below 100Hz. TBM vibration levels are:

Distance (m)	TRMS vibration (mm/s)	PPV (mm/s)
5	0.1 to 1	-
10	0.05 to 0.6	0.3 to 3
20	0.025 to 0.4	0.1 to 1.5
30	0.015 to 0.3	0.06 to 1
50	0.012 to 0.25	0.04 to 0.8

TBM ground borne noise level is 10dB (A) below airborne noise limits and the critical frequency range of ~50 to 500 Hz, based on $L_{eq, 5min}$.

Distance (m)	Typical TBM Ground borne Noise Level, dB(A)
5	~65 to 75
10	~55 to 70
20	~40 to 60
30	~30 to 50
50	~25 to 45

The potential environmental impacts in terms of noise, dust and visual on sensitive receives are significantly reduced and are restricted to those located near the launching and retrieval shafts. The disturbance to local traffic and associated environmental impacts would be much reduced. The quantity of C&D materials generated would be much reduced.

4.5 Water environment

Construction sites, if not properly managed and operated, can lead to significant impact on surface or groundwater. The main potential source of impact from construction activities will be the discharge of effluent from a temporary treatment plant that treat spoil slurry from the tunnel boring machine (TBM). Other sources will include effluents from dewatering of deep excavations (not expected), discharges of site run-off potentially contaminated with silt and hazardous materials, discharges at stream crossings, sewage disposal, wheel washing, accidental releases from work sites, and release of specialist chemicals used in tunnelling and grouting.

Operation of a closed drainage system and establishment of emergency response plans to be implemented in the event of spills, fire etc should prevent significant risks of contamination of soils during operation. Provided that all these mitigation measures are in place no significant impacts related to geology, soils and contaminated land are expected.

The scale and nature of the proposed scheme mean that the change in area of impervious surfaces is relatively small and will not significantly increase runoff from the existing road sections during operations. No significant impact on watercourses will occur from structures such as bridges and culverts at road crossing points. All tunnel and underpass sections will be constructed in a watertight manner so that groundwater will not infiltrate into them. As a result

groundwater will divert around structures causing localized changes in groundwater levels and flow. As there are no uses of groundwater in the area, there will be no adverse impacts.

4.6 Biological Environment

4.6.1 Biodiversity and nature conservation

All existing vegetation and habitats within the existing roadside verges ie ROW will be removed for laying of pipeline. None of the habitats affected are of nature conservation importance and their loss is not considered to be significant for biodiversity. The Forest land has been identified and necessary permission will be taken from Forest department although Forest department has already given permission to NHAI for this area during construction of National Highway and land is in possession of NHAI.

Clearance of vegetation for temporary land take will result in the felling of trees of varying species, sizes and ages. Their loss is considered to constitute a minor impact on biodiversity. In a broader regional context this loss is of minor significance as displaced birds are likely to be able to find replacement sites relatively easily. The construction activities and the changes in traffic during operation are not expected to result in any significant impact on habitats or fauna of conservation importance, especially given the urban nature of the existing land use. In the project area of 8 metres from highway in the ROW of State & National Highway there are no rare & endangered species of flora & fauna of economic significance which require management.

The Surya water supply system envisages abstracting raw water from the Kawadas weir, treating the water by adopting appropriate process in water treatment plant and transmitting to master balancing reservoirs to be located at outskirts of the two ULBs. The MBRs shall be bulk supply points and destinations for the water supply system. Hence there is no impact on ecological functioning of Surya river system, its aquatic life & biota. Also there will not be any impact on aquatic ecology including fisheries, their spawning and migration

Table 4.3 Affected Tree list

Sr. No.	Name of Trees	Number of Trees
1.	Babool	40
2.	Taad	6
3.	Mango	1
4.	Neem	6
5.	Peepal	6
6.	Badam	1
7.	Sagwan	10
8.	Nilgiri	3
9.	Small patches of trees	108
10.	Other unidentified trees	295

4.6.1.1 Construction Phase:

The laying of the pipeline will require felling of about 203 trees. Thus during construction phase of the project, significant adverse impact is anticipated on the ecological environment of the project corridor. The Route of the pipeline has forest land, private land and government land along the route. The water pipe line passes southwards from Dhamni covering Thane upto Vasai-Virar, Mira Bhayandar region. There will be some displacement and cutting of trees along the route with prior permission of the authority**.** The compensatory tree plantation plan shall be prepared in consultation with the authority. The proposed project does not envisage filling up of any existing water bodies. Hence the issue of impact on aquatic fauna also does not arise. There are no endangered faunal species / birds found within the core zone.

4.6.1.2 Mitigation measures

During pre-construction phase, the clearing of RoW will require felling of about 203 trees essentially from the roadside plantations. Trees falling within the alignment which are to be removed before commencement of construction shall be identified and approved by Project Implementation Agency. Prior permission from Tree authorities shall be obtained as laid out in the Tree act. Compensatory plantation plan shall be prepared &executed in consultation with Tree Authority. Some trees will be transplanted as a mitigation measure. However, the Tree authority/ Forest dept. shall be consulted for identifying compensatory plantation area.

4.7 Traffic and Transport

During **project initiation phase**, significant adverse impact on traffic and transport scenario is anticipated to occur for short-term duration. The impact would be felt adversely especially near villages where area has to be cleared for the project. To mitigate this adverse impact, site clearance activities must be carried out swiftly and in well-planned manner. During **construction phase**, significant adverse impact for temporary duration is anticipated. The work shall be completed well within the budgeted time frame as per the construction program. Proper traffic management plan during construction phase shall be prepared. During **operation phase,** the RoW will be restored to the earlier state which will smoothen out the traffic movement reducing the conflict between local traffic movement and traffic passing through National Highway.

Environmental Issues of Concern

From the analysis of the proposed project it appears that, following are the environmental parameters of concern which will need suitable mitigation measures:

- Land Environment: Major negative impact is due to solid waste generated in construction / operation phases.
- Air Quality: Deterioration of air quality during construction phase.
- Noise Pollution: Noise pollution caused during construction phase.
- Water Environment: Requirement of water during construction & operation phases.

The impacts on rest of the components are found to be negligible though mitigation measures to minimize the adverse effects on them should be implemented.

Significant Beneficial Impacts

Various positive impacts of the proposed project can be summarized as follows:

- MMRDA proposed Surya Integrated Water Supply Scheme will meet shortage of water in sub-region.
- Improvement in aesthetics of the general locality, which will also lead to enhancement of property values.

4.8 Socio-economic Environment

The main socio-economic impacts of this project will be positive and economic benefits through water availability. There may be a small loss of employment through the need to expropriate buildings which currently house small businesses. The Pipeline is aligned to avoid direct

displacement of premises and minimizing the need for additional land. During the construction, the residential and commercial land use activity near market area of villages along the route might be impacted adversely as they are located very close to the project road. The RAP studies are planned for the project will address the R&R issues adequately and mitigate the impact to large extent. Hence the adverse impact will be of short duration. Induced impacts during operation stage on land use pattern are expected to occur within the beneficial ULBs, VVCMC & MBMC & 27 villages where water is proposed to be supplied through this project. With increase in water supply, the land values are bound to go up in short duration. This will lead to exploitation of vacant land area/ space available in the ULBs.

Public Health

During construction phase, dust hazards due to earthwork and transportation of construction material may cause nuisance. However, the impact will be temporary and restricted (due to water sprinkling)

Cultural Properties

Religious places which are located within the RoW, will experience the fallout of adverse impact on ambient noise levels, both during construction and operation stages of the project, All these places of worship may have to be relocated. MMRDA is planning to follow the same approach that has been followed by them in other projects towards addressing the issue of relocation of places of worship. The adverse impact, if any, will be suitably addressed in the RAP for the project.

Utility Diversion

Before commencement of the construction, significant number of utility service will be relocated / shifted. The utility services such as Telephone cables, Underground electricity cables, Water supply line which are to be relocated, shall be done before commencement of the construction.

Mitigation measures

In order to mitigate adverse impacts, all utilities, such as water supply lines, electrical installations, telephone lines etc. shall be shifted after prior approval of agencies. Utility relocation shall be carried out in shortest possible time to reduce inconvenience to public. Special safety measures will have to be taken while shifting of the gas pipeline which is located in the initial 1.5 km stretch of the road.

Labor 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: 1) sewage and garbage pollution; 2) depletion of fauna and flora through illegal harvesting (poaching); 3) infrastructure overloading- health services, 4) sewage treatment, and 5) law enforcement.

Mitigation Measures:

It would be contractor's responsibility to locate a site suitable for his work under the general conditions of contract and as per MRTH specifications for road and bridge works (MRTH specifications will form part of the contract). However it is suggested that the construction and labour camp should be located at Surya Nagar. It would be contractor's responsibility to ensure that he complies with the local laws, if any, pertaining to construction camps siting and the area identified for siting construction camps are approved and authorized by competent authorities. The PIA/ PMC will approve the area selected/ identified by the contractor.

4.9 Environmental and Social management system

It is proposed to manage the environmental, health, safety and social impacts and risks of the Project in accordance with applicable laws and regulations. Details of all measures planned to avoid, reduce or compensate for adverse environmental and social impacts and to provide benefits where possible are set out. All possible efforts shall be made to avoid intrusion into existing habitats and communities and options will be explored to avoid such locations and properties. However the details of the structure will be affected during construction falling within 8m from road boundary line are listed in **table below.**

Table 4.4 Affected Structure list

Sr. No.	Name of Structure	Number of affected structures
1.	Boards	112
2.	Dhaba	68
3.	Shops	162
4.	Compound Wall	376
5.	Bus Stop	92
6.	Garage	24
7.	Electric Pole	40
8.	Hut	75
9.	Petrol Pump	16
10.	Street light	44
11.	Tabela	2
12.	Toilet rooms	4

There are 27 villages identified along the route of the pipeline. The survey number of these villages through which pipeline is proposed to be laid has been identified. The survey numbers falling in forest area are also demarcated. Necessary permission from Forest department will be taken before implementation of project.

List of Villages

Sr. No.	Name of Village	Sr. No.	Name of Village	Sr. No.	Name of Village	Sr. No.	Name of Village
1	Sasunaghar	8	Pelhar	15	Bhoerale	22	Chillar
2	Juchandra	9	Shirshad	16	Dhekale	23	Wade
3	Bapane	10	Mandvi	17	Warle	24	Somte
4	Kolhi	11	Kashidkopar	18	Kude	25	Tawa
5	Chinchoti	12	Kunkwade	19	Halode	26	Varoto
6	Sativali	13	Bhativali	20	Durvesh	27	Veti
7	Waliv	14	Sakwar	21	Awadhan		

4.10 Resettlement Policy framework (RPF)

A key aspect of the environmental and social management of the Project will be the management of acquisition of land required either temporarily or permanently for construction and operation. This includes land acquired by voluntary agreement, land acquired by involuntary acquisition, and land transferred between public agencies.

4.10.1 Grievance Process

A Grievance Process unit will be set up through which any person or organization can complain about any aspect of the Project.

1) Every complaint received from any external party or worker about any part of the process of the Project implementation will be formally registered and receipt of Grievance Form and a copy will be given to the person registering the complaint.

2) An initial response to all complaints will be made by an appropriate person (within MMRDA) within 5 working days and resolve grievances within one month. If this is not possible the complainant will be kept advised of progress on a regular basis.

3) Complaints will be tracked through to satisfactory resolution by the Project Environment and Complaints Manager. All actions will be recorded on the Grievance Form until such time as the contact is resolved. The contact will then be recorded in the Grievance Log as closed.

4.11 Terrain & Geology

Insignificant adverse impact is anticipated on the **geological environment** of the project corridor during construction phase of the project and no impact is anticipated during operation phase of the project. Impact on geological resources is anticipated to occur at quarry sites and borrow areas identified for the project. The excavated material to the extent possible would be reused and the quarrying material will be exclusively procured by the Contractor from licensed quarries. The quarry site‘s proximity to project site will have an advantage in transporting quarry material to project site. Since as per the license conditions, the quarry sites will have an approved quarry site management and closure plan, the environmental issues pertaining to quarry site will be addressed and impacts, if any, will be mitigated.

Chapter 5

Environmental Management Plan

5.1. Introduction

An Environmental Management Plan (EMP) has been recommended in this Section. This EMP takes into account all the environmental issues and the corresponding mitigation measures to minimize the impacts. The EMP presented below includes:

- Specific actions to be taken vis-à-vis site-specific issues;
- Responsible agencies for its implementation & supervision;
- Time frame for implementing Mitigation actions;
- Reference to contract documents and specifications;
- Project level environmental monitoring;
- Environmental status reporting frequency; and
- Institutional arrangement, Strengthening of their capability, and role.

It also includes a monitoring plan to enable evaluation of the success or failure of environmental management measures and reorientation of the plan if required. Several of the protective and enhancement measures can be implemented by adopting suitable planning and design criteria during construction of the project. Further, it is necessary that the resources required for the mitigation / protection, enhancement measures and monitoring are provided for in the cost estimates of the project, to ensure proper implementation.

5.2. Environmental Management and implementation

The EMP has been delineated for all the three stages viz., Pre-construction, Construction and Operation stages of Surya project. During construction phase, contractors as well as site-in-charge will be responsible for implementing all the mitigation measures. **Table 5.1, Table 5.2** and **Table 5.3** show the EMP for Pre construction, construction & operational phase respectively.

Table 5.1 Pre Construction Stage

Sr No	Environmental Issue	Mitigation Measures	Cross Reference to Documents	Time Frame	Responsibility	
					Implementation	Supervision
1	Resettlement and rehabilitation	The entitlement framework to the PAPs shall be in accordance to the RAP of the project. It shall be ensured that all R&R activities be reasonably completed as per RAP, before the construction activity starts in the relevant section.	RAP Requirement	Before Start of construction	MMRDA	MMRDA
3	Ecological impacts due to tree cutting	Trees falling within the alignment (206 nos) which are to be removed before commencement of construction shall be identified and approved by PIA. Prior permission from Forest dept. Tree authorities shall be obtained. Compensatory plantation shall be carried out	Preservation of Tree Act of Maharashtra, 1975	Before Start of construction of relevant section	Contractor	MMRDA
4	Local traffic arrangement	Temporary traffic arrangement during construction within RoW shall be planned. This plan shall be periodically reviewed with respect to site conditions. During site clearance activity, the demolition debris shall be preferably removed during non-peak hours and with deployment of more vehicles for the purpose.	M/O RT&H: 112	During site clearance and construction	Contractor	MMRDA
5	Providing labour camps and facilities	The Contractor shall abide by the Contract conditions and directions of PMC/PIA with respect to siting of labour camps, providing sanitation facilities and labour welfare issues etc.	M/O RT&H 105.2	During construction	Contractor	MMRDA
6	Siting of construction site/casting yard	The Contractor shall abide by the Contract conditions and directions of PMC/PIA with respect to siting of construction camps. The construction camps should located at least 500 m away from sensitive receptors/residential	M/O RT&H 105.2	During construction	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Cross Reference to Documents	Time Frame	Responsibility	
					Implementation	Supervision
		area.				
7	Traffic Control and Safety	The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the PMC for the information and protection of traffic.	M/O RT&H: 112.4 M/O RT&H: 112	During pre-construction	Contractor	MMRDA
8	Safety of pedestrians	Special consideration shall be given in the local traffic management to the safety of pedestrians.	M/O RT&H: 112.2	Before Construction and during construction	Contractor	MMRDA
9	Impact on land use outside RoW	Construction activities shall be preferably restricted within project road RoW.	M/O RT&H 201.2	During site clearance and construction	Contractor	MMRDA
10	Utility relocation including shifting of gas pipeline	All utilities, such as water supply lines, electrical installations, telephone lines etc. to be shifted after prior approval of agencies. Utility relocation shall be carried out in shortest possible time to reduce inconvenience to public.	M/O RT&H 110	Before Start of construction of relevant section	Contractor	MMRDA

Table 5.2 Construction Stage

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
1	Traffic Control and Safety	The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the PMC for the information and protection of traffic.	M/O RT&H: 112.4 M/O RT&H: 112	During construction	Contractor	MMRDA
2	Air Pollution	All vehicles delivering material to the site shall be covered by tarpaulin to avoid material spillage.	M/O RT&H :111.9M/O RT&H :111.11M/O RT&H :111.12	Entire construction phase	Contractor	MMRDA
3	Using existing hot mix/ Concrete/ asphalt plants	If the contractor uses the existing Concrete, Asphalt and Hot Mix Plants, he shall ensure that existing plants, which are sourced, are licensed and authorised for operation by concerned authorities and shall intimate the PMC/PIA prior to procuring materials from them. PMC shall procure relevant documents from the plant owners to ensure that they are adhering to relevant emission norms as laid out by MoEF/ CPCB. If the contractor wishes to establish a new plant, he should obtain consent-to-establish and consent-to-operate under Air and Water Act from MPCB.	M/O RT&H: 111.5	During entire construction phase	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
4	Plying vehicles on unpaved roads	The unpaved roads, if used by the contractor, shall be sprinkled with water at least once in a day to control the fugitive dust emissions. Dust emission will be a critical issue near villages.	M/O RT&H:111.10	Construction phase	Contractor	MMRDA
5	Location of batching plant	Batching plant, if contractor wish to establish, shall be located away from the residential/sensitive area and shall be licensed and authorised for operation by concerned authorities.	-	During construction phase	Contractor	MMRDA
6	Watering to control dust at site	Construction site to be watered periodically to minimize fugitive dust generation during construction near urbanised area	M/O RT&H: 111.8	During entire construction phase	Contractor	MMRDA
7	Roads used for transport	Contractor shall ensure that the transport vehicles used to ferry materials and dispose debris does not create hazardous conditions for general traffic using the roadway especially the National Highway.	M/O RT&H:111.9	During entire construction phase	Contractor	MMRDA
8	Barricading site	The construction site especially near habitation should be barricaded at all time in a day with adequate marking, flags, reflectors etc., for the safety of general traffic movement and pedestrians.	M/O RT&H 112	During construction phase	Contractor	MMRDA
9	Earthwork	All earthwork and construction material should be stored in such a manner to minimise generation of dust and spillage on roads. The stacks of earthwork shall be preferably located away from habitation	M/O RT&H 201.4	During entire construction phase	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
10	Inspection of site	Daily inspection at construction site should be carried out to ensure removal of construction debris. Debris removal frequency shall be quicker to the extent possible. Piling up of debris generated near steep slope section would create hazardous condition for traffic movement and pedestrians.	Contract document	During construction phase	Contractor	MMRDA
11	Earthwork debris disposal	The excavated material to the extent possible would be reused for proposed construction and the remaining material would be disposed at authorised dumping grounds. In no case, loose earth should be allowed to pile up along the alignment.	M/O RT&H 201.4 M/O RT&H 301.3.11	During construction phase	Contractor	MMRDA
12	Idling of vehicles	Idling of delivery trucks or other equipment should not be permitted during periods of unloading or when they are not in active use.	M/O RT&H 201.2	During construction phase	Contractor	MMRDA
13	Construction equipment emissions	Exhaust and noise emissions of construction equipment's shall adhere to emission norms as laid out by MoEF/ CPCB.	Legal requirement	During construction	Contractor	MMRDA
14	Noise from construction equipments	All construction equipment's shall be fitted with exhaust silencers. Damaged silencers to be promptly replaced by contractor.	M/O RT&H: 111	During construction	Contractor	MMRDA
15	Noise impact due to operation of DG sets	DG sets, if used, shall adhere to noise standards of MoEF. Operation of DG sets shall be preferably avoided near habitation and sensitive receptors.	M/O RT&H:111	During construction	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
17	Noise level near residential areas and sensitive receptors	Construction activity induced noise levels shall be mitigated. The contractor can employ mitigation measures such as restricted and/or intermittent activity or as directed by PMC.	M/O RT&H:111	During construction of relevant sections	Contractor	MMRDA
18	Exposure to loud noise	Workers exposed to loud noise shall wear earplugs/earmuffs.	M/O RT&H: 111.6 M/O RT&H 105.2	During construction	Contractor	MMRDA
19	Storage of construction material	Construction material containing fine particles shall be stored in an enclosure such that sediment-laden water does not drain into nearby storm water drains and underground sewage pipes.	M/O RT&H: 306	During construction	Contractor	MMRDA
20	Blockage and change in drainage pattern	Along steep slope section located along alignment, earth, stone, pipes or any other construction material shall be properly stored, if storage can't be avoided, so as not to block the flow of water. If the channel/ drains get blocked due to negligence, contractor should ensure that they are cleaned especially during monsoon season. Once the work is completed in all respects, the contractor shall, as a mark of good gesture, clean up the drains along the project road to the extent possible.	M/O RT&H: 306	During construction	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
22	Areas susceptible to erosion	Along the steep hill section along the alignment, earthwork should be preferably carried out before rainy season or temporary/permanent erosion protection work as may be feasible shall be provided.	M/O RT&H : 306.2/Project/ Contract requirement	During construction	Contractor	MMRDA
23	Debris disposal	Debris generated due to dismantling of existing road/ pavement/structures shall be suitably reused in proposed construction. Un-utilisable debris shall be suitably disposed at sites authorised by competent authority with the approval of PMC.	M/O RT&H :112.10 M/O RT&H 301.3.11	During construction	Contractor	MMRDA
24	Soil contamination by construction wastes, fuel etc.	Oil and fuel spills from construction equipment shall be minimised by good O&M practice. Soils contaminated by such spills shall be disposed as per MoEF requirements.	Project requirement	During construction	Contractor	MMRDA
25	Sourcing quarry materials	Sand, aggregates and other quarry material shall be sourced from licensed quarries.	M/O RT&H 111.3	During construction	Contractor	MMRDA
26	Compensatory plantation	Compensatory plantation shall be done in line with Tree authority / Forest Dept. regulations and guidelines. Also it is recommended to grow trees in lieu of loss of trees	Preservation of Trees Act of Maharashtra, 1975	During construction	Tree Authority	MMRDA
27	Providing labour camps and facilities	The contractor shall abide by the contract conditions and directions of PMC with respect to labour camps, providing sanitation facilities and labour welfare issues.	M/O RT&H 105.2	During construction	Contractor	MMRDA

Sr No	Environmental Issue	Mitigation Measures	Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
28	Occupational Health and Safety	The contractor is required to comply with all the precautions as required for the safety of workmen as per the International Labour Organisation (ILO) Convention No. 62, as far as those are applicable to the contract.	M/O RT&H 105.2	During Construction	Contractor	MMRDA
29	Provision of Safety accessories/ appliances to each worker	The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, masks etc. to the worker and staff. All laws related to safe scaffolding, ladders, working platform, gangway, stairwells, excavations, safety entry and exit etc. shall be complied with.	M/O RT&H 105.2	During Construction	Contractor	MMRDA
30	Safety precautions	Adequate precautions shall be taken to prevent danger from electrical equipment. All machines/equipment used shall confirm to the relevant Indian Standards (IS) codes and shall be regularly inspected by the PMC.	-	During Construction	Contractor	MMRDA
31	Availability of first aid kit at construction site	A readily available first aid unit including an adequate supply of sterilized dressing material and appliances shall be provided.	M/O RT&H 105.2	During Construction	Contractor	MMRDA
32	Workers health and hygiene	All anti-malarial measures as prescribed by the PMC shall be complied with, including filling up of burrow pits.	M/O RT&H 105.2	During Construction	Contractor	MMRDA
33	Non-compliance of EMP	If during progress of work, breach in compliance/observance of mitigation measures observed, competent authority/committee will have right to levy any penalty as per the nature of default summarily without assigning any reasons thereof.	-	During Construction	MMRDA	MMRDA

Table 5.3 Operation Phase

Sr No	Environmental Issue	Mitigation Measures	Cross Reference to Contract Documents	Time Frame	Responsibility	
					Implementation	Supervision
1	Air quality impact	Ambient air concentrations of various pollutants shall be monitored as per the pollution monitoring plan.	Project requirement	Starting immediately after completion of construction	Pollution monitoring agency appointed by MMRDA	MMRDA
2	Noise pollution	Monitoring of noise levels at locations as per monitoring plan.	Project requirement	Starting immediately after completion of construction	Pollution monitoring agency appointed by MMRDA.	MMRDA
3	Survival rate of plantation	Adequate care of the compensatory plantation should be taken up so as to comply the survival rates recommended in the relevant policies of the Tree authority	Project requirement	Up to 3 years after project becomes operational	MMRDA	MMRDA
4	Road embankment & cut section stability	Road embankment & cut section stability should be checked for erosion and rutting. The high embankment section along the alignment shall be periodically checked for soil erosion and stability. Any sign of instability should warrant adequate response immediately and well before succeeding monsoon season	Project requirement	Throughout operation stage	MMRDA	MMRDA

5.3 Environmental Monitoring Plan

Recommended Project level Environment monitoring plan is presented in **Table 5.4**

Table 5.4 Environmental monitoring plan

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration	Institutional Responsibility	
							Implementation	Supervision
Air Quality	Before Construction	SPM, PM10, SO2, N0x	NAAQS of CPCB	Surya Nagar	Once every season –Winter,	24 hr/day for 2 consecutive working days per week	Contractor through pre-approved monitoring agency	MMRDA
Air Quality	Construction	SPM, PM10, SO2, N0x	NAAQS of CPCB	Surya Nagar	Once every season – Summer, Winter, post monsoon	24 hr/day for 2 consecutive working days per week	Contractor through pre-approved monitoring agency	MMRDA
Air Quality	Operation	SPM, PM10, SO2, N0x	NAAQS of CPCB	Surya Nagar	Once every season – Summer, Winter, post monsoon	8 hr/day for 2 consecutive working days per week	MMRDA	MMRDA

Noise level	Construction	Leq Day, Leq night, L10, L50, L90 dB(A)	CPCB noise standards	And at sensitive and residential locations located near construction equipment	At start of construction activity, followed by every season (Summer, winter and post monsoon) during construction period	Continuous 24 hr reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks	Contractor through pre-approved monitoring agency	MMRDA
Noise level	Operation	Leq Day, Leq night, L10, L50, L90 dB(A)	CPCB noise standards		Once every season (excluding monsoon) for 1 year after operation starts	Continuous 24 hr reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks	MPCB	MMRDA
Soil Quality	Construction	Heavy metals and Oil and grease	Contamin ant threshold level given by USEPA	- Debris disposal site	At start and end of construction activity	One time sample	Contractor through pre-approved monitoring agency	MMRDA
E COLOGY	Pre-construction	Monitoring of tree felling/ transplantat ion	As laid out in project detail design. Trees to be adequatel y marked for felling	At locations of Tree felling	During tree felling	--	Contractor through pre-approved monitoring agency	MMRDA

ECOLOGY	Operation	Survival rate of plantation and other compensatory plantation	Survival rate to be at least 70%.Below which replantation should be done.	At locations of compensatory plantation	Annual	For 3 years after operation starts	Contractor	Forest Dept.

5.4 Cost of Implementation

The EMP implementation will require financial commitments for the following

 Budget for implementing various mitigation measures proposed in EMP

 Budget for undertaking project level environmental monitoring

These budgets has been estimated and provided in the following **Table 5.5.** The measures recommended in the tables are part of good construction practices that are recommended in M/O RTH specification for road and bridge works and FIDIC general conditions of contract. These specifications, guidelines and conditions of contract are to be adopted by the contractor and other implementing agencies as part of their contractual obligation with no additional cost. The project proponent i.e MMRDA shall include cost presented below as part of project budget.

Table 5.5 Cost estimation for Environmental monitoring

	Samples	Rate (in Rs)	Total (Rs)
Construction phase (24 months)			
Air quality	16 samples/quarter and total samples = 128	15,000 / sample	19,20,000
Noise level	16 samples/quarter and total samples = 128	5,000 /sample	6,40,000
Water quality	4 samples per quarter and 32 samples	5000 per sample	1,60,000
Cutting of trees	Trees having girth size more than 300 mm = 303 nos.	800 / tree	2,42,400
Transplantation	Trees having girth size less than 300 mm = 500 nos.	5000 / tree	25,00,000
Total Environmental monitoring cost during Construction Phase			**54,62,400**
Operation phase			
Air quality	8 samples per season and 24 samples per year	10,000 / sample	2,40,000
Noise quality	8 samples per season and 32 samples per year	2,000	64,000
Water quality	4 samples	5000 / sample	20,000
Compensatory plantation	Two trees per loss of one tree.. 406 trees for the loss of 203 trees (Approx)	250 / tree	1,01,500
Survival rate of compensatory plantation.	Ecological survey once per annum for three years	5000/year	15,000
Total cost for yearly Environmental Protection Measures for Operation Phase			4,40,500

Note: The cost of the following mitigation measures are covered under the engineering cost – 1) utility Relocation, 2) Dust control measures, 3) Barricading the site, 4) Cross-drainage works, and 5) Drainage and protective works.