Proposed Road Tunnel between Tikujiniwadi (Thane) & Borivali (Mumbai) in Maharashtra, India

Pre-Feasibility Report

This report provides the rationale for the proposed project based on the current and future needs of the population commuting between two suburbs of Mumbai Metropolitan Region.
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1. INTRODUCTION

Thane Ghodbunder Road (SH-42) is a major link road connecting Mumbai-Ahmadabad Road (NH-8) part of Golden Quadrilateral near Ghodbundar to Mumbai-Agra Road (NH-3) near Kapurbawadi. This link passes through Municipal Limits of Mira Bhayander Municipal Corporation area from Ch.00/000 to Ch.04/400 and thereafter it passes through Thane city urban area from Ch.04/400 to Ch.14/900. This is an important East-West link and carries heavy commercial traffic between NH-3 and NH-8. This road faces massive traffic congestion at various spots during peak traffic time. Congestion of traffic causes undesired burning of automobile fuel, which is a national loss in addition to the contribution of pollution, which would be a contributing factor for air quality in the adjacent Sanjay Gandhi National Park. Keeping in view, these factors in addition to reducing travel time and easy access between Thane and Western suburbs of Mumbai, it is proposed to construct twin tube 3 lane tunnel between Thane and Borivali under Sanjay Gandhi National Park.

The Maharashtra State Road development Corporation (MSRDC) is proposing to construct Twin tube, 3 Lanes (each side) highway tunnel of about 10.8 km, which passes through below the Sanjay Gandhi National Park (SGNP), connecting Western Express Highway (WEH) near Borivali and Ghodbunder road (of Thane) Near Tikujiniwadi. The feasibility of tunnel boring machine technology will be explored for doing the tunneling work as it causes very low vibrations and will have minimal impact on the surface environment. The tunnels may be connected by central 3 m wide baby tunnel; the vertical clearance in each tunnel is proposed to be minimum 5.50 m. The two twin tunnel would be about 2D apart in base and each tunnel will consist of three unidirectional lanes.

2. EXISTING CONNECTIVITY BETWEEN WESTERN & EASTERN SUBURBS OF MUMBAI

Major arterial roads in this region are Western Express Highway leading to NH8 and Eastern Express Highway leading to NH3. Both these Highways; especially Western Express Highway (5+5 lane wide) experiences huge traffic jams between 8am to 12pm in the morning and 6 pm to 11 pm in the evening with average travel speed reduced to less than 20 km/hr, resulting in huge fuel loss, causing major air and noise pollution in the city.

At present main east-west connecting links between these two major arterial roads from Bandra to Dahisar on Western Express Highway and Sion to Mulund on Eastern Express Highway, as shown in are as below;

1. Bandra – Sion Road
2. SCLR (Santacruz - Chembur Link Road)
3. AGLR (Andheri-Ghatkopar (Kurla) Link Road)
4. JVLR (Jogeshwari – Vikroli Link Road)

All these links are overcrowded and experience huge traffic jams. Further, there is no east-west link available between JVLR and Thane-Ghodbandar Road i.e. between Jogeshwari to Mira Bhayander on Western Express Highway – NH8 and Vikroli to Thane on Eastern Express highway-NH3. The next link available is Thane-Ghodbunder road connecting Thane on NH3 and Ghodbunder on NH8. Due to non-availability of east-west connectivity, vehicles coming from NH8 (Ahmedabad) and Western Suburbs, (Goregaon to Mira Bhayander) and going to Thane or to
eastern suburbs have to travel up to Ghodbunder, take Thane-Ghodbunder Link and then to their destination in eastern suburbs. Similarly vehicles from Nashik, Kalyan-Dombivali, Navi Mumbai, Thane, and Eastern Suburbs going to western suburbs have to take Thane-Ghodbunder link and from Ghodbunder they have to travel to their destination. Thus large numbers of vehicles have to take huge detour leading to wastage of time, fuel and resulting in more air and noise pollution. Considering present east-west traffic volume and future increase; at least two to three new connectivity links between JVL and Thane Ghodbunder road needs to be developed.

3. NEED TO STRENGTHEN CONNECTIVITY

Current population of MMR region is about 18.5 million (2011 census) and out of this population about 70% population resides in Mumbai Suburb (east-west) and Thane region. Major developments are also happening in this region. The need for connectivity between two suburbs has been studied with respect to projected increase in population, traffic volumes and response from existing transportation network as summarized as below.

A study conducted by Mumbai Metropolitan Region Development Authority (MMRDA) titled “Comprehensive Transportation Study for Mumbai Metropolitan Region” has analysis three preferred deferent development scenarios. Some of the results of analysis providing a feel of increase in traffic are as follows.

After reviewing the growth of population, employment and external goods vehicle travel by 2031 as compared to 2005 (1.63 times growth in population, 2.04 times growth in employment and 4.00 times growth in external goods travel), a growth factor of 3.00 has been assumed for internal goods vehicle travel by 2031. External travel demand, vehicle entering, leaving or passing through the MMR play a crucial role, connecting the study area with the state and the rest of India principally along the national and state highway, Eastern Express highway, Sion-Parvel Highway, Thane-Godbandar Road, etc.) corridors connecting the ports (Wadala Truck Terminal Road, Rafi Ahmed Kidwai Road, PD’Mello Road, NH4B, SH54, etc.) economic growth in the catchment areas of the connective road systems.

Over a period of 16 years (2005-21), it is estimated that, the private vehicle (two wheeler and car) model share will increase from 12.8% to around 21.5%. IPT trips (Auto Rickshaw and Taxi) area expected to decrease from 9.1% to around 5.6 % in three different growth scenarios reflecting the increase in private vehicle ownership and walk to metro.

Therefore considering the potential increase in demand and limited available connectivity strengthening of existing roads have been proposed by removing bottlenecks and additional connectivity is proposed.

4. ANALYSIS OF ALTERNATIVES

Distance between existing east-west link roads i.e. NH8 near Borivali and Thane-Ghodbunder road is about 25 km. Therefore, in order to reduce the load on Thane-Ghodbunder road and to meet future requirements the 2 to 3 link road should be provided between east and west. Almost entire area between Western Express Highway and Eastern Express Highway is covered by Arrey Dairy (forest) and SGNP, hence, no east-west link could be developed in this area in spite of genuine necessity. Considering this difficulty following alternates, in the best favour of environment, are being explored.
a. Capacity enhancement of Thane-Ghodbander road by providing widening or elevated road

Elevated road on Thane-Ghodbander road chg. 0/400 to 4/500 passing through SGNP at some locations is underway. This work is being performed to avoid the present situation of traffic congestion and cannot bear the load of further increase in traffic volume over the years.

Further to this, Right of Way (ROW) in the Thane Municipal Corporation has already been fully utilized by providing 3+3 lanes road and 1 lane of service road on either side. This stretch cannot be further widened.

b. Goregaon-Mulund Link Road (Elevated or Tunnel under Aarey Dairy) – by MCGM.

A new link road which has been proposed by MCGM is under consideration and being studied by the consultants. However, this road doesn’t shorten the route for commuters travelling between Thane and Borivali. Instead the Travelling length and travel time for the commuters is increased. In the present condition, commuters need to travel approx. 23 km via Ghodbunder road to reach Borivali from Thane. After completion of GMLR it would be more than 30 km, which won’t serve the purpose of providing a shortest route to connect NH3 with Western suburb (Borivali) and vice-versa. Therefore, considering the expected travel demand from Thane to Western Suburbs (Dahisar to Goregoan), Thane – Borivali Tunnel is critical.

c. Tikujiniwadi - Borivali Link (Tunnel under SGNP) by MSRDC

Elevated road between Tikujiniwadi and Borivali, would be cheaper than tunnel connectivity. However, elevated road option is not being considered as the same, if passes through SGNP, may lead to significant disturbance to wild life and use of forest land.

On the other hand tunnel construction would not require any forest land (or very minimum land), no displacement of people, no tree cutting etc. and lead to no or very little air and noise pollution during construction as well as during operations (muck removal and / disposal during construction will be planned meticulously). The proposed tunnel alignment can be finalized only after survey and investigations, for which permission is being sought.

d. Borivali-Thane ropeway over SGNP by MMRDA

An aerial tour over Sanjay Gandhi National Park (SGNP) with amazing scenic view of the forest has been proposed by The Mumbai Metropolitan Region Development Authority (MMRDA). The ropeway from Borivali to Thane is proposed in a bid to make the park a bigger attraction for the tourists. This is not a bid to decongest the east-west suburb connecting roads.

http://www.hindustantimes.com/mumbai/borivli-thane-ropeway-planned-over-sgnp/story-2Gb17j0d2fKDTeWVznlhPN.html
5. SIMILAR PROJECTS IN INDIA

Other recent project involving protected forest area in India cleared in recent past. Reference and respective weblink from public domain are as below;

5.1 Dedicated Freight Corridor in Western India gets Forest Clearance

The Dedicated Freight Corridor (DFC) project in western India, spanning over about 1,500 kilometres and covering six states, has received forest clearance from the Central Forest Advisory Committee on December 22, 2015. The clearance is for 58 hectares (ha) of forestland in Maharashtra in the reserved and protected forest areas of Thane (16 ha) and Dahanu (31 ha) forest divisions. It includes 10.8 ha of forestland diversion in Mumbai’s Sanjay Gandhi National Park (SGNP).


5.2 Sevoke-Rongpo BG Rail line (52-km) project gets Clearance from National Board for Wildlife

The National Board for Wildlife (NBWL), the apex body chaired by the Prime Minister of India, gave its final nod to the Sevoke-Rongpo new broad-gauge railway line earlier during mid 2015. The NBWL standing committee, in its June 2, 2015 meeting urged that the Northern Frontier Railways be allowed to start work immediately.


5.3 Maharashtra State Board for Wildlife approves two projects

Maharashtra State Board for Wildlife (SBWL) has cleared two major projects, including upgradation of the railway line through Melghat Tiger Reserve (MTR) and a lift irrigation scheme through Koka Wildlife Sanctuary.

Of the 176 km broad gauge line that will pass from Akola to Khandwa, over 38 km line passes through wildlife-rich area of tiger reserve and buffer zone.

Chief wildlife warden (CWLW) and member-secretary of SBWL, Shree Bhagwan, has recommended that existing underpasses need to be extended up to required width, besides creating new underpasses. Fencing should also be provided along the length of the railway line. It has also recommended relocation of Pili, Harisal and Mangia villages by the railways and that provision of the amount for relocation is included in the project cost itself. The board also cleared Surewada lift irrigation project situated on left bank of Wainganga river near Surewada in Bhandara. The project consists of 8.10 km underground rising main and 16.14-km-long main canal with 40 km distribution system. The project aims to provide irrigation for a 7,050 hectare area in 28 villages. Out of the 8.10 km, 0.650 km-long raising main falls within Koka Sanctuary.

The proposed canal work will be passing through the sanctuary, buffer zone and the eco-sensitive zone of Navegaon - Nagzira Tiger Reserve (NNTR).

http://www.projectstoday.com/News/Maharashtra-State-Board-for-Wildlife-approves-two-projects
Figure 1: Connecting Road between Eastern and Western Suburban areas of Mumbai
6. PROJECT DESCRIPTION

The proposed 10.8 km road tunnel will start from Tikujiniwadi near Patlipada in Thane-Godbunder road and end at the Western Express Highway end near Magathena Bus depot with twin tube tunnel. The proposed tunnel option will explore the possibility of another shorter and economical alignment to connectivity of two National Highways NH-3 and NH-8 which will not only save the time but will also help in reducing the traffic congestion from current route. At present, motorists have to travel 25 km in order to reach the Thane Tikujiniwadi area from Borivali via the Western Express Highway (WEH) and Thane-Godbunder road. Thane and Borivali will be connected in 20 minutes by this tunnel.

The objective of the proposed project is conducting detailed feasibility study and preparation of detailed project report for the construction of twin tube, 3 Lanes each highway Tunnel between Tikujiniwadi in Thane city to Western Express Highway. Approximate project cost would be about INR 2500 Crores.

7. ALIGNMENTS OF PROPOSED ROAD TUNNEL

The alternative locations/routes will be analysed during the survey so as to leave least impact on the environment. The tentative options as identified during the preliminary assessment. Three portals on either end were identified and respective alignments were evaluated. Many possible alignments due to involvement of forest and defense land in large extent were rejected. Other possible alignments (Option-1, Option-2 and Option-3) are shown in Figure-2 and discussed subsequently.

8. BENEFITS OF THE PROPOSED PROJECT

In view of increasing traffic load on thane Ghodbander road, it is necessary to look for an alternative. Therefore road tunnel passing below Sanjay Gandhi National park is being proposed which will provide fast and smooth movement of traffic from Thane to Borivali. The distance between thane and Borivali is also expected to reduce by over 10 km. This will also result in avoidance of traffic jams and saving fossil fuel and protecting environment due to reduced vehicular emissions.

- Distance saving for Thane to Borivali by about 10 Km.
- No disruption to existing township
- Travel time saving 20 to 25 minutes

Road tunnels were adopted in past only where other practicable means of road were not possible mostly for the highways in hilly terrains. Urban road tunnels were often discouraged due to an expensive option. However, it is increasingly difficult to provide the additional road space that may be required. Tunnels reduce noise, air pollution, community disharmony and are visually attractive unlike surface roads. The intangible costs, such as effect on community health, air pollution and noise, make tunneling viable if they are assessed. Construction costs are used to compare alternative transportation routes and in case other factors are considered, then tunneling would become a viable option. Currently the local community has to bear these costs as they are not recognized or accounted for in the normal evaluation of alternatives.
The three alignments were studied comprehensively and compared. After the detailed assessment, Option 2 is being persuaded for further studies.
### Table -1: Salient Features of Various Alternates to be studied for Alignment

<table>
<thead>
<tr>
<th>Option</th>
<th>Location</th>
<th>Land availability for development of portal/ Cut n cover</th>
<th>Topography and Landuse</th>
<th>Approx. Length of proposed alignment (km)</th>
<th>Ground Elevation Approx. m above msl</th>
<th>Proximity to eco-sensitive area</th>
<th>Population Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>From Western Express Highway near Magathane DP road to Shastri Nagar junction on Pokhran road no. 1</td>
<td>Private/ Government land on Western side and Government (Defence) land on Eastern side</td>
<td>The proposed western end is far away from the National park boundary and is habitated at present. However, there is a redevelopment plan of BMC of the region. The proposed eastern end lies outside the National park in the defence land. The topography along the alignment is Undulating on a hilly terrain under green cover.</td>
<td>9.68</td>
<td>470 m (max.)</td>
<td>&gt; 95% of total proposed alignment is within SGNP. However, no National park land required for the construction.</td>
<td>Significant population of slum area at the Western end at present which is the part of BMC’s redevelopment plan.</td>
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<td>2</td>
<td>From NH8 near Magathane DP road to Tikujiniwadi near Patlipada</td>
<td>Private/ Government land on both Western and Eastern side</td>
<td>The proposed western end is far away from the National park boundary and is habitated at present. However, there is a redevelopment plan of BMC of the region. The proposed eastern end lies outside the National park in the forest area. The topography along the alignment is Undulating on a hilly terrain under green cover.</td>
<td>10.85</td>
<td>357 m (max.)</td>
<td>&gt; 95% of total proposed alignment is within SGNP. However, no National park land required for the construction.</td>
<td>Significant population of slum area at the Western end at present which is the part of BMC’s redevelopment plan.</td>
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<td>3</td>
<td>From Ekta Nagar in Western side to Shastri Nagar junction on pokhran road no. 1</td>
<td>Private/ Government land on Western side and Government (Defence) land on Eastern side</td>
<td>The proposed western end location is on the border of SGNP (north-western corner). The topography of the area undulating rocky area sloping towards north west direction. Eastern portal is outside the SGNP. Open land parcel sloping towards eastern direction.</td>
<td>12.56</td>
<td>397 m (max.)</td>
<td>&gt; 95% of total proposed alignment is within SGNP. However, no National park land required for the construction.</td>
<td>No population along the proposed alignment.</td>
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<td>Option 1</td>
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<td>Population along the proposed alignment above Yeoor hills</td>
<td>Developing residential societies of Patlipada near eastern end.</td>
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<td>Direct Connectivity to National Highway</td>
<td>Direct Connectivity to NH8 and Pokhran road number 2 at both western and eastern end respectively through Cut n cover.</td>
<td>Direct Connectivity to NH8 and Thane Ghodbunder road at both western and eastern end respectively through Cut n cover / access roads.</td>
<td>Connectivity to NH8 on western side through elevated structures and Pokhran road on eastern end through access roads.</td>
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<td>Proximity to identified water Sources</td>
<td>Alignment is crossing one identified stream flowing from south to north in the middle east of the forest area</td>
<td>Alignment is crossing one identified stream flowing from south to north in the middle east of the forest area</td>
<td>Alignment is crossing one identified stream flowing from south to north in the middle east of the forest area</td>
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<td>Loss of agricultural land</td>
<td>Nil</td>
<td>Nil</td>
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<td>Proximity to ASI sites</td>
<td>No</td>
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9. APPROACH AND METHODOLOGY FOR GEOTECHNICAL INVESTIGATION AND ENVIRONMENTAL MONITORING

The survey activity will include geotechnical investigation and environmental monitoring by core recovery drilling of bore holes, by calyx drilling machine simultaneously on both the portals, for geological assessment at few locations, environmental baseline monitoring including sample collection of ambient air quality, noise, surface water, soil, etc. and lab analysis of samples.

Keeping in view the sensitivity of the forest and wildlife in addition to the homogeneous lithology of the area, drilling of boreholes throughout the alignment may not be required. Sample bore holes of NX Dia may be restricted to the portal area and possible locations along the routes in the park. The cores shall be collected throughout the length of the drill hole. This data will be supported by surface rock samples which may collected during trekking along the suitable alignment as a part of survey. These samples shall be collected at the change of geology on an average at 1.0-2.0 Km distance based on the accessibility inside the forest area. The locations for drilling of boreholes have been selected in consultation with forest authorities during joint survey with a criteria that no tree felling is sought for the survey work. The proposed locations of drilling for study of Option-2 as identified during walkthrough survey conducted during 5th and 6th January 2017 with SGNP representative are mentioned in subsequent section of this report. These locations have been identified based on the ease of accessibility and out of these only about 9 (7 in Tulsi/Krishnagiri and 2 in Yeur range inside the national park along the alignment) best suitable locations have been identified during the survey.

9.1 Machinery to be used for drilling

The drilling equipment and machinery will depend upon the type of strata encountered.

Figure 3: Machinery to be used for soil borehole drilling
Figure 4: Soil SPT Testing

Figure 5: Core recovery boxes (to be used in case of rock encountered)
9.2 Equipment’s for environmental baseline monitoring

Figure 6: High volume dust sampler

9.3 Schedule for Geotechnical investigation

An indicative schedule for the geotech investigation is as proposed below. The schedule for Environmental Baseline monitoring will be proposed separately once the Terms of References are approved from competent authority for the study.

Table 2: Indicative Schedule for Geotech Investigation

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Area inside park

Considered rate of drilling as an average of 2.5 m/day

Schedule for environment monitoring will be prepared once the work is started.
10. SITE SELECTION FOR GEOTECHNICAL INVESTIGATION THROUGH JOINT SURVEY

MSRDC had originally submitted an application for seeking prior permission for carrying out investigative survey vide letter no. MSRDC/02/JMD(III)/Tunnel/File No. 01/3136 dated 8-Jun-16. However, due to alignment change another request was submitted by MSRDC to the office of CCF cum Director – Sanjay Gandhi National Park (SGNP) for joint walkthrough survey. A permission for joint survey for the purpose was granted by CCF and Director of SGNP vide letter no. 4033 dated 3-Jan-17 was accorded in response to above referred MSRDC request.

Accordingly, a walk through joint survey was conducted along the proposed alignment by forest and project representatives on 5-Jan-17 and 6-Jan-17. During the joint survey, locations for geotechnical investigations were identified with the criteria of minimal reversible impact on environment.

Joint team of forest representatives and project representatives as below met at SGNP followed by the survey was conducted;

SGNP Representatives

- Assistant Conservator of Forest (Protection & Wildlife)
- Smt. Priyanka Barge - Range Forest Officer (Tulsi Range)
- Mr. Rajendra Pawar - Range Forest Officer (Krishnagiri Range)
- Mr. Sanjay Waghmode - Range Forest Officer (Yeoor Range)

MSRDC Representatives

- Mr. Shridhar Arlikar, Executive Engineer
- Mr. Aniruddha Borde, Assistant Engineer

AECOM (Consultant to MSRDC)

- Mr. Atul Kumar,
- Mr. Manas Shirsat,
- Ms. Rashmi Dutta,

Series of photographs tied up with identified Geotech investigation locations on the proposed alignment during the joint survey is presented as below. The photographic log below, represents that the identified locations have enough open space for the installation of drilling machine and no tree felling is required, a flat surface and not a part of dense forest.
Overall Proposed alighnemtn of tunnel and identified borehole locations
The identified locations for Geotech investigation and drilling bore holes are as listed below:

Table -3: Exploratory Borehole Locations and Quantity of Samples to be collected from SGNP area

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Bore Hole no.</th>
<th>Easting</th>
<th>Northing</th>
<th>Depth</th>
<th>Soil</th>
<th>Rock</th>
<th>Size of Rock Samples</th>
<th>Length (m) of drill hole for</th>
<th>Diameter (Dia)</th>
<th>Rock Sample Vol (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FBH-1</td>
<td>276255.8</td>
<td>2126766</td>
<td>21</td>
<td>1</td>
<td>20</td>
<td></td>
<td>20</td>
<td>54.7</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>FBH-2</td>
<td>276641.8</td>
<td>2126841</td>
<td>31</td>
<td>1</td>
<td>30</td>
<td></td>
<td>30</td>
<td>54.7</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>FBH-3</td>
<td>277135.6</td>
<td>2126940</td>
<td>33</td>
<td>1</td>
<td>32</td>
<td></td>
<td>32</td>
<td>54.7</td>
<td>0.08</td>
</tr>
<tr>
<td>4</td>
<td>FBH-4</td>
<td>277606.5</td>
<td>2127032</td>
<td>39</td>
<td>1</td>
<td>38</td>
<td></td>
<td>38</td>
<td>54.7</td>
<td>0.09</td>
</tr>
<tr>
<td>5</td>
<td>FBH-5</td>
<td>278118.2</td>
<td>2127136</td>
<td>45</td>
<td>1</td>
<td>44</td>
<td></td>
<td>44</td>
<td>54.7</td>
<td>0.10</td>
</tr>
<tr>
<td>6</td>
<td>FBH-6</td>
<td>278437.7</td>
<td>2127202</td>
<td>49</td>
<td>1</td>
<td>48</td>
<td></td>
<td>48</td>
<td>54.7</td>
<td>0.11</td>
</tr>
<tr>
<td>7</td>
<td>FBH-7</td>
<td>278879.7</td>
<td>2127288</td>
<td>60</td>
<td>1</td>
<td>59</td>
<td></td>
<td>59</td>
<td>54.7</td>
<td>0.14</td>
</tr>
<tr>
<td>8</td>
<td>FBH-8</td>
<td>284817.2</td>
<td>2128460</td>
<td>86</td>
<td>1</td>
<td>85</td>
<td></td>
<td>85</td>
<td>54.7</td>
<td>0.20</td>
</tr>
<tr>
<td>9</td>
<td>FBH-9</td>
<td>283950.3</td>
<td>2128283</td>
<td>98</td>
<td>1</td>
<td>97</td>
<td></td>
<td>97</td>
<td>54.7</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td>453</td>
<td>453</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.07</td>
</tr>
</tbody>
</table>

**Surface Samples**

About 2 kg rock Samples at each change of geology / 1Km length.

The drill holes from FBH-1 to FBH-9 shall be carried out in the park area and the cumulative quantity of Surface Rock, Soil and Rock Core samples to be collected and transported out of Sanjay Gandhi National Park will not exceed 2.00 m$^3$. 
11. IMPACT ASSESSMENT – DESKTOP ASSESSMENT

The purpose of this desktop study for “impact assessment” is to identify potential impacts on the existing environmental conditions within the national park, due to the proposed survey work. Based on the impacts identified, the mitigation measures, corresponding to the impacts, have also been suggested in the report.

These investigations are necessary to identify the types of soils and materials present below the ground surface in the area, in order to determine feasibility to construct the major components. These major components would require specific and accurate geotechnical information, such as different amounts and types of support from the underlying earthen materials.

The aim of this assessment is to protect park resources, to minimize the extent of surface and subsurface disturbance, and to ensure that sites are left as close to pre-disturbance conditions to the extent possible. Hand equipment and pedestrian access is preferred. It is recognized that mechanized equipment may be a reasonable or sole alternative depending upon the type of project and site characteristics. This report will also help in defining the terms for obtaining permission for taking up proposed non forestry activities inside Sanjay Gandhi National Park, Borivali.

The rationalizing and upgrading the transport system is imperative especially long distance routes. In the process of development there has been intensive use of natural resources. Very often the process of development has adversely affected the environment leading to ecological imbalances. The importance of conserving and enhancing the environmental assets has assumed urgency.

The Impact Assessment process began with the scoping process to identify the significant environmental impacts due to the proposed survey work inside SGNP. The type and magnitude of the impacts, however, depend on the specific attributes of the given environment. As far as possible, based on the secondary data, attempts have been made to quantitatively predict the impacts due to the proposed survey work. However, for non-quantitative impacts, qualitative assessment has been done. Potential impacts on environment due to the proposed activities have been summarized in Table-4. The impacts due to the project location are generally irreversible but minor in nature. However, impacts related to the survey work are very short term, which can be set-off by observing a set of precautionary measures.
### Table-4: Impact Matrix of Potential Environmental Impacts

<table>
<thead>
<tr>
<th>Major Proposed Activities</th>
<th>Potential Aspect</th>
<th>Potential Impact</th>
<th>Reversible / non reversible</th>
<th>Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization of Machines inside SGNP</td>
<td>Noise from movement of machine transport vehicles</td>
<td>Increase in Noise level</td>
<td>Reversible</td>
<td>Movement to be managed on predefined roads closest to the park boundary. All the movement during day time. Route to be decided in consultation with SGNP authorities.</td>
</tr>
<tr>
<td>Mobilization of Machines inside SGNP</td>
<td>Fugitive dust emission due to movement of vehicle</td>
<td>Degradation of ambient air quality</td>
<td>Reversible</td>
<td>Movement to speed to be maintained within 20 kmph. Movement during day time only.</td>
</tr>
<tr>
<td>Mobilization of Manpower inside SGNP</td>
<td>Domestic waste generation from food, etc.</td>
<td>Aesthetic pollution &amp; odour</td>
<td>Reversible</td>
<td>Waste management plan to be prepared, implemented and monitored.</td>
</tr>
<tr>
<td>Mobilization of Manpower inside SGNP</td>
<td>Noise due talking and shouting by drilling workers</td>
<td>Increase in Noise level</td>
<td>Reversible</td>
<td>Training to the manpower for maintaining discipline inside SGNP.</td>
</tr>
<tr>
<td>Drilling Activity</td>
<td>Clearing of shrubs (minimum to the extent possible)</td>
<td>Loss of vegetation</td>
<td>Reversible</td>
<td>Drilling locations to be selected requiring minimum clearing of vegetation.</td>
</tr>
<tr>
<td>Drilling Activity</td>
<td>Noise &amp; Vibration generation from rock drilling</td>
<td>Increase in Noise level</td>
<td>Reversible</td>
<td>- Drilling activity to be restricted to day time only; - Drilling locations to be selected away from controlled drilling core area of the forest; - Drilling area close to core area will be provided with noise barriers.</td>
</tr>
<tr>
<td>Drilling Activity</td>
<td>Fugitive dust emission from rock drilling</td>
<td>Degradation of ambient air quality</td>
<td>Reversible</td>
<td>Water spray around drilling area to supress the fugitive dust emission.</td>
</tr>
<tr>
<td>Drilling Activity</td>
<td>Emission from fuel combustion for generating compressed air</td>
<td>Degradation of ambient air quality</td>
<td>Reversible</td>
<td>- Compliance certificate on applicable emission standard from the power generator; - Pollution under control certificate as per applicable motor vehicle act for the vehicle.</td>
</tr>
<tr>
<td>Drilling Activity</td>
<td>Noise generation from Air compressor / diesel power generator</td>
<td>Degradation of ambient noise level</td>
<td>Reversible</td>
<td>- Compressor should be noiseless - Acoustic enclosure to be provided with power generator;</td>
</tr>
<tr>
<td>Environmental Baseline Monitoring</td>
<td>Noise generation from high volume sampler</td>
<td>Increase in Noise level</td>
<td>Reversible</td>
<td>High volume samplers to be installed in areas near to human population inside SGNP, where baseline noise is already high compared to core forest area.</td>
</tr>
<tr>
<td>Demobilization of Machines from SGNP</td>
<td>Waste (drill cuttings, leftover from machine operations)</td>
<td>Aesthetic pollution &amp; odour and environmental contamination</td>
<td>Reversible</td>
<td>Waste management plan to be prepared, implemented and monitored.</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Demobilization of Manpower from SGNP</td>
<td>Domestic Waste (leftover cloths, food, packaging material, etc)</td>
<td>Aesthetic pollution &amp; odour</td>
<td>Reversible</td>
<td>Waste management plan to be prepared, implemented and monitored.</td>
</tr>
</tbody>
</table>
12. IMPACTS OF NOISE AND VIBRATION ON VEGETATION AND WILDLIFE

Drilling equipment and machinery would generate the noise from the associated activities. The potential impact of the proposed construction activities on the ambient noise quality of nearby areas will include the following:

The geotechnical investigation and collection of soil samples would utilize construction equipment commonly used on roadway construction projects which typically range from 80 to 89 dBA at a distance of 50 feet. Construction noise is expected to increase during peak construction time with operation of equipment and machinery engaged for construction activities. Drilling may have local site-specific impacts but probably not long-term effects.

Wildlife may be sensitive receptors to noise and vibrations. Animals rely on meaningful sounds for communication, navigation, avoiding danger, and finding food. The level of disturbance may be qualified as damage, which may harm health, reproduction, survivorship, habitat use, distribution, abundance or genetic distribution, or disturbance which causes a detectable change in behaviour. Behavioural and physiological responses of wildlife to noise have the potential to cause injury, energy loss, decrease food intake, habitat avoidance and abandonment, and reproductive losses.

The potential impact of high noise generation is mainly disturbance to the habitations in the proximity. The SGNP is a house of a wide variety of flora and fauna and wildlife, including many species of insects, types of mammals, and a myriad of bird species. Inside the Park, there are two lakes: Vihar and Tulsi but these are over 3 km away from proposed locations. In addition archaeological sites within the Park trace back to the Golden Age of Buddhism in 1st century BC. Religious sites are scattered around the park; the most famous being the Kanheri Caves, 109 caves in an area overlooking the Park that bring up to 10,000 visitors per year. Incidentally this archaeological site is also over 3 km away from proposed survey locations.

No significant noise impacts from the geotechnical investigations or soil surveys are anticipated because activities would be conducted in accordance with National Ambient Quality Standards and would be temporary and short term. Furthermore, the equipment would not operate continuously at any single location. Noise associated with the field survey would be limited to vehicle noise accessing the site. Once on site, the field survey activities are not expected to result in excessive noise, as activities would involve a field surveyor walking the site by foot with a survey road and making visual observations. There would be no significant impacts to noise as a result of project related noise.

12.1 Impact on Vegetation and Wildlife habitats due to manual entrance into the National Park

The rich flora and fauna of Sanjay Gandhi National Park attracts more than 2 million visitors every year. The park is home to a number of endangered species of flora and fauna. The forest area of the park houses over 1000 plant species, 251 species of migratory, land and water birds, 50,000 species of insects and 40 species of mammals. In addition, the park also provides shelter to 38 species of reptiles, 9 species of amphibians, 150 species of butterflies and a large variety of fish.
Project activities such as drilling would temporarily produce activity and manual entrance that would disturb wildlife and cause them to disperse. This local displacement would create a short-term impact to large and small mammals. Displacement would affect a small number of overwintering breeding birds. Overall, effects on wildlife would be short-term and minor.

12.2 Mitigation Measures

The mitigation measures to the identified impacts have been mentioned in the table 3.1 This section describes environmental commitments that would be implemented as part of the project. The avoidance/minimization measures discussed below would be included as part of the project, and would further decrease the severity of any short term or temporary impacts on resources.

12.2.1 Mitigation measures for Potential Noise pollution:

The mitigation measures to be adopted for mitigation of excess noise are as below;

- Movement to be managed on predefined roads closest to the park boundary. Vehicular movement to be restricted to day time;
- Route for movement to be decided in consultation with SGNP authorities;
- Training to the manpower for maintaining discipline inside SGNP;
- Drilling activity to be restricted to day time only;
- Drilling locations to be selected away from controlled drilling core area of the forest;
- Drilling area close to core area will be provided with noise barriers;
- Compressor should be noiseless;
- Acoustic enclosure to be provided with power generator;
- High volume samplers to be installed in areas near to human population inside SGNP, where baseline noise is already high compared to core forest area
- All equipment will have sound control devices no less effective than those provided on the original equipment. No equipment will have an unmuffled exhaust.
- Truck loading and unloading will be conducted so that associated noise impacts are kept to a minimum by carefully selecting routes to avoid going through residential neighbourhoods to the greatest extent possible.

In case of noise complaints by the public, the field manager will be notified and implementation of noise mitigation measures will be reviewed, if necessary.

12.2.2 Mitigation measures for potential Air Pollution

Suggested mitigation measures for impacts identified on air quality are as below;

- Movement to speed to be maintained within 20 kmph. Movement during day time only;
- Water spray around drilling area to supress the fugitive dust emission;
- Compliance certificate on applicable emission standard from the power generator;
- Pollution under control certificate as per applicable motor vehicle act for the vehicle.

12.2.3 Mitigation measures for the impacts related to manual intervention:

Mitigation measures required towards impacts identified due to manual intervention inside the SGNP are as follows;

- Training to the manpower for maintaining discipline inside SGNP in order to avoid or terminate activities on-site that attract or harass wildlife;
• Waste management plan to be prepared, implemented and monitored. All work areas are to be closely policed for litter, and food and food waste may be stored only within an approved bear-proof facility, or secure building or vehicle. Food waste is to be kept separate from construction waste and removed daily;

Temporary work space may require clear marking with flagging to contain the work area, minimize soil and vegetation disturbance, and to prevent trespass violations by the contractor.

Generally, clearing vegetation beyond herb layers and surface litter is to be avoided, and alternate or surrogate locations sought. Where, absolutely necessary to work adjacent to existing trees and shrubs, the permittee shall exercise all possible care to avoid injury to vegetation.

Protect roots of trees to drip line during excavation to prevent disturbance or damage. Avoid unnecessary traffic, dumping, and storage of materials over root zone. The drilling locations to be identified requiring minimum clearing of vegetation.

13. CONCLUSION

Proposed work is limited to geotechnical investigation and environmental monitoring work for conducting Environmental Impact Assessment study. The geotechnical investigation locations have been identified during joint survey with criteria of minimal reversible impact with no tree felling. The minimal reversible impacts have been identified, evaluated and mitigation measures have been identified. Implementation of the measures described in Section 11.4 above as Avoidance / Minimization Measures would result in to further reduction of impacts due to proposed geo-technical investigation and environmental baseline monitoring.