Volume I. Main Report

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY (ESIA) FOR WESTERN CORRIDOR OF DEDICATED FREIGHT CORRIDOR PROJECT (PHASE 2) FOR JNPT–VADODARA AND REWARI–DADRI SECTIONS

FINAL REPORT

NOVEMBER 2011

Dedicated Freight Corridor Corporation of India Ltd.
(A Govt. of India Undertaking under
Ministry of Railways)

Environmental and Social Impact Assessment Study for Western Corridor of Dedicated Freight Corridor Project (phase 2) for Vadodara-JNPT and Rewari-Dadri Sections

Final Report

Table of Contents

CHAPTER 6 POLLUTION CONTROL STUDY

CHAPTER 7 NATURAL ENVIRONMENT

CHAPTER 8 SOCIAL ENVIRONMENT

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

List of Abbreviation

AF_S	:	Affected Families
BIS	:	Bureau of Indian Standard
BOD	:	Biological Oxygen Demand
BPL	:	Below Poverty Line
BSR	:	Basic Schedule of Rates
cc	:	Cubic Centimetre
CF	:	Conservator of Forest
Cl	:	Chlorine
COD	:	Chemical Oxygen Demand
COI	:	Corridor of Impact
CPCB	:	Central Pollution Control Board
CPR	:	Common Property Resources
CSO	:	Civil Society Organisation
CSR	:	Common Schedule of Rates
CS	:	Construction Supervision
CWC	:	Central Water Commission, India
DC	:	District Collector
DDP	:	Desert Development Programme
DFC	:	Dedicated Freight Corridor
DFC	:	Dedicated Freight Corridor
DFCCIL	:	Dedicated Freight Corridor Corporation of India Limited
DFO	:	Divisional Forest Offices
DO	:	Dissolve Oxygen
DPR	:	Detailed Project Report
DSP	:	Density of the Species
EIA	:	Environment Impact Assessment
EMAP	:	Environmental Management Action Plan
EMP	:	Environment Management Plan
EMU	:	Environment Management Unit
EP	:	Entitled Person
ESCS	:	Environmental and Social Considerations Study
ESIMMS	:	Environmental and Social Impact Mitigation Measure Study
Fe		Iron (Ferrum)
GOI	:	Government of India
GRC	:	Grievance Redressal Committee
GSFC	:	Gujarat State Fertilizer Company
Hg	:	Mercury (Hydrargyrum)
IBG	:	Important Broad Gauge
ICD_S	:	Inland Container Depot
ILO	:	International Labour Organisation
IS	:	Indian Standard
JARTS	:	Japan Railway Technical Services
JBIC	:	Japan Bank for International Cooperation
JICA		Japan International Corporation Agency
K	:	Potassium (Kalium)
LA	:	Land Acquisition
LA Act	:	Land Acquisition Act
LA_E	:	Exposure Noise Level
LAeq	:	Equivalent Noise Level
M&E	:	Monitoring and Evaluation
MLA	:	Member of Legislative Assembly
MOEF	:	Ministry of Environment and Forest
MOR	:	Ministry of Railways
NGO	:	Non Government Organization
NPRR	:	National Policy on Resettlement and Rehabilitation
NRCP	:	National River Conservation Plan
NRP	:	National Rehabilitation Policy

NTH	:	Non Titleholder
ODA	:	Official Development Assistance
OBC		Other Backward Caste
PAF_S	:	Project Affected Families
PAH	:	Project Affected Household
PAP_S	:	Project Affected Person
PCCF	:	Principal Conservator of Forest
PI	:	Performance Indicator
PIAW	:	Potential Impact Area of Wildlife
PUC	:	Pollution Under Control
PVAC	:	Property Valuation Assessment Committee
RAP	:	Resettlement Action Plan
RF	:	Reserved Forest
RFM	:	River Flow Measurement
ROB	:	Road Over Bridge
ROW	:	Right of Way
R&R	:	Resettlement and Rehabilitation
RRO	:	Resettlement and Rehabilitation Officer
RRP	:	Resettlement and Rehabilitation Plan
RRS	:	Resettlement and Rehabilitation Specialist
RUB	:	Road Under Bridge
SAC	:	Space Application Centre
SAL	:	Study Area Location
SC	:	Scheduled Caste
SC	:	Supervision Consultant
SIA	:	Social Impact Assessment
SiI	:	Sighting of Individuals
SPCB	:	State Pollution Control Board
SR	:	Sensitive Receptor
ST	:	Scheduled Tribe
TH	:	Title Holder
TOR	:	Term of Reference
U/s	:	Under Section
VRC	:	Village Rehabilitation Committee
WB	:	World Bank
WHH	:	Women Headed Households
WHO	:	World Health Organization
WLS	:	Wild Life Sanctuaries

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY OF FINAL ESIA REPORT

The Ministry of Railways (MOR) through the Dedicated Freight Corridor Corporation of India Limited (DFCCIL), a Special Purpose Vehicle (SPV) is implementing Computerized Multi Modal High Axle Load Dedicated Freight Corridor Project between Delhi-Mumbai under the Western DFC Corridor and Ludhiana-Delhi-Kolkata under the Eastern DFC Corridor. The Western DFC Corridor for a total length of 1,483 km has been divided into 2 phases, in which Phase 1 covers corridor between Vadodara and Rewari and Phase 2 includes JNPT in Mumbai to Vadodara and Rewari to Dadri including a single line connection of approximately 19 km long from the DFC mainline near Faridabad District to Tuglakabad area of Delhi. The total length of the freight corridor of Phase 2 is approximately 565 km.

The corridor shall be predominantly double line (except where single line is justified on traffic considerations) with electrification and advanced signaling system facilitating running of freight trains at higher speeds up to 100 km/hour. The track sub structure like formation, bridges etc. shall fit for 32.5 tonne axle load whereas the track structure shall fit for 25 tonne axle load to provide infrastructure fit for heavy/long haul operation up to trailing load of 13,000 tonnes and train lengths of up to 1,500 meters. The provision of grade separators with all existing rail/road infrastructure i.e. ROB/RUBs at important level crossing gates shall be provided to avoid any detention to either road or rail traffic. Higher schedule of dimensions (SODs) and maximum moving dimensions (MMDs) shall be included in the design in order to run wider stock, double stack containers and newly designed wagons so as to have improved payload to tare ratio.

Implementation of the DFC project will result in reducing the carbon intensity of India's transport sector. The GHG emissions under DFC scenario will be primarily coming only from electricity consumption in locomotives during freight movement and fossil fuel and electricity usage in support infrastructure of DFC.

The DFC project will also restore the Indian Railways' competitive strength in the freight transportation market and emerge as the major low carbon and energy efficient transport system in the country. It will drive the establishment of industrial corridors and logistic parks along its alignment and play a crucial role in supporting India's growing economy.

S.1 OUTLINE OF ESIA

S.1.1 Scope of ESIA

A detailed ESIA, including preparation of an Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP), is conducted in order to mitigate potential negative environmental and social impacts by the Phase 2 of the Western Corridor. The specific objectives of the ESIA study are to:

i) Identify and assess potential environmental and social impacts and recommend specific mitigation, management, and monitoring measures to avoid, offset or minimize the impacts,

ii) Formulate an implementable EMP and EMoP integrating the technically and economically feasible measures to avoid the identified impacts and an appropriate monitoring and supervision mechanism to ensure its implementation,

iii) Recommend suitable institutional mechanisms to monitor and supervise effective implementation of EMP and EMoP,

The Environmental and Social Impact Assessment (ESIA) was conducted from September 2010 to October 2011 under technical support by the Japan International Cooperation Agency (JICA) and following '*JICA Guidelines for Environmental and Social Considerations, April 2010*'.

The area covered by ESIA is spread over 14 districts of 5 states where relevant railway facilities will be built for Dedicated Freight Corridor (DFC) development. The ESIA area is as shown in Table S.1.1 and Figure S.1.1.

Table S.1.1 Affected Areas of Phase 2 of the DFC Western Corridor

Section	State	Districts
JNPT-Vadodara	Maharashtra	Thane, Raigad
	Gujarat	Vadodara, Bharuch, Surat, Navasari, Valsad
Rewari-Dadri (including TKD line)	Rajasthan	Alwar
	Haryana	Faridabad, Gurgaon, Rewari, Palwal, Mewat
	Uttar Pradesh	Gautam Buddh Nagar
Total	5 State	14 Districts

Nearly 70% of the alignment length in JNPT-Vadodara section has been kept parallel to the existing lines. However, it is entirely on a new alignment route from Rewari to Dadri. For providing connection to Tuglakabad ICD, a single TKD line is partly on detour route and partly parallel to the existing Delhi-Mathura line.

S.1.2 Components of ESIA

The ESIA study consists of pollution control study, natural environmental study, social impact study, public consultation and information dissemination, impact identification and assessment, preparation of mitigation measures, preparation of EMP and EMoP. Various environmental and social parameters are studied along the proposed corridor route during 2010-11 with the relevant primary data generated on the river water quality, natural environment, land use, sensitive receptors, noise and vibration, hydrogeological and social baseline surveys along with the secondary information collected from various statutory agencies of the State Governments to identify, assess and predict potential impacts due to various activities of the project. The public consultation meetings were conducted in various districts of the five states and the affected population's responses were recorded.

The ESIA report has covered detailed analysis of project alternative alignments, analysis of Indian environmental legislations applicable to the project along the proposed corridor and the necessary statutory clearances likely to be obtained by the executing agencies, also highlighting the clearance procedures involved for the execution of the project and detailed overview of the existing environmental conditions along the project corridor. Mitigation measures are identified for all environmental impacts due to the proposed project activities and its components. Environmental Management and Monitoring Plans has focused on the implementation of mitigation measures at various stages of the project to curtail adverse impacts including a detailed monitoring plan for a safeguard of the environment with a time frame for the monitoring activities.

Figure S.1.1 Phase wise Map of Western Corridor

S.2 OUTLINE OF THE PROJECT

S.2.1 Project Scope for ESIA

The Project scope evaluated subject to the ESIA is shown in Table S.2.1.

Table S.2.1 Summary of Project Scope for ESIA

Items \ Section		JNPT-Vododara	Rewari-Dadri
Length of Alignment		420 km (Detour:121 km and Parallel:299 km)	145 km (Detour:137 km and Parallel:8 km)
Tunnel		1 (540 m)	-
Junction Station		3 (JNPT, Kharbao, Gothangam)	3 (Pirthala, Dadri and TKD)
Cross Station[*1]		9 (Nilje, Palghar, Gholvad*, Navsari, Joravasan*, Sanjali, and Varediya)	2 (Dharuhera and Mewat)
Railway Flyovers		7	2
ROB		58	19
RUB		145	95
Total Bridges over rivers	All Bridge	701	72
	Important Bridge	13	2
Substation		60 km distance[*3]	60 km distance[*3]

Note: 1.Additional Cross Station is under planning.
2. The depot plans are not included in the Phase 2 section.
3. The distance is referred to Phase 1 data.

S.2.2 Examination of Alternatives

(1) Examination of Detail of Alternatives

1) Examination of Detour Alignment

In Phase 2, the entire mainline section of Rewari-Dadri is a complete detour. For providing connection to Tuglakabad ICD, a single TKD line is partly on detour route and partly parallel to the existing Delhi-Mathura line. In JNPT-Vadodara section, detour has been largely considered to avoid heavily built-up areas involving major rehabilitation problems of large number of people and difficulties in land acquisition even on high cost as well as difficulties in execution of the project in heavily built-up area. Detour routes have been carefully planned so as to minimally affect fertile agricultural land though complete avoidance is not possible. Table S.2.2 and

Figure S.2.1 show alternatives for the detour alignment in JNPT-Vadodara section within DFC Western Corridor.

2) Examination of Parallel Alignment

Less urbanized areas have more land width available for ROW near the existing railway track. Even minor rehabilitation and resettlement of illegal settlers who have settled within or near railway land is cost effective as compared to adopting an option of detour route. All possible environmental impacts such as drainage, tree cutting, noise and vibration in parallel alignment could be easily addressed. Also the cost of the project is considerably reduced even after including cost of compensation for resettlement. Hence for the less developed areas near the existing IR tracks, the alignment is preferably considered for parallel alignment.

Table S.2.2 Alternatives for Detours in JNPT-Vododara Section

S. No	Detour	Contents of Alternatives and Considerations	Selected Alternative and Reason of the selection
1	Kunde Vahal Detour	**Alternative 1:** A length of 3.45 km passing from outside of the village to smoothen out sharp radius of curve, and avoid metal quarry mountainous site. Provision of tunnel alignment also considered but this alignment route traverses through a large area of agricultural land. **Alternative 2**: Open cut to cross over the already degraded quarry mountain and passing through Kunde Vahal Village i.e. 50 to 65 m away from the existing IR track in a stretch of 400 to 500 m. However, the alignment was affecting many existing habitation in the village entailing major issue of R&R. Further, the local community in the village was completely getting affected due to a division of village into two parts by the DFC embankment. **Alternative 3**: An alignment route with a total length of 2.30 km to pass along the edge of metal quarry mountainous site and between outer boundary of Kunde Vahal and Ovale Villages. This alignment gave many advantages – reduced length of detour alignment, minimal effect on loss of agricultural land, minimal effect on resettlement issue, minimal interference of quarrying operations on DFC activities, and other social and environmental benefits. However, this route will affect Electrified High Tension Towers (HTT) line in the area.	**Alternative 3** - Sharp curve of the existing IR track - Main habitation of Kunde Vahal Village getting bifurcated by DFC track - Avoidance of metal quarry mountainous site
2	Datiwali (Diva) Detour	This detour route is selected vis-à-vis a parallel route to avoid built up area in and around Datiwali Station, marshy area near Ulhas creek, and many sharp curves of existing IR track. No existing village habitation will be affected by this detour route. In the parallel alignment immediately after detour and south of Ulhas River, it is proposed to provide reinforced vertical wall near the built up area where embankment will be approximately 10-meter height.	-Heavy built-up area in and around Dativali Station - Marshy area near Ulhas Creek - Many sharp curves of the existing IR track
3	Vasai Detour	This detour of a total length approximately 18 km will be provided between Juchandra and Vaitarana Stations to avoid a number of built up areas between these stations at Vasai Road, Nalasopara and Virar in particular. In the surrounding area of Vaitarana River, there is marshy land. There are lots of development activities along the existing Railway track. Also, there are three Road over Bridges (ROB) which will have to be rebuilt. It is extremely difficult to rebuild these ROBs as the area is fully developed.	- Large scale built up area at 3 stations at Vasai Road, Nalasopara and Virar on existing IR track - Illegal settlers on railway land at these 3 stations - Marshy area near Vaitarana River - Difficult to rebuild 3 ROBs as the area is fully developed around them
4	Dahanu Detour	**Alternative 1**: It was planned to provide detour of length of 7 km around Dahanu Road Station due to the following two reasons. Firstly, there exists a ROB near Dahanu Road Station which is difficult to re-construct as the area is fully occupied by residential buildings and the traffic on this ROB is so heavy that it is not possible to suspend traffic on ROB during re-construction period. Secondly, as part of the augmentation of the Suburban services, a new goods shed has been constructed on the south east side of the Dahanu Station and in the north there will be EMU terminal with circulating area in the east. As a result, it will not be possible to have any access for the DFC tracks through the yard. Moreover, many new construction activities are on-going in the area adjoining the station and also along the existing western railway line before and after Dahanu Station. **Alternative 2**: It was found that the above alternative had some limitations. The southern part of Dahanu Road Station or the eastern side along the existing railway line has swampy area and also surrounded by a number of salt pans. As a result, this part of area was found not suitable for providing DFC alignment as it would need extensive soil stabilization measures for proper foundation treatment to run heavy load DFC trains. It was, therefore, decided to extend detour route on the southern end by another 5 km to avoid both swamp area and salt pans. Overall efforts were	**Alternative 2** - Difficult to rebuild ROB near Dahanu Road Station as the area is fully developed - Dahanu Road Station is already developed as a yard for suburban services and any access for DFC track is not feasible - Number of on-going construction activities in and around existing track leading to and from Dahanu Road Station - Existing IR track in Dahanu area is

S. No	Detour	Contents of Alternatives and Considerations	Selected Alternative and Reason of the selection
		made to select appropriate alignment route for detour so as to minimally affect existing vegetation and habitation area in Dahanu but in view of the DFC design criteria, some area having matured trees will be affected. The project will compensate the loss of trees by adopting pre-afforestation measures which will be done in consultation with the Dahanu Taluka Environmental Protection Authority (DTEPA).	surrounded by swampy area and number of salt pans
5	Surat Detour	**Alternative 1**: It was considered to provide a parallel route along existing railway track. Considering a large number of illegal settlement along existing railway track between Udhna Junction and Surat Junction, it was, however, found that this option was not feasible. In case this alternative is implemented, it would require a large scale of resettlement plan for illegal slum dwellers and would invite a lot of social issues. Also, site conditions were not found conducive for construction of important bridge on Tapi River on this route. **Alternative 2**: It was considered to provide full detour from Sachin to Gothangam. In this alternative, there is no settlement along the alignment route but the entire route would traverse through cultivated agricultural fields. However, expansion of Surat City development on the eastward side and towards the DFC line would pose a serious challenge to this alignment option. **Alternative 3**: It was considered to provide parallel route of 4 km along the existing feeder line before taking a full detour route at Northern part. In this alternative, there is no settlement along the alignment route. Considering the further expansion of Surat City to the eastward side, this alternative would give some advantage as compared to the Alternative 2 but addressing the entire issue would be difficult due to long and high embankment of DFC detour on the east side. It is also being considered to provide viaduct structure after parallel line to the feeder route toward Tapi River Bridge but the cost-benefit analysis is under consideration.	**Alternative 3** - Large number of illegal slum dwellers within and around railway land along existing railway track between Udhna Junction and Surat Junction - Unsuitable site conditions for constructing bridge on Tapi River on this route - Expansion of Surat City Development on the eastward side and towards DFC track
6	Bharuch Detour (a part of Sanjali Nadiad Detour)	The project will provide a complete detour route of length approximately 30 km between Sanjali and Varediya in Section 4 and of length approximately 30 km between Varediya and Makanpura in Section 5. The proposed alignment from Gothangam Station (end of Surat Detour) would run parallel to the existing track on east side up to Sanjali. The alignment crosses Mumabi-Delhi mainline of Indian Railways on north of Sanjali Station by a flyover and then runs along the detour route on west side of existing track till the end of Phase 2 alignment in JNPT-Vadodara Section.	- Heavy built-up area of Bharuch and Ankleshwar City - Number of industrial units close to existing IR track in Ankleshwar - Existing bridge at Bharuch is passing through the main city and an additional bridge cannot be built here

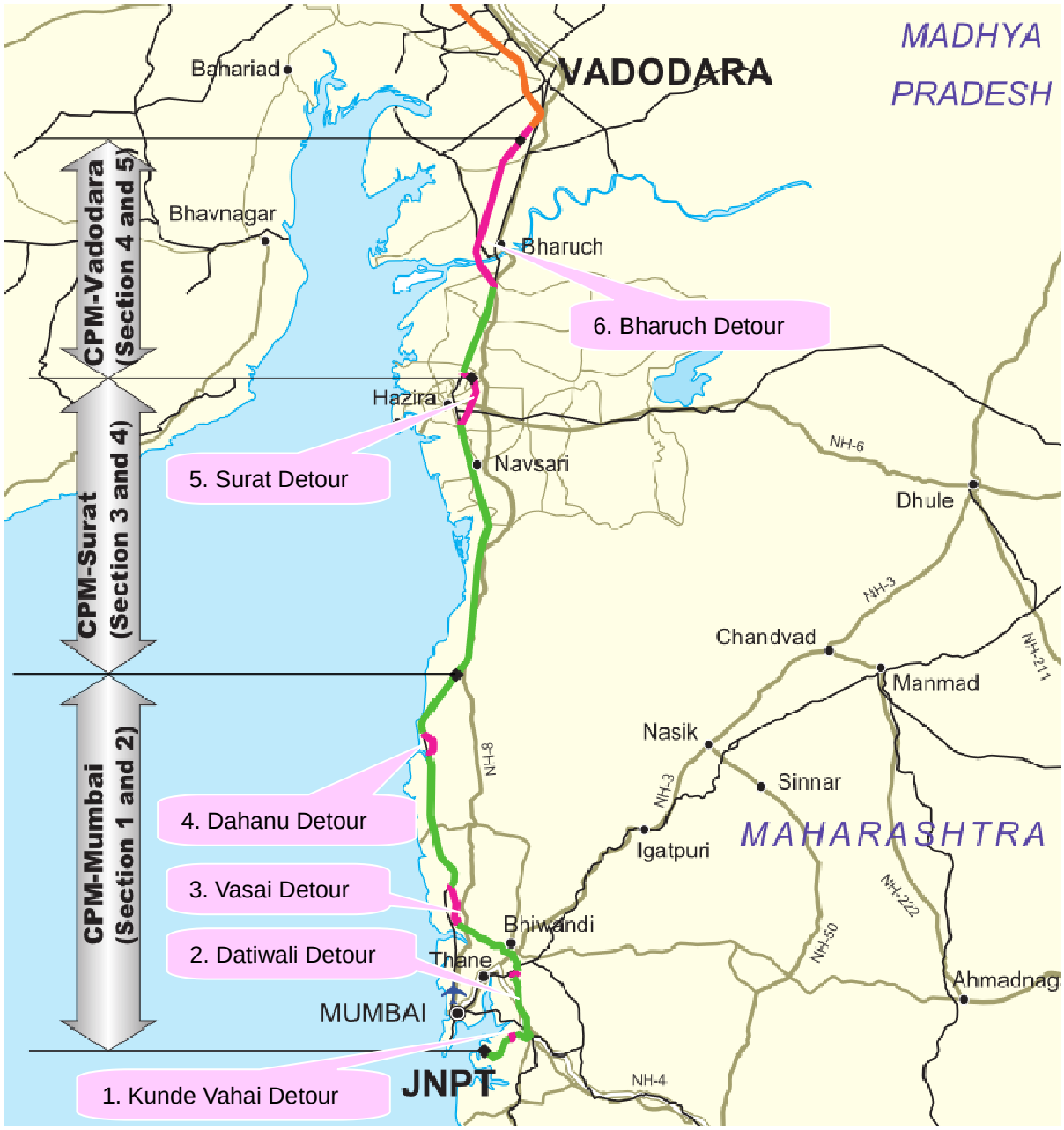


Figure S.2.1 Location of Alternatives for Detours in JNPT-Vadodara Section

S.3 EXISTING ENVIRONMENTAL CONDITIONS OF THE PROJECT AREA

Summary of the overview of the existing environmental conditions of the project area is as shown in Table S.3.1.

Table S.3.1 Summary of the Overview of the Existing Environmental Conditions

Item	Summary of the existing conditions
1. Climate	Maharashtra section falls in tropical wet and dry (warm and humid) climatic zone with an annual average rainfall of 3030 mm and 2300 mm in Raigad and Thane Districts respectively. Gujarat section falls in hot and dry climatic zone with varying annual average rainfall from 2200 mm in Valsad District to 800 mm in Bharuch District and other Districts falling within this range. Rewari-Dadri section falls in semi-arid (composite) climatic zone with annual average rainfall from 542 mm in Faridabad & Pawal Districts to 731 mm in G. B. Nagar District. Other Districts also have rainfall in this range.
2. Ambient Air	Relatively higher to critical levels of PM_{10} are observed in the ambient air of most of the cities and in some cities, values are much above the permissible limits prescribed in the Revised National Ambient Air Quality Standards, 2009. The levels of sulphur dioxide are below the prescribed values even for the notified ecologically sensitive areas in most of the cities. However, values of nitrogen dioxide show trend closer towards or slightly above the prescribed unified standards for industrial, residential, rural and other areas. Some DFC Project areas are identified as critically polluted areas by CPCB based on Comprehensive Environmental Pollution Index (CEPI).
3. Physiography	The dominant physical trait of the Maharashtra State is its plateau character. Thane and Raigad Districts are part of the north Konkan Region that lies towards the west of the Sahyadri Ranges. The state of Gujarat is situated on the west coast and is divided into three parts - the coastal, the plains, and the eastern highlands. Surat, Valsad, Vadodara and Navsari Districts come under the 'main land Gujarat' regions. The Aravalli in Mewat and Alwar Districts consist of organic and volcanic action and presently it is undergoing weathering and denudation. Palwal District has monotonous physiography and has alluvium deposits. Alwar District is a fairly regular quadrilateral in shape and the Aravalli range forms ridges of rocky hills for the most part and are parallel. Mewat District largely comprises of planes and the area is divided into two tracts - upland and low land. Gurgaon District area is conspicuously flat topography. G. B. Nagar District belongs to area of highly fertile alluvial soils and flat topography.
4. Land Use	Land use classification survey for acquired land reveals that in JNPT-Vadodara section, the agricultural area is nearly 30.4% as compared to 72% in Rewari-Dadri section. This is mainly due to the fact that the entire Rewari-Dadri main line as well as the major part of TKD line is a detour route whereas in JNPT-Vadodara section, the detour part is about 29%. The wasteland and low land area together constitute about 30.3% and 19.4% in JNPT-Vadodara and Rewari-Dadri section respectively.
5. Water Resources	The DFC Project is crossing over eleven important rivers between JNPT to Vadodara and these rivers are - Ulhas & Vaitarna in Thane District; Damanganga, Par, Auranga in Valsad District; Kaveri (South & North), Ambika, North Poorna, Mindhola in Navsari District; Tapi in Surat District; and Narmada in Bharuch District. In Rewari to Dadri section, the corridor will cross over Yamuna River at the border between Faridabad and G. B. Nagar District and Hindon River in G. B. Nagar. Both are perennial rivers in the area.
6. Soil	Mainly three types of soil are found in Thane District – regur soil, red soil and brownish black soil. Laterite and lateritic soils cover most of the part of Panvel and Uran tehsils of Raigad District. The soils are sandy clay loam to clay in texture. The deep black soils are found in major part of Bharuch, Surat, Valsad, and the southern part of Vadodara Districts. These soils in general are clay in texture, poor in drainage and neutral to alkaline in reaction. Coastal alluvium soils are also predominant in south Gujarat. Overall, the soil fertility indices are average from the point of view of agriculture in project villages. Soils from Rewari to Mewat district are sandy to loamy sand alluvial soil (Bhanger) with low water table and undulating topography. The soils in Gurgaon district are mostly rocky surfaces of Aravalli Hills except some areas. G. B. Nagar District is covered by soils of active flood plains, which are sandy to coarse loamy in texture.
7. Geology and Hydrogeology	The detailed study has been done on geology, hydrogeology and drainage characteristics in Aravalli Hills where there will be deep rock cutting and Vasai Detour where the project will build tunnel. Geologically the Vasai detour area is underlain by alluvium and Deccan basalt inter-bedded with pyroclastic material. The area is represented by flat alluvium terrain undulated with flat topped

Item	Summary of the existing conditions
	hills of basalts forming chain of plateaus. The area is also structurally disturbed and seismically active. Ground water in the area lies within the range of 5 to 10 m bgl. The rock formations in the Aravalli area are represented by quartzites, mica schist and pegmatite intrusive. Structurally the area represents an active tectonic zone. In the major part of the project area, the depth of water table lies between 10 m and 20 m. There are two perennial rivers in Rewari-Dadri section - the Yamuna and Hindon Rivers.
8. Habitat	Natural environment conditions vary along the DFC alignment route due to different ecological and ago-climatic variation. Nearly 45% of the alignment route passes through the cultivated agricultural area, barren land and wasteland. Besides this, the alignment crosses over number of important, major, and minor rivers and streams and also traverses through many recorded forest area. The length of alignment in these forest areas comprises approximately 1.6 km length in Gulistanpur reserved forest in G. B. Nagar District and 9.2 km in Thane District. The forest areas in Thane District are mostly dry and degraded land and supports very little habitat pattern. Most of these forest areas are under the influence of encroachment and increased human activities. The alignment also passes near the edge of the range boundary of the Sanjay Gandhi National Park (SGNP) and through the buffer area but away from the range boundary of the Tungareshwar Wildlife Sanctuary.
9. Flora	Flora along the proposed alignment in JNPT to Vadodara belongs to arid, semi-arid, coastal climatic system. Forest type comprising of mainly tropical dry deciduous, the Western Ghats, and monsoon forests occur both on the western (coastal) margins of the Ghats and on the eastern side where there is less rainfall. These forests contain several tree species of great commercial significance. In Rewari-Dadri section, the Gulistanpur reserved forest area is a plantation work of the Forest Department. The area has semi-arid climatic plantation of thorny plants such as *Prosopis juliflora* and *Acacia nilotica*.
10. Fauna	In Maharashtra, the varied climate and topography have resulted in rich vegetation and a good animal population. The fauna of Gujarat is also quite diverse. The extensive coastal regions of the state give shelter to a number of birds such as plovers, stints, sandi pipers, curlews, lesser flamingoes, terns and gulls. In G. B. Nagar District, back-naped hare (*Lepus nigricollis*) and neelgai (*Boselaphus tragocamelus*) droppings in the areas of the Gulistanpur forest were observed during investigation for biodiversity.
11. Legally protected Areas	The two notified eco-sensitive areas include the Aravalli Hills in Mewat & Alwar Districts and Dahanu in Thane District. The recorded forest area villages fall in Bhivandi, Vasai, and Palghar Talukas/Tehsils and Dahanu and in Sadar Taluka in G. B. Nagar District. The SGNP is the only protected area falling close to the DFC alignment route.
12. Seismicity	Almost 54% of the land in India is vulnerable to earthquakes. The corridor in Rewari-Dadri section falls in zone IV whereas the JNPT-Vadodara section falls in zone III. Zone IV is called the high damage risk zone. According to the present zoning map, zone V expects the highest level of seismicity whereas zone II is associated with the lowest level of seismicity.
13. Socio-economic conditions	1) Demographic profile: In project affected States and Districts, U. P. is the most populous state followed by Maharashtra, Rajasthan, Gujarat and Haryana. Among main cities, population density is the highest in Faridabad. The detailed analysis based on 2001 and 2011 census data is given in the main report. 2) Economic profile: Major commercial activities in Raigad District are fish farming, food processing, coir, herbal and tourism. Thane is the third most industrialized district in the Maharashtra State. Valsad is an industrial base for sectors such as chemicals, textiles, and paper & pulp industries. Textiles, diamond business, sugar industry, agro & food processing, paper, engineering and chemicals are some of the key business sectors in Navsari. Industrial development in Surat District is due to a large number of diamond processing, textiles, chemical and petrochemical industries. Bharuch has diversified industrial base in chemicals & petrochemicals, textiles, drugs & pharmaceuticals and ports & ship building. The industrial clusters in Vadodara include chemicals and fertilizers, pharmaceuticals, biotechnology, cotton textiles, machine tools, glass, engineering, tobacco, fisheries and dairy. In Rewari, agriculture constitutes the main source of economy. At present there are fifteen industrial areas developed in Alwar District. The main occupation in Mewat District is agriculture and allied agro-based activities. Gurgaon District has witnessed a phenomenal growth in all spheres of development particularly in urbanization and creating industrial climate. Palwal is going to have a big cargo for road, rail and air transport. The industrial areas of G. B. Nagar will grow due to its inclusion in the proposed Delhi Mumbai Industrial Corridor. 3) Health Status There are a lot of primary healthcare centers, community healthcare centers and sub centers in each project-affected district.

Item	Summary of the existing conditions
	4) Education Status The state-wise literacy rate on 2011 census is 82.91% in Maharashtra, 79.31% in Gujarat, 67.06% in Rajasthan, 76.64% in Haryana and 69.72% in U. P. Overall Surat has the highest literacy rate amongst all the districts. 5) Heritage There are 28 World Heritage Properties in India, out of which 23 are Cultural Properties and 5 are Natural Properties. All properties are out of the ESIA study area. There are 104 properties of national importance in districts covered by the ESIA. Out of these, 14 are located within project affected Taluk/Tahsil. For properties whose exact location is identifiable, it is confirmed that they are at least several km away from the railway alignment.

S.4 RESULTS OF SCOPING

S.4.1 Environmental Scoping for the ESIA Study

Environmental scoping for Phase 2 of the Western Corridor is described in Table S.4.1.

Table S.4.1 Environmental Scoping Matrix for the Proposed Project

	No.	Likely Impacts	Overall Rating	Project-related Activities								
				Planning / Design Phase		Construction Phase					Operation Phase**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of track, station,, viaduct/bridges and other related facilities	Traffic restriction in construction area	Operation of trains	Appearance / occupancy of track and related facilities
Pollution	1	Air pollution	B-/ B+	-	-	-	-	B-	B-	-	B+	-
	2	Water pollution	B-	-	-	-	B-	-	B-	-	-	-
	3	Soil contamination	B-	-	-	-	-	B-	-	-	-	-
	4	Waste	B-	-	-	-	B-	-	B-	-	-	-
	5	Noise and vibration	A-	-	-	B-	B-	B-	B-	-	A-	-
	6	Ground subsidence	-	-	-	-	-	-	-	-	-	-
	7	Offensive odor	B-	-	-	-	B-	-	B-	-	-	-
	8	Bottom sediment	B-	-	-	-	B-	-	B-	-	-	-
	9	Electromagnetic / radio wave interference	C-	-	-	-	-	-	-	-	-	C-
	10	Obstruction of sunshine	C-	-	-	-	-	-	-	-	-	C-
	11	Disaster	A-	-	-	-	-	-	A-	-	-	-
Natural Environment	12	Topography and geographical features	B-	-	-	-	B-	-	-	-	C	-
	13	Soil erosion	B-	-	-	-	B-	-	-	-	-	-
	14	Groundwater	B-	-	-	-	B-	-	-	-	-	-
	15	Hydrological situation	B-	-	-	-	B-	-	-	-	-	-
	16	Coastal zone	B-	-	-	-	B-	-	-	-	-	-
	17	Flora, fauna and biodiversity	B-	-	-	B-	B-	-	C-	-	-	-
	18	Meteorology	-	-	-	-	-	-	-	-	-	-
	19	Landscape	B-	-	-	-	B-	-	-	-	-	C-

	No.	Likely Impacts	Overall Rating	Project-related Activities								
				Planning / Design Phase		Construction Phase					Operation Phase**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of track, station,, viaduct/bridges and other related facilities	Traffic restriction in construction area	Operation of trains	Appearance / occupancy of track and related facilities
	20	Global warming	C-/ B+	-	-	C-	-	-	-	-	B+	-
Social Environment*	21	Involuntary resettlement	A-	A-								
	22	Local economy such as employment and livelihood, etc.	A-/ A+	A-	-	B +	B-/ B+	-	B-/B +	B-	A+	-
	23	(Surrounding) Land use and utilization of local resources	B-	B-	B-	-	-	-	-	-	B-	-
	24	Social institutions (including regional severance)	B-	B-	B-	-	B-	-	B-	B-	B-	-
	25	Existing social infrastructures and services	B-/ C-	B-	-	-	B-	-	B-	B-	C-	-
	26	Socially vulnerable groups such as the poor, indigenous and ethnic people	C-	C-	-	C-	C-	-	C-	C-	C-	-
	27	Misdistribution of benefit and damage	C-	C-	-	-	-	-	-	-	C-	-
	28	Historical and cultural heritage (including religious matters)	B-/ C-	C-	-	-	-	B-	B-	B-	B-	-
	29	Water usage or water rights and rights of common	-	-	-	-	-	-	-	-	-	-
	30	Local conflict of interests	C-	C-	-	-	-	-	-	-	C-	-
	31	Sanitation	B-	-	-	-	-	-	B-	-	-	-
	32	Hazardous (risk) infectious diseases such as HIV/AIDS	B-	-	-	-	B-	-	B-	-	-	-
	33	Accident	B-/ B+	-	-	B-	B-	B-	B-	-	B-/ B+	-
	34	Occupational Safety	B-	-	-	B-	B-	B-	B-	B-	-	-

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.

** 'Operation and maintenance of depot' is excluded in the final scoping matrix and changed from the original scoping matrix, as it is not a part of DFC Phase 2

<Rating>

A-: Serious impact is expected, if any measure is not implemented to the impact.

B-: Some impact is expected, if any measure is not implemented to the impact.

C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)

-: No impact is expected. Therefore, EIA is not required.

A+: Remarkable effect is expected due to the project implementation itself and environmental improvement caused by the project.

B+: Some effect is expected due to the project implementation itself and environmental improvement caused by the project.

Overall rating: Highest rate will be the overall rating among the rating of relevant project-related activities for negative and positive ratings, respectively. (e.g. Even only one "A-" is included in an environmental item, overall rating of the environmental item becomes "A-".)

Reference: Japan Transport Cooperation Association (JTCA) and Japan Railway Technical Service (JARTS) (1996) "Manual for Environmental Considerations in International Cooperation for Transportation Technology (Railway Project) (provisional translation)", Tokyo, Japan.

S.4.2 Checklist of Environmental Scoping

Checklist of environmental scoping with explanation of all potential impacts associated with the proposed Project is described in Table S.4.2.

Table S.4.2 Checklist of Environmental Scoping for the Proposed Project

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
Pollution					
1	Air pollution	B-/ B+	B-	C	<*Operation of construction equipment and vehicles*> <*Construction of track, station, , viaduct/bridges and other related facilities*> Emission of exhaust gas from construction equipment and vehicles and dust pollution due to operation of the construction equipment and vehicles would cause air pollution in and around the construction sites during the construction.
			B+	O	<*Operation of trains*> Reduction of hazardous substances emitted from vehicles would be expected due to reduction of traffic congestion and traffic volume by changing freight transportation mode from truck to the proposed railway system.
2	Water pollution	B-	B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, , viaduct/bridges and other related facilities*> Muddy water from construction site and oil spill from construction equipment and vehicles would cause water pollution in the channel/river in and around the construction site.
3	Soil contamination	B-	B-	C	< *Leakage of oil and grease from construction equipment*> Soil contamination is likely to take place due to leakage of asphalt emulsifier at pavement of road. Soil contamination may also take place during filling of oil in vehicles or leakage from vehicles..
4	Waste	B-	B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> Residue soil due to earth works would cause environmental impact in the disposal site.
			B-	C	<*Construction of track, station, , viaduct/bridges and other related facilities*> Construction waste including residue soil would cause environmental impact in the disposal site.
5	Noise and vibration	A-	B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Operation of construction equipment and vehicles*> <*Construction of track, station, , viaduct/bridges and other related facilities*> - Noise and vibration caused by such construction works and construction vehicle/equipment would annoy the residents and school/hospital nearby. - Vibration caused by such construction works would cause damage to the existing house and other kinds of building structures such as cracks in the wall.
			A-	O	<*Operation of trains*> Operation of the trains would cause noise along the railway track during operation time. Religious places near the freight railway and relevant facilities might be affected by the noise and vibration of the freight trains.
6	Ground subsidence	-	-	-	The project does not have any factor which may cause the ground subsidence in terms of project location and construction method.
7	Offensive odor	B-	B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, , viaduct/bridges and other related facilities*> In some sections where pass along rivers and channels, offensive odor would occur around the construction site due to excavation and dredging of mad in the rivers/channels during the construction.
8	Bottom sediment	B-	B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, viaduct/bridges and other related facilities*> During the works in the construction phase, excavated soil would cause sedimentation, flushed into water course in case of rain.
9	Electromagnetic / radio wave interference	C-	C-	O	<*Appearance / occupancy of track and related facilities*> Embankment/bridge structure of the railway might interfere with the radio wave such as radio and television in the case where building structure is very close to the railway.
10	Obstruction of sunshine	C-	C-	O	<*Appearance / occupancy of track and related facilities*> Due to embankment/bridge structure for elevated track, some railway tracks very close to the building might cause obstruction of sunshine to the building, especially residential house.
11	Disaster	A-	A-	O	<*Construction of track, station, , viaduct/bridges and other related facilities*> Embankment structure of the DFC, which is mainly applied in most of the section, would trap rain water and cause flood around the project area.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
Natural Environment					
12	Topography and geographical features	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* In the most of sections, elevated bridge structure of the railway track will mainly be constructed in the center or along the existing road. However, earthworks would affect topographic condition in some sections along the river/channel.
13	Soil erosion	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works along the river/channel in some sections would cause soil erosion in some sections.
14	Groundwater	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Associated with the tunnel construction at the Vasai detour, a groundwater flow at the area would be affected. Associated with the deep cutting at the Aravalli range at the section of Rewari-Dadri, groundwater flow at the area would be affected.
15	Hydrological situation	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works along the river/channel in some sections would affect hydrological situation in such channel/river.
16	Coastal zone	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* DFC alignment passes the swamp area at river mouth in Dahanu, Thane District. Earth works associated with the construction works would affect the coastal environment through contamination by turbid water.
17	Flora, fauna and biodiversity	B-	B-	C	*<Land clearing / tree cutting>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Existing trees and plants on the ROW and work sites would be removed tentatively or permanently for the construction. DFC alignment is passing through the areas of National Park, Wildlife Sanctuary, Eco sensitive area in Raigad and Thane Districts, Maharashtra State in parallel to the existing railway. Animal movements on those areas are likely affected.
18	Meteorology	-	-	-	The project does not have any factor which may affect and/or be related to the meteorology.
19	Landscape	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works such as earthworks would affect the landscape in the project site.
			B-	O	*<Appearance / occupancy of track and related facilities>* Existing of elevated bridge structure of the railway track would affect the landscape from prior one in and around the project site.
20	Global warming	C- / B+	C-	C	*< Land clearing / tree cutting>* Cutting of existing trees and plants alongside the ROW due to construction of the railway will partly reduce amount of total resource of the CO_2 absorption in the area.
			B+	O	*<Operation of trains>* With change of transport mode from fossil fuel used automobile to electrified railway system, reduction of emission of greenhouse gas such as CO_2 will be expected as per unit transport distance per person.
Social Environment*					
21	Involuntary Resettlement	A-	A-	P	*<Land acquisition>* It is expected that a large scale of involuntary resettlement (more than 200 persons to be displaced) will be caused by the Project, even though the railway alignment is planned to minimize the scale of the involuntary resettlement by applying the following policy: (1) Existing railway land is used for the DFC as much as possible to avoid land acquisition; (2) In the section where existing railway land is not available in built-up area, detour is planned to avoid/minimize the involuntary resettlement; and (3) Due to some limitations such as a feature of the railway alignment which makes design sharp curb unable, and topographic condition in the project area, involuntary resettlement will be caused by the project. Additionally, a larger impact is expected for land owners which land will be partially required due to a feature of the linear project. According to DFCCIL's "Section Wise Progress of Land Acquisition" as on 31 August 2010, it is expected that approximately 2,348 ha.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
22	Local economy such as employment and livelihood, etc.	A-/ A+	A-	P	*<Land acquisition>* While detour route is applied to minimize the involuntary resettlement in the built-up area, the detour route passes through agricultural land in the most project area. Acquisition of the agricultural area for the Project would affect livelihood for a large number of farmers whose farmland will be acquired.
			B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Overall construction activities and traffic restriction would affect local economy activities to some extent due to disturbance in smooth operation of commercial/public transportation during construction.
			B+	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* Overall, the construction of the Project will make more employment and business opportunities for local residents during construction.
			A+	O	*<Operation of trains>* After operation of the DFC, regional economy particularly industrial sector in major industrial locations along the DFC would have positive impact due to improved freight transportation.
23	(Surrounding) Land use and utilization of local resources	B-	B-	P	*<Land acquisition>* *<Change of land use plan, control of various activities by regulations for the construction>* Land use could be worsened due to the acceleration of unplanned development along the proposed route and around new stations unless the land use is property planned by the local government.
			B-	O	*<Operation of trains>* - ditto -
24	Social institutions (including regional severance)	B-	B-	P	*<Land acquisition>* *<Change of land use plan, control of various activities by regulations for the construction>* Regional severance is expected due to construction of a new freight tracks with mainly embankment structure as well as stations, viaduct/bridges and other related facilities.
			B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* During construction, if access to the rest of the community is disturbed, social institution could be temporarily disturbed.
			B-	O	*<Operation of trains>* Regional severance is expected due to construction of a new freight tracks, stations, viaduct/bridges and other related facilities.
25	Existing social infrastructures and services	B-/ C-	B-	P	*<Land acquisition>* Land acquisition for the project, involving relocation of public and/or community facilities, would affect local communities to some extent.
			B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction work and traffic restriction would disturb access to the existing social infrastructures and services.
			C-	O	*<Operation of trains>* Unless affected existing social infrastructure is replaced in a proper manner, nearby residents' access to existing social infrastructure will be negatively affected.
26	Socially vulnerable groups such as the poor, indigenous and ethnic people	C-	C-	P	*<Land acquisition>* Overall, it is expected that the poor, illegal occupants, small scale farmers, women headed households, and the disables would be affected by land acquisition and/or resettlement. The extent shall be studied through the RRP and public consultation meetings. As for the impact on the indigenous and ethnic people, the potential impacts on the Scheduled Caste and Scheduled Tribes needs to be studied in the RRP.
			C-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction activities and traffic restriction would cause inconvenience to the disables in construction area.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
			C-	O	*<Operation of trains>* The project would cause inconvenience to the disables to during operation in the detour areas. Construction of RUBs in the detour areas should be considered as the Phase 1 project.
27	Misdistribution of benefit and damage	C-	C-	P	*<Land acquisition>* Inequality between beneficiaries of the Project (e.g. overall DFC owners/users) and the Project Affected Persons (PAPs) (e.g. affected land owners/users and nearby residents) would occur to some extent. The type and extent of the damage (negative impacts of the project) shall be studied and mitigated by under the ESIA and RRP.
			C-	C	*<Operation of trains>* - ditto -
28	Historical and cultural heritage (including religious matters)	B-/ C	C-	P	*<Land acquisition>* Some existing historical, cultural and religious assets along the planned alignment and in proposed relevant facilities will be affected by the Project; however the number is not known and should be studied in the RRP.
			B-	C	*<Operation of construction equipment and vehicles >* Religious places which usually require silence might be affected by the noise and vibration of the construction equipment and vehicles. *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Access to historical places, cultural, and religious places might be disturbed by construction activities and traffic restriction and during construction temporarily.
			B-	O	*<Operation of trains>* Religious places near the freight railway and relevant facilities might be affected by the noise and vibration of the freight trains.
29	Water usage or water rights and rights of common	-	-	-	The impact on water usage is not directly relevant to the project except some limited amount of water will be used for during construction.
30	Local conflict of interests	C-	C-	P	*<Land acquisition>* Conflicts of interests related to the Project could occur among beneficiaries and the PAPs unless the adequate RRP and public consultation are not arranged.
			C-	O	*<Operation of trains>* - ditto -
31	Sanitation	B-	B-	C	*<Construction of track, station, , viaduct/bridges & other related facilities>* Sanitary issues would occur in labor camp and neighboring area in the case sanitary facility is not adequately installed such as toilet and septic tank.
32	Hazardous (risk)infectious diseases such as HIV/AIDS	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* Risk of infectious diseases by labors would be expected during construction due to the inflow of the construction workers from outside.
33	Accident	B- B+	B-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Some accidents are inevitable during construction.
			B+	O	*<Operation of trains>* In the long run, with a change of transport mode from freight trucks to railway system, a reduction of accidents would be expected due to a decrease of the number of freight trucks.
			B-	O	*<Operation of trains>* Some minor accidents are inevitable during operation.
34	Occupational safety	B-	B-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Minor negative impacts on occupational safety are inevitable during construction; however, it will be secured in accordance with the domestic laws and regulations during construction.

S.5 POLLUTION CONTROL STUDY OF ESIA

S.5.1 Noise and Vibration

(1) Survey of Existing Circumstance

1) Railway and Background Noise and Vibration Survey

The background noise levels were measured in L_{Aeq} (sound exposure level) and vibration levels were measured in L_{peak} (maximum sound level) at sixteen (16) sites relatively near and densely populated area for daytime. Together with background noise and vibration measurements, railway noise and vibration were also measured simultaneously using noise and vibration level meters at 2 points i.e. at a distance of 12.5 m and 25 m distance from the centre of the nearest railway track.

2) Survey of Sensitive Receptor and Land use

Survey of Sensitive Receptors (SRs) was conducted within the range of approximately 100 m from the centre of the nearest railway track on one side (about 200 m at both sides). The satellite imagery analysis and geographic positioning system (GPS) were used for the identification of landuse.

(2) Result of the Survey

1) Background Noise and Vibration Level

The noise level at all the sites except Panvel (MAX 57dB (A)) and Asaoti (MAX 59dB (A)) is within the limits of daytime ambient standard (55dB (A)) of residential area in India. The results of vibration value indicated 30-40 dB, and below 55 dB which is the perceivable limit value.

2) Railway Noise (L_{AE} and L_{Amax}) and Vibration Levels from Existing Railway

The results of railways noise also indicated L_{AE} and L_{Amax} of different train type and direction of the trains, such as up and down directions. At the nearest measurement point from the railway, the range of 75 to 90 dB (A) as L_{Amax} and approximately 90 dB (A) as L_{AE} were measured. At that time, train's speed was almost 60 to 90 km/hr at each measurement site.

The railways vibration measured was below 70 dB at a distance of 12.5 m from the center of railway track. Hence, under the present situation, no serious damages of building due to railway vibration are expected.

3) Sensitive Receptor and Land use

Sensitive receptors located within 100 m from the center of the railway were extracted. 12 sensitive receptors in Rewari-Dadri Section, 100 sensitive receptors in Sections 3, 4 and 5, 20 sensitive receptors in Sections 1 and 2 have been identified respectively. Among these sensitive receptors, the closest facility was located within 5 m or less from DFC rail in Rewari-Dadri section, and on the planned DFC railway or within 5 m or less from DFC railway in Sections 4 and 5, and within 10 m or less in Sections 1 and 2, respectively.

Agriculture is the main land use in Rewari –Dadri as well as Vadodara-JNPT section. The length of DFC alignment which pass thorough the human settlement areas approximately 67.3 km in Section 3, 4 and 5, 54.2 km in Sections 1 and 2, and 6.5 km in Rewari-Dadri.

(3) Impact Assessment during Construction phase

Construction of DFC structures and facilities would require the use of heavy equipment/ vehicles, and adversely affect sensitive receptors. As for ROB construction areas, increase of noise and vibration pollution is envisaged by a traffic jam and operation of the construction machine due to construction work on the existing road. There are 77 ROBs proposed in this project. 18 ROBs of these are existing on the parallel sections. There are 12 existing ROBs on the parallel section in Section-1, and 3, 2 and 1 existing ROBs on the parallel sections in Section-2, Section-3 and Section-4, respectively. There are no existing ROBs on the parallel section in Section-5, Section-15 or Section 16.

Adequate measures will be planned and provided to reduce the negative impacts of noise and vibration pollution during construction stage, such as planning the deliberate and efficient equipment use, use of the low pollution type machine, regular maintenance of construction machines.

This impact is short duration, direct, temporary and reversible, it can be considered minor if mitigation measures and site management practices are applied.

(4) Impact Assessment during Operation phase

1) Procedure of Prediction and Evaluation of Railway Noise and Vibration

Prediction and evaluation of railway noise and vibration from the passing freight trains have been carried out for each of the selected SR sites based on the procedure of prediction and evaluation as shown below. For evaluation of the predicted noise and vibration levels, the following standards were taken into consideration in ESIA. Procedure of Prediction and Evaluation of Noise and Vibration Levels is shown in Figure S.5.1. The location for prediction is shown in Table S.5.1.

- Guidelines for Countermeasures for Railway Noise in Case of New Constructions and Large-scale Improvement of Existing Railways, Environmental Agency of Japan, 1995
- Guideline Value of Vibration from Shinkansen Superexpress Railway in Japan Environmental Agency of Japan, 1976
- The Noise Pollution (Regulation and Control) Rules, 2000

2) Results of Prediction

a) Parallel Section

The predicted future noise levels (L_{Aeq}) at 30 m and 50 m of distances, that is estimated average ROW end, from the centre of existing railway track in the parallel section range from 57 through 71 dB (A) at Day time, and 55 through 71 dB (A) at Night time at 30 m away, then 55 through 70 dB (A) at Day time), and 54 through 70 dB (A) at Night time at 50 m away respectively.

The result of the predicted vibration levels of the existing railway ranges respectively from 42 through 64 dB (Z-axis) at 30m away, then 41 through 61 dB (Z-axis) at 50m away. The result of the predicted vibration levels of the DFC railway ranges respectively from 57 through 70dB (Z-axis) at 30m away, then 55 through 69 dB (Z-axis) at 50 m away.

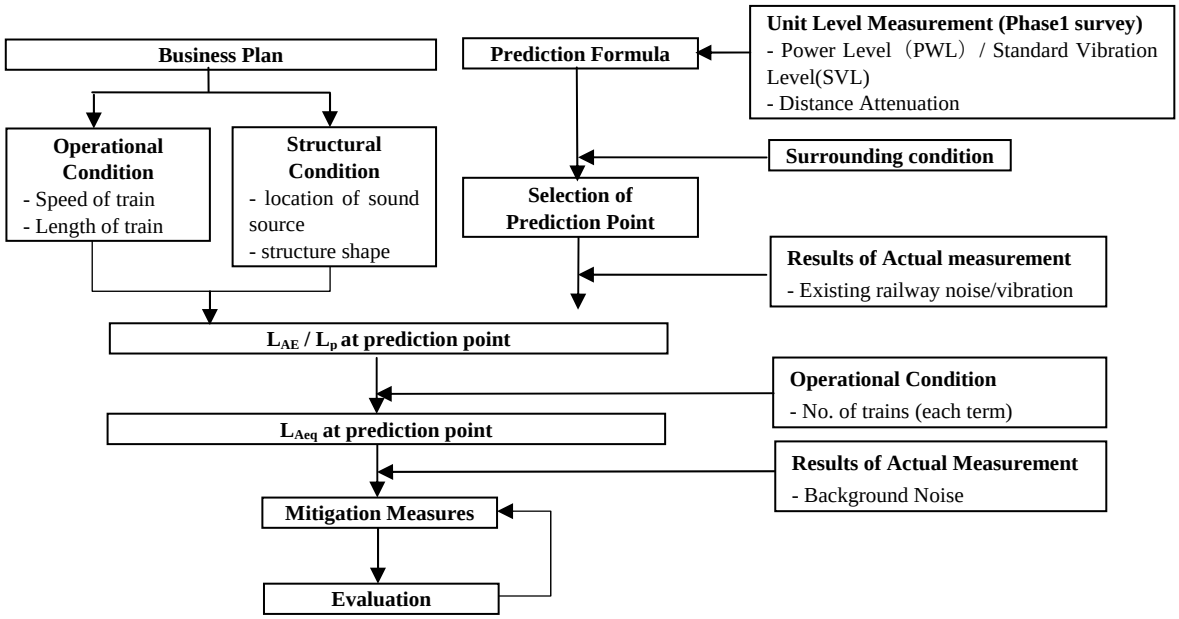


Figure S.5.1 Procedure of Prediction and Evaluation of Noise and Vibration Levels

Table S.5.1 Location of Railway Noise and Vibration Prediction

Section	Prediction Location	Background Noise Levels used	Result of Existing Railway Noise Measurement (L_{AE} No.of Freight Train)
Parallel section	Panvel	Panvel	Panvel
	Kopar	Panvel	Panvel
	Palgar	Palgar	Palgar
	Boisar	Boisar	Boisar
	Vapi	Vapi	Vapi
	Valsad	Valsad	Valsad
	Amalsad	Amalsad	Amalsad
	Navsari	Amalsad	Amalsad
	Kim	Kim	Kim
	Asaoti	Asaoti	Asaoti
Detour section	Bharuch	Kim	-
	Miyagan	Kim	-
	Sohona	Asaoti	-
	Tigaon	Asaoti	-

b) Detour Section

The predicted noise level (L_{Aeq}) at 30 m and 50 m from the centre of DFC alignment ranges from 54 through 57 dB (A) at daytime, and 54 through 57 dB (A) at nighttime at 30 m away, then 53 through 56 dB (A) at daytime and nighttime at 50 m away respectively.

The result of the predicted vibration levels of the DFC railway is respectively 63 dB (Z-axis) at 30m away, then 59 dB (Z-axis) at 50 m away.

(5) Evaluation

1) Setting of Environmental Preservation Target

a) Parallel Section

As for parallel section, it is targeted that predicted noise level which consists of DFC railway noise level and existing railway noise level meet guideline value at 30 m and 50 m from the center of existing railway where ROW might be located. As the result, in all of location for prediction and at both daytime and nighttime, predicted values didn't meet guideline value (daytime: 60 dB(A), nighttime: 55 dB(A)) except Kopar point. In fact, the result also indicates that only railway noise levels from the existing railway track already exceed the recommended standard level for the half sites at nighttime. Therefore, environmental impact due to railway noise is judged to be significant. So some mitigation measures are recommended to be taken especially along the residential areas and near the sensitive receptors.

It is targeted that predicted vibration level (L_p) which consists of DFC railway vibration and existing railway meet guideline value (70 dB) at 30 m and 50 m from the center of DFC embankment where ROW might located.

In all of prediction location, predicted values resulted in meeting guideline value. Therefore, environmental impact due to railway vibration is judged to be light.

b) Detour Section

As for detour section, it is targeted that predicted noise level which consists of DFC railway noise level meet guideline value at 30m and 50m from the center of existing railway where ROW might be located. As the result, predicted values slightly exceed the guideline value in Sohona and Tigaon at nighttime. However in other site, predicted noise level (L_{Aeq}) which consists of only DFC railway noise level meet guideline value at each prediction point and at each time. Therefore, environmental impact due to railway noise is judged to be light.

It is targeted that predicted vibration level (L_p) which consists of DFC railway vibration meet guideline value (70 dB).

In all of prediction location, predicted values resulted in meeting guideline value. Therefore, environmental impact due to railway vibration is judged to be light.

c) Sensitive Receptor

As for parallel section, it is targeted that predicted noise level which consists of DFC railway noise and existing railway noise meets guideline value within 100 m from the center of the existing railway. Also as for the detour sections, it is targeted that predicted noise level which consists of only DFC railway noise meet the guideline value within 100 m from the center of the DFC railway. As the result, regarding above a) and b) judgments of Parallel Section, it does not meet the guideline level and some points of the Detour Section also. Therefore, environmental impact due to railway noise is judged to be significant.

2) Consideration of Environmental Mitigation Measures

As environmental preservation: In a parallel section, it is necessary to establish soundproof walls. In detour section, residential areas are already considered for set-up of soundproof. Although the result of predicted noise level meets environmental preservation target, the

establishment of soundproof wall and limitation of train operation at night time should be considered.

a) Case Studies on Establishment of Soundproof Wall

If ROW is set at 30 m from the center of railway track, the soundproof walls at height of range from 0.5m (Kopar) to 4.0 m (Panvel, Palgar and Amalsad) may be required at Parallel Sections and rang from 0.5 m (Tigaon) to 1.0 m (Sohona) may be required at Detour Sections. While if the ROW is set 50 m from the center of railway track , soundproof wall of height range from 0.5 m (Panvel, Kopar and Asaoti) to 4.0 m (Valsad) may be required at Parallel Sections and 0.5 m (Sohona) may be required at Detour Section.

b) Case Studies on Shifting Train Operation Number from Night to Day Time

For the Detour Sections where exceeded the guideline (Sohona, Tigaon), a consideration of shifting some of nighttime scheduled trains to daytime was made without changing total number of daily schedule. The result of case study is summarized in Table 6.1.19. Supposing that ROWs were set 30 m away from the center of DFC railways, shifting 22 night trains to daytime at Sohona, 16 night trains to daytime at Tigaon are required. Then if ROW at 50 m away from the center of the DFC railways, 7 trains are required to be shifted to daytime at Sohona.

S.5.2 Water Pollution

(1) Survey of the major river water quality

Water quality survey was conducted to study baseline information in 15 important rivers at bridge construction sites in order to suggest preventive measures to avoid damage to the water quality during bridge construction and afterwards.

(2) Analysis of Results

Analysis of water quality results of the first season or wet season, the second season or dry season together with the available secondary data for all important rivers indicate a high fluctuation in test values for important parameters in different seasons in a year. This may be attributable to changes in temperature and flow conditions, variation in activities in catchment area, and low dilution of receiving water body, especially in dry season.

Table S.5.2 Summary of the Water Quality Results Analysis for Important Rivers

Major Rivers	Water Quality Analysis	
	Wet Season	Dry Season
Yamuna	-DO from 3.9 to 5.8 mg/l -BOD from 3.2 to 4.2 mg/l -Free ammonia from 2.16 to 2.21 mg/l	- DO values near zero -BOD from 57.1 to 64.5 mg/l -Free ammonia from 5.81 to 6.02 mg/l
	Results show high degree of pollution level in this particular stretch of the river. In wet season, since monsoon was receding, the river banks were muddy due to deposited silt. Oil & grease, heavy metals and inorganic contamination is although not exceeding the limits but is still on a higher side. Water quality also shows impacts of faecal contamination and direct disposal of sewage into the river.	

Major Rivers	Water Quality Analysis	
	Wet Season	Dry Season
Hindon	-Turbidity from 147 to 158 NTU -DO from 3.3 to 3.5 mg/l with BOD around 4.1 to 6.0 mg/l -No heavy metals contamination -Free Ammonia from 1.94 to 2.2.3 mg/l	-Turbidity from 143 to 174 NTU -DO level was near zero with BOD values 36.4 to 44.4 mg/l -No heavy metals contamination -Free Ammonia from 3.35 to 3.72mg/l
	Overall water quality shows heavy impact of faecal contamination and direct disposal of untreated and partially treated sewage.	
Daman Ganga	-BOD from 0.6-19.8 mg/l -Turbidity from 18 through 179 NTU within 400 meter difference from upstream to downstream -Free Ammonia from 1.4 to 4.18 mg/l from u/s to d/s location -No heavy metal contamination	-BOD from 4.0-10.3 mg/l -Turbidity from 14 through 58 NTU -Free Ammonia from 1.6 to 1.8 mg/l -No heavy metal contamination
	-The results show not only tidal influence but also effect of discharge from an outfall of a sewage treatment plant, particularly during wet season in the downstream direction. -pH and DO meet the water quality criteria in dry season for all three sampling locations but only for location at center in wet season. -Mostly, BOD, conductivity and Free Ammonia do not conform to the criteria in both the seasons. BOD meets the criteria for locations at upstream and center during wet season. -High fluctuations in certain parameters indicate the need for more rigorous spatial sampling for these locations. -The dry season results show favorable value of DO for aquatic biota. An impact of effluent on water quality was low due to dilution with tidal water.	
Par	-DO levels below the permissible limits required for aquatic biota and bathing standards. -BOD values comparatively lower -TDS, TSS and hardness values comparatively lower -Turbidity from 96 through 112 NTU -Free Ammonia from 1.64 through 2.11 mg/l -High level of F.coli and T.coli.	-DO levels below the permissible limits required for aquatic biota and bathing standards. -BOD values are significantly higher and are a clear indication of mixing of untreated sewage or effluent near the sampling locations. -TDS, TSS and hardness values are comparatively much higher due to less dilution conditions -Turbidity from 282 through 342 -Free Ammonia from 4.00 through 4.90, which is beyond permissible limit for designated best use for propagation of wild life and fisheries -High level of F.coli and T.coli.
	-EC values for both the seasons also show a high influence of sea water into the overall quality of river water at proposed bridge site locations.	
Auranga	-pH and DO meet the water quality criteria -BOD and Free Ammonia do not conform to the criteria -EC and corresponding TDS values are well within the prescribed limits -Faecal Coliform and Total Coliform counts far exceeding the permissible limit -For other inorganic parameters, the values are well within the permissible limits. -No heavy metal contamination	-pH and DO meet the water quality criteria -BOD and Free Ammonia do not conform to the criteria. However, BOD values are only marginally higher to the permissible limits. -EC and corresponding TDS values are well within the prescribed limits but much higher than wet season. This clearly shows the influence of sea water into the quality of river water. -Faecal Coliform and Total Coliform counts far exceeding the permissible limit -For other inorganic parameters, the values are well within the permissible limits. -No heavy metal contamination

Major Rivers	Water Quality Analysis	
	Wet Season	Dry Season
Nourth and South Kaveri	-pH, EC and DO meet criteria -BOD values close to permissible limits -Free Ammonia does not conform to the criteria -Faecal Coliform and Total Coliform counts is far exceeding the permissible limit -Turbidity from 84 through 130 NTU -No heavy metal contamination	-pH, EC and DO meet criteria -BOD values exceeding the limits -Free Ammonia does not conform to the criteria -Faecal Coliform and Total Coliform counts is far exceeding the permissible limit -Turbidity values range from 84 through 130 NTU -No heavy metal contamination
Ambika	-Overall water quality is fairly good -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -No heavy metals contamination	-BOD and Free Ammonia do not meet the criteria -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -No heavy metals contamination
N. Poorna	-pH, conductivity, DO and BOD are meeting the water quality criteria -Free Ammonia does not conform to the criteria -BOD value from 2.2-2.9 mg/l -Faecal Coliform and Total Coliform counts is exceeding the permissible limit of water quality criteria for bathing reaches in river, thereby indicating contamination due to domestic wastewater -No heavy metals contamination	-Only pH and conductivity are meeting the criteria -Free Ammonia does not conform to the criteria -BOD value from 18.0-19.5 mg/l -Faecal Coliform and Total Coliform counts is exceeding the permissible limit of water quality criteria for bathing reaches in river, thereby indicating contamination due to domestic wastewater. -No heavy metals contamination
Mindhola	-DO values are very low indicating less aeration capacity as well as high degree of pollution. -BOD value from 12.3 to 12.6 mg/l -pH and EC are well within limit -*T.coli and F.coli* contamination is also very high in all the sampling locations -No heavy metal contamination	-DO values are very low indicating less aeration capacity as well as high degree of pollution. -BOD value from 14.3 to 16.7 in dry season. -pH and EC are well within limit -*T.coli and F.coli* contamination is also very high in all the sampling locations -No heavy metal contamination
Tapi	-pH, conductivity, DO and BOD are meeting the water quality criteria and Free Ammonia does not conform to the criteria -BOD values from 0.5-0.8 mg/l -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -Turbidity and TSS are in low concentration as compared to other important rivers along the alignment. -No heavy metal contamination	-Only pH, conductivity, DO and Free Ammonia are meeting the criteria -BOD values from 3.9-6.5 mg/l -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -Turbidity and TSS are in low concentration as compared to other important rivers along the alignment. -No heavy metal contamination
Narmada	-pH, EC, DO and BOD are meeting the water quality criteria -BOD values within limit -Free Ammonia does not conform to the criteria. -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -Lower TDS and TSS values	-Only pH and EC are meeting the criteria -BOD values from 9.3-12.2 and is beyond the permissible limit. -Free Ammonia does not conform to the criteria. -Faecal Coliform and Total Coliform counts is exceeding the permissible limit -Lower TDS and TSS values as compared to other tidal water affected rivers along the alignment
North and Sourth Vaitarna	-pH and DO meeting the water quality criteria whereas BOD, conductivity and Free Ammonia do not conform to the criteria -BOD values from 18.4-21.9 mg/l in South Vaitarna River and 17-20.3 mg/l in North Vaitarna River. -Faecal Coliform and Total Coliform counts is far	-pH and DO meeting the water quality criteria whereas BOD, conductivity and Free Ammonia do not conform to the criteria -BOD values from 9.7-10 mg/l for South Vaitarna River and 4.4-6.9 mg/l for North Vaitarna River. -Faecal Coliform and Total Coliform counts is far exceeding the permissible limit

Major Rivers	Water Quality Analysis	
	Wet Season	Dry Season
	exceeding the permissible limit -High values of EC and TDS in both the seasons mainly due to inter-mixing of sea water into the fresh river water due to creek area	-The higher values of EC and TDS is due to low flow conditions and more impact of sea water.
Ulhas	-pH and conductivity are meeting the water quality criteria whereas BOD, DO and Free Ammonia do not conform to the criteria -BOD values from 8.6-10.4 mg/l -Faecal Coliform and Total Coliform counts is far exceeding the permissible limit -Turbidity ranges from 57 through 71 NTU -No heavy metal concentration	-pH and conductivity are meeting the water quality criteria whereas BOD, DO and Free Ammonia do not conform to the criteria -BOD values from 7.1-9.7 mg/l -Faecal Coliform and Total Coliform counts is far exceeding the permissible limit -Turbidity ranges from 57 through 71 NTU which is on higher side than the aquatic habitat wellness. -No heavy metal concentration

(3) Impact Assessment

The most significant impact anticipated from bridge construction activities would be increased turbidity due to earth works in and around rivers which causes decrease of photosynthesis and primary productivity process. Silt in the river water during construction phase needs to be minimized. The organic and bacterial loads are continued to be critical in all the important rivers. Site drainage and wastewater from toilets and washrooms would pollute surface water if discharges without adequate treatment. Therefore, during construction, a special care should be also taken so that wastewater discharge from the labour camps and construction site do not discharge directly into the river.

S.5.3 Air Pollution

The freight corridor would improve the air quality along the proposed areas by reducing the emissions from the vehicular traffic and the traffic congestions. The only time when the air pollutants are emitted is during the construction of the fright corridor. The pollution caused during the construction activities could be for a temporary period.

S.5.4 Soil Contamination

During construction phase, soil contamination is likely to take place due to leakage of asphalt emulsifier at pavement of road. Soil contamination may also take place during filling of oil in vehicles or leakage from vehicles. For this, asphalt emulsifier will be handled with caution and any leakage detected should be immediately rectified.

S.5.5. Waste

Under the existing planning phase, type of construction waste which is expected to occur are asphalt chunks, chunks of concrete, surplus soil, construction scrap materials and others. The amount and percent composition of construction waste is not clear in this phase. However, surplus soil is planned to be reused as much as possible in construction of the DFC embankment. In addition, all other construction waste is also planned to comply with relevant Center or State laws pertaining to the waste management.

S.5.6 Bottom Sediment

During construction of bridge over the rivers, sediment pollution may occur. As one of the mitigation measures, silt fencing will be provided to restrict runoff into the water during construction phase

S.5.7 Obstruction of Sunshine

In case of parallel section, vertical alignment of DFC may be designed in the same level almost as the existing railway/ground level to reduce the modification. In case of detour section, the shade of DFC structure might be predicted in the ROW. Therefore it's predicted that there are no negative impact to the residential area along the proposed line.

S.5.8 Disaster

The seismic factors should be appropriately incorporated in the civil and structural designs of major structures in DFC project. Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.

S.6 NATURAL ENVIRONMENTAL STUDY

S.6.1 Flora

(1) Study Methodology

The field survey was conducted in all identified 'Recorded Forest Area' in the JNPT-Vadodara and Rewari-Dadri sections so that an accurate assessment of the status and likely potential impacts on fauna and flora could be made.

In this study, the vegetation and faunal surveys in the forests to be impacted by the project were conducted in the winter, and summer seasons. The actual survey periods were determined based on the common classification of the Indian Metrological Department (IMD) i.e. January-February for winter months, March – May for pre-monsoon (Summer) months, June – September for Monsoon Season (Southwest Monsoon Season) and October – December for Post Monsoon Season in the India.

Supplemental (Monsoon) survey was also conducted from August to September 2011 to confirm if presence of any critical (rare/endangered/endemic) species exist or not in the survey area based on the results of the previous surveys in winter and summer seasons and recheck the status with IUCN, RET[1] species and WPA India .

(2) Major Finding

1) JNPT-Vadodara Section

a) Overall situation (including Tree Census Results)

Approximately 45,000 trees will be required to be removed for the corridor in the JNPT-Vadodara section. The census was carried out for a 60 meter strip along the alignment i.e. within the RoW. For each of the districts the estimated number of trees to be removed is provided in Table S.6.1. Bharuch district has the highest number of trees

[1] RET refers to rare, endangered and threatened species

within the RoW. In addition, there is only few mangrove vegetation in the Proposed DFC alignment.

Table S.6.1 Tree Census in Vadodara - JNPT Section

District	No. of Trees
Vadodara	2,376
Surat	5,490
Bharuch	22,332
Navsari	1,193
Valsad	2,940
Thane	9,915
Raigad	951
Total	45,197

b) Protected Areas: Sanjay Gandhi National Park (SGNP)

The proposed corridor area touches the northern boundary of the SGNP near the Kaman Station. There is one existing railway track and on the other side is National Highway. The result of field survey of Flora in SGNP is shown in Table S.6.2.

Table S.6.2 Result of Field Survey on Flora in Sanjay Gandhi National Park Area

Season	Description
Winter	The villages of Nagale, Shilottar, Sarjamori (Thane District) are located along the northern boundary of SGNP. Within the area, two (2) sites were surveyed in winter season (Jan). Three (3) tree species, Two (2) herbal species, three (3) grass species and 8 flora species in total were found in the Shilottar village forest area. Nine (9) tree species, one (1) shrub species, eight (8) herbal species, four (4) grass species, two (2)climber, one (1) woody climber species and 25 species in total were found in the Sarjamori village forest area. An endangered tree species, *Sterculia urens* was found in Sarjamori.
Summer	In the summer season (April) survey, three (3) sites were surveyed within the area. In Nagale village forest area, (3) tree species, (1) shrub species, (1) herbal species and (5) species in total were found at the site. Three (3) tree species, two (2) herbal species, three (3) grass species and eight (8) species in total were found in Shilottar village forest area. Seven (7) tree species, three (2) shrub species, three (3) herbal species and 12 species in total were found in Sarjamori village forest area including an endangered tree species, *Sterculia urens*.

c) Forest area

The result of field survey of Flora in Forest area is shown in Table S.6.3.

Table S.6.3 Result of Field Survey on Flora in Forest Area

No.	Forest Area	Description
1	Ovali Reserved Forest	A total 18 of species were recorded in Ovali. The forest is located on the north side of the existing railway. Approximately 350 m of total length and 0.1288 ha of the land is likely to be affected by conversion to railway. The area is dominated by herbal and grass plant species with no endangered or otherwise protected species.
2	Nagale Forest	Nagale forest plot falls within SGNP. Approximately 95 m of total length of the land is located adjacent to the northside of the existing railway. The area is dominated by herbal and grass plant species with no endangered or otherwise protected species.

No.	Forest Area	Description
3	Sarjamori Forest	The forest is located within Sanjay Gandhi National Park. Approximately 110 m of total length of the land is located adjacent to the north side of the existing railway. One (1) Endangered plant species, Sterculia urens (Sarjamori) was found in the area.
4	Shilottar Forest	Shilottar area forest plot falls within SGNP. Approximately 108 m of total length of the land is located adjacent to the north side of the existing railway. The following tree species, Aplauda mudica, Azadirachta indica, and Bauhenea racemosa were observed in Shilottar forest plot. Herbal and grass plant species were only observed in the winter season.
5	Dhaniv Forest	In Dhaniv forest plot, 8 plant species were recorded as classified below. No endangered species were found in the field survey at this site during either season.
6	Bhatpada Forest	13 plant species in winter and 6 species in summer were observed during the field surveys. No endangered species were found in the field survey at this site during either season.
7	Bilalpada Reserved Forest	A total of 8 species were recorded in Bilalpada. No endangered species were found during the field survey at this site during either season.
8	Kasarali Forest	A total of 9 species were recorded in Kasarali forest area. Mangrove vegetation is also found in the lowland area of this village. No endangered species were found in the field survey at this site during either season.
9	Kelve Road Forest	Very little vegetation was observed. The forest land area can be described as open scrub or barren land. Only 3-4 plant species were noted. No endangered species were found in the field survey at this site during either season.
10	Kasbe Mahim Forest	The Mahim plot of forest land area is open scrub and no vegetation was recorded. No endangered species were found in the field survey at this site during either season.
11	Dandipada Forest	There are no trees in Dandipada forest plot, only invasive species and grasses were recorded. No endangered species were found in the field survey at this site during either season.
12	Boisar Forest	Boisar Forest is categorized as protected forest. The area is characterised by open, barren land with no vegetation cover present. No endangered species were found in the field survey at this site during either season.
13	Rani Shirgaon Forest	A total of 13 species were recorded in Rani Shirgaon. No endangered species were found in the field survey at this site during either season.
14	Kolavali Forest	9 plant species in winter and 6 species in summer were recorded in the field survey at Kolavili. No endangered species were found in the field survey at this site during either season.
15	Vangaon Forest	Vangaon village forest area is categorized as protected forest. Acacia auriculiformis, Agave americana, Lantana camara and Zizyphus oinoplia were species recorded in Vangaon. No endangered species were found in the field survey at this site during either season.
16	Pade Forest	This site is characterized by sparse mangrove vegetation. Only 1 tree species in winter and 3 plant species were recorded in the field survey. No endangered species were found in the field survey at this site during either season.
17	Ambevadi Forest	2 species in winter and 9 species in summer were recorded in field surveys.
18	Gholvad Forest	Gholvad forest area is parallel to the existing track. Bushes, grasses and a few tree saplings were recorded in the alignment area. Acacia leucocephala and Phoenix sylvestris and Prosopis juliflora were among the recorded species during the survey. No endangered species were found in the field survey at this site during either season.
19	Bordee Forest	During the field surveys 9 plant species in winter and 5 species in summer were recorded in Bordee forest plot. No endangered species were found in the field survey at this site during either season.

d) Summary of Conclusion

- A total of 133 plant species were recorded in the two season survey.
- Winter season (January) as well as summer season (April) analysis reveals that biodiversity is low in the village forest area falling in the proposed corridor.
- Species diversity in the winter season was higher than in the summer season.
- The village forest areas of Gholvad, Kolavali, Bilalpada and Sarjamori contained the greatest species diversity although the Gulistanpur Reserve of Gautam Buddha Nagar exhibited the highest species diversity of all the sites surveyed.
- The proposed DFC corridor alignment will have a minor impact on forest ecosystems and the natural environment in the Vasai detour village forest areas.
- In other village forest areas the DFC corridor will also only have a minor impact on the natural environment as these areas are not rich in vegetation cover.

2) Rewari-Dadri Section

a) Overall situation

Based on the Rewari-Dadri section tree census, it is estimated that a total 3,100 trees are located in the corridor and will require felling. The Reserved Forest area of Gulistanpur is dominated by *Prosopis juliflora, Dalbergia sissoo* and *Butea monosperma.* The corridor will bisect the reserved forest.

Table S.6.4 Tree Census in Rewari-Dadri Section

S.No.	District	No. of Trees
1	Rewari	415
2	Alwar	146
3	Mewat	350
4	Gurgaon	253
5	Palval	216
6a	Faridabad	1,066
6b	Faridabad-new	520
7	Gautam Buddha Nagar*	134
	Total	3,100

*Does not include the reserved forest trees.

b) Forest Areas: Gulistanpur Reserved Forest

The Gulistanpur Reserved Forest is located close to the industrial area of Surajpur and is not a natural forest but a result of plantation work by the forest department. Mainly *Prosopis juliflora*, *Acacia arabica*, *Dalbergia sissoo*, *Butea monosperma* and *Calotropis procera* were observed. The corridor will pass through 1.6 km of the reserved forest and it is estimated that a total of 476 trees will be cut. The maximum number of trees expected to be removed are *P.juliflora* (310), followed by *Dalbergia sissoo* (115), *Butea monosperma* (51) and *Acacia arabica* (13). However, this plantation forest consists mainly of semi-arid and arid plants for greenery development. Therefore, the corridor will not damage any critical habitat. Further plantation can be carried out to restore the area and compensate for the loss of forest cover

(3) Impact Assessment

1) Impacts

a) Loss of forest cover/tree cover:

Loss of forest cover/tree cover due to felling of private and government trees within the proposed ROW is anticipated. Approximately 45,197 trees in JNPT-Vadodara section and 3,100 trees in Rewari-Dadri section are required to be felled, although there is only one endangered species.

b) Diversion of Forest Land:

It is estimated that, approximately 32 hectares of forest land in the JNPT-Vadodara section and 10 ha in Rewari-Dadri section will be converted for use as ROW for the DFC. The area includes outer part of Sanjay Gandhi National Park and other recorded forests.

2) Mitigation measures

a) Loss of forest cover/tree

Tree cutting is to proceed only after all the legal requirements including Formal Clearances are completed and subsequently a written order is issued to the Project Proponent/ Contractor.

Appropriate compensatory plantation should be carried out to compensate for the vegetation loss due to felling of trees for site clearing. For trees to be cut, sufficient compensatory plantation, about 2 times the number of trees felled, will be carried out. If adequate space for compensatory plantation is not available along the DFC corridor, plantation may be carried out along State Highways (SH), Major District Roads (MDR), and Other District Road (ODR) or in degraded forest land.

For trees to be felled in private land, compensation for land and trees will be given to the owners. The rate of compensation for trees lost will be decided by the State Forest Department.

Compensatory afforestation and reforestation will follow preferences for mixed plantations consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value.

Under the plantation programme, more valuable tree species will be planted in place of existing non-valuable mono crops of the project area, where appropriate.

b) Diversion of Forest Land

Monetary compensation should be provided to Forest Dept. towards the cost of forest land to be diverted and costs of compensatory afforestation.

Before starting any activity within the Forest area, Forest Clearance must be obtained as per the Forest Conservation Act, 1980 and it’s amendments from the State Forest Department.

An action plan for tree felling should be prepared to avoid uncontrolled and indiscriminate tree felling.

Appropriate compensatory plantation should be initiated to compensate for the vegetation loss due to felling of trees for site clearing. For trees to be cut, sufficient compensatory plantation should represent approximately 2 times the number of trees felled.

Preferential mixed plantation consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value should be carried out.

Under the plantation programme, more valuable tree species should be planted in place of existing non-valuable mono crops of the project area, if any.

S.6.2 Fauna

(1) Study Methodology

Fauna species were also surveyed in the same forest areas of Thane and G. B. Nagar as for the flora species and in same seasons.

(2) Major Finding

1) JNPT- Vadodara section

a) Overall situation

The major fauna species in the districts studied included: Blue bull (Nil gai), Jungle cat, Jackal (Shiyal), Indian Fox (Lomdi), Common Langur (Hanuman langur), Indian Rat Snake (Dhaman), Checkered Keel back (Dendavo), Common Indian Krait (Kadotaro), Common cobra (Nag), Red sand Boa (Andhadi chakad), Pale Hedgehog (Shelo), Common mongoose (Noliyo), Indian Porcupine (Shahudi), Indian Hare (Sasalu), Indian Flying fox (Vagol), Indian Cricket Frog, Indian palm squirrel, Indian mud or lap shell turtle (Kacher), Common Indian Monitor (Patala Gho) Marsh crocodile.

In terms of Avifauna the species commonly found were: Asian koel, Rose ringed parakeet, White breasted kingfisher, pied kingfisher, Small blue kingfisher, Small bee eater, Common hoopoe, Common golden backed woodpecker, Coppersmith barbet, Black drongo, Common myna, House crow, Red vented bulbul, Common babbler, Purple sunbird, White wagtail, Yellow wagtail, Baya weaver, House sparrow.

b) Protected Areas: Sanjay Gandhi National Park (SGNP)

In the Diva - Vasai Section, the alignment of the proposed corridor has been planned parallel to the existing central railway track with a view to utilise the available railway land to the fullest extent and minimize acquisition of additional land. Near the villages listed below, all efforts to ensure that the track runs outside the Sanjay Gandhi National Park have been taken. However, the existing track safety and geological considerations require the proposed line to be near the existing line. Nagale, Shillotar, Sarjamori and Mori village forest areas will have minor additional impacts due to the proposed corridor. A total of 1.823 ha from the village forest area (Reserved forest) is expected to be affected.

c) Forest Areas

During the field survey, movement of some mammal species was confirmed in the forest areas even near the existing railway.

The summary of fauna species recorded in the forest areas of Thane and Raigad are provided in Table S.6.5.

Table S.6.5 Total Number of Species in Major Fauna Classes along the Proposed Corridor

No.	Forest Village	Winter				Summer			
		Reptiles	Birds	Mammals	Total	Reptiles	Birds	Mammals	Total
1	Ovali	7	30	6	43	3	26	3	32
2	Nagala (SGNP)	-	-	-	-	3	24	6	33
3	Sarjamori (SGNP)	10	48	12	70	8	25	7	40
4	Shilottar(SGNP)	10	48	11	69	5	27	6	38
5	Dhaniv	7	27	4	38	5	26	2	33
6	Bhatpada Dandipada	7	29	6	42	7	20	4	31
7	Bilalpada	7	29	6	42	8	24	6	38
8	Kasarali	7	28	7	42	5	26	6	11
9	Kelve road	7	32	5	44	3	18	3	24
10	Kasbe Mahim	8	23	5	36	4	24	1	29
11	Dandipada	7	36	4	47	3	27	3	33
12	Boisar	7	23	5	35	7	19	2	28
13	Rani Shirgaon	7	21	5	33	7	24	1	32
14	Kolavali	7	20	5	32	8	20	8	36
15	Vangaon	7	42	4	53	3	19	4	26
16	Pade	7	20	4	31	3	19	2	24
17	Ambevadi (Protected Area)	7	40	5	52	3	23	4	30
18	Gholvad	6	35	5	46	8	20	4	32
19	Bordee	8	34	7	49	7	23	11	41

2) Rewari-Dadri Section

a) Overall situation

In the Rewari-Dadri section, the proposed track is a detour where the alignment mainly goes through agricultural areas. Spotted Deer, Sambar, Blue Bull, Leopard, Caracal, Rusty Spotted Cat, Jungle Cat, Four-horned Antelope, Wild Boar, Jackal, Striped Hyena are some of the larger mammal species found in the forests of Alwar. Among bird species, Peafowl, Grey Partridge, Bush Quail, Sand Grouse, Tree Pie, Golden backed Woodpecker, crested Serpent Eagle and The Great Indian horned Owl are common.

b) Forest Areas: Gulistanpur Reserved Forest

The wide range of hardy vegetation species in the reserve despite being surrounded by an area of heavy industry is surprising but it is this biodiversity that enables resilience. The plantation forest of Gulistanpur is thorny and bushy. Gulistanpur is the only area in Gautam Buddha Nagar. Tourism infrastructure has been developed in the area.

(3) Impact Assessment

1) Impacts

Disturbance of occasional animal movement: During the field survey, movements of some mammal species were confirmed in the forest areas even near the existing railway. This may mean that animals may be hit by passing trains. Adequate measures should be considered to separate fauna from the railway by fencing and the construction of a underpass in the national park.

Habitat loss in Raigad mangrove area is expected. Similarly, mangrove vegetation near the Ulhas River and Vaitarna bridge construction sites, Pade and Kasarali Villages in Thane district are also expected to be impacted during the construction phase.

Minor losses in forest villages of Thane, as the majority of the area do not have dense vegetation.

At the Gulistanpur Reserve Forest, the proposed corridor passes through the middle of the entire forest area and is likely to affect animal movement in the forest land requiring adequate separation and passage to avoid traffic accidents at the operation.

2) Mitigation Measures

Fencing and development of safe passages for wildlife and local residents should be provided.

Detailed study of the protected area (SGNP) should be conducted to ascertain the future development aspects so that plans can be prepared in a timely fashion to avoid habitat loss and minimise stress.

The proposed corridor is likely to affect the Gulistanpur Reserved Forest areas the alignment route bisects the forest area. Therefore, immediate action should be taken to compensate by new plantation in the open scrub area adjacent to the reserve so that loss of habitat can be minimized.

S.6.3 Eco-Sensitive Area

(1) Dahanu Taluka Eco-sensitive Area

1) Existing condition

The study area was located in Vasai Taluka of Thane District. The length of the tunnel is 540 m. Summary Observation and Impact Matrix is shown in Table S.6.6.

Table S.6.6 Summary of Observation and Impact Matrix for Dahanu Taluka Eco-Sensitive Area

No	Issues	Observations	Significance of Impact
1	Topography & Drainage	DFC alignment shall pass through a valley surrounded by denudational hills. One closed tunnel of length 540 m and the other open cut have been proposed to cross over two nearby hills. The valley represents the trough of the undulating ridge topography and also acts as a groundwater recharge area. It is expected that natural drainage conditions will be altered during construction phase as well as due to filling (embankments) proposed for elevating the rail line between the hills which in turn may reduce groundwater recharge and obstruct down slope water availability i.e. to the west of the rail line. Therefore, appropriate mitigation measures are required to overcome anticipated impacts on the local natural drainage conditions.	High
2	Geology & Geological hazard	The rock formations in hills are comprised of basalts and in the valley portion, alluvial deposits. Occasionally the basalts are intruded by dykes. Structurally the area is an active tectonic zone and several moderate to high intensity earthquakes have been reported from the area. Though, in the area no major faults or shears zones are reported, the seismic activities are indicative of weak zones and require consideration. The possibility of weak zones such as faults, joints, and shear zones could increase the potential for rock-joint rupture hazards during deep cutting and rock excavation work. Also, the Geological succession of the area along with the topography indicates that the hill is fit for underground tunnel as at least 25 m overburden height is needed for closed loop to provide Arch section of the	Medium

No	Issues	Observations	Significance of Impact
		tunnel.	
3	Hydrogeology	The intervening area between the two hill sites is a valley floor area. The low ground area through which the proposed rail alignment is to pass through is also occupied with seepage out-flows of shallow groundwater that exists at the intersection of thin overlying soil mantle and the underlying basal rocks. The low lying valley floor area between two hill sites is mixed lateralised clay and eroded soil deposit washed down the hill slopes. The inhabitants of the area use this seepage out-flow for their domestic use. The water is scooped through small holes of 3 to 4 m diameter which extend to about 3 to 4 m depths. The seepage is a shallow ground water flow which enters the rail alignment from the eastern part of the watershed. Test exploratory wells may be drilled.	Medium to High
4	Ground Water Conditions	The bedrock around Belapur (19º 26' 17''.5N; 72º 51' 27''E) and Dhaniv (19º 26' 40''N; 72º 51'21''E) Villages occurs at shallow depths below a soil cover of 2 to 5 m. The groundwater level which rests at 2 to 2.5 m below ground level is a perched water table and the main ground water level in the underlying basaltic rock formation occurs at a greater depth. The excavation work for the rail corridor may result in changed groundwater conditions in the area and may affect groundwater flow. This could affect drinking water sources (open wells, dug wells, hand pumps etc.) in the area.	Low to moderate depending on the results of Site based Permeability tests at identified locations
5	Ground Water Regime	The deep cutting and excavation work may affect the groundwater levels mainly during the construction activities. Some of the existing open wells and borewells in and around the hill area can be identified and used for groundwater level and groundwater quality monitoring. Additional piezometers or observation wells are required to better understand the baseline groundwater levels.	Medium to High

2) Conclusions and Recommendations

The pattern of ground water flow, which is expected to be controlled by secondary rock fractures and joints in the tunneling area as well as the areas between the two hills, needs detailed study. Three boreholes for each hill are recommended to be drilled in and around the tunnel section. Out of three, one borehole of 150 m depth on the designated ridge areas and the other two at inlet and outlet tunnel portal points at 100 m depth to obtain subsurface geological and hydro-geological information. Tests such as in situ permeability testing should be conducted using these wells and data collected on the variability of rock units and rock permeability along the alignment.

The groundwater table in basalt aquifer is expected to occur below the tunnel depth however there are chances of seepage in the tunnel during rainy season due to rises in the groundwater levels in the study area. Where there is tunneling below the groundwater table, it would need to be drained or sealed as appropriate.

The area between the two hills for closed tunnel and open cut is the major ground water flow zone recharging from the catchment and feeds the downstream wells. It is recommended that the corridor between the two hills should be elevated so that the existing groundwater flow would not be altered. Alteration of the same may result into reduction of discharge of the wells downstream of the tunnel section.

Ground water levels may be monitored on a monthly basis for which stand-pipe bores are recommended to be drilled in valley-fill areas and piezometer bores on ridges and portal areas.

The water samples from monitoring boreholes should be collected and analyzed in the first year and prior to the construction phase and at least once in the post-construction phase

from installed standpipes and piezometers. The standpipe in the valley-fill area should be monitored for water quality for at least two years after the project completion phase and tunneling. The water quality data should be analyzed for pH and TDS levels of water in the well bores.

The above mentioned studies shall be taken up by DFCCIL through suitable experts / institutes during the detailed engineering stage, pre-construction stage, construction stage and post construction stage.

(2) Aravalli Eco-sensitive Area

Keeping in view of the physiologically aspects, two sub-areas / blocks were identified for preliminary investigative study representing the central part of the corridor stretch between Bhiwadi in Alwar and Sohna in Gurgaon and the eastern section of corridor and falling within Faridabad District bounded by Yamuna River in the east. The Aravalli area under the study consists of highly undulating topography around Sohna area and it is proposed to build the corridor by deep cutting of hill rocks.

A preliminary hydro-geological study was carried out to identify the potential issues and assess the possible impacts of the various construction activities for the proposed DFC project on the groundwater and geological conditions in and around the deep rock cutting. Summary Observation and Impact Matrix is shown in Table S.6.7.

Table S.6.7 Summary Observation and Impact Matrix

No	Issues	Observations	Significance of Impact
1	Topography	The DFC project site near Aravalli area basically lies in valley fill surrounded by denudation hills from almost three sides. The valley fills represent the trough of the typical undulating ridge topography and also acts as ground water recharge area. Natural conditions may be affected due to the construction activities of the DFC project, thereby affecting the recharge conditions in the area.	Low
2	Drainage	It has been observed that in the middle of Gurgaon stretch there is a surface water divide owing to the presence of nearly N-S trending Aravalli ridges. The streams originating from the western flank of the ridge flows westerly and joins Sahibi River and the east flowing streams finally join the Yamuna River forming the eastern boundary of study area. The DFC intersects both perennial and non-perennial drainage systems at several places between Bhiwadi and Sohna. This has the potential to directly affect the drainage conditions of the area.	Medium
3	Slope Stability	The rock formations in the area are comprised of Quartzites, Mica schist and pegmatite intrusions. Structurally the area represents an active tectonic zone. The area is dissected by a number of faults, fractures and shears, tending to run in a NNE-SSW to ENE-WSW direction. Locally the Delhi region forms the northern part of the southerly plunging fold known as Harchandpur anticline. Since the Aravalli rocky hill ridges from Banban Village to Keherani Village in Tijara Block, Alwar District and from Dhulawat Village to Rojka Village in Mewat District is made up of quartzites which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure map showing major as well as minor faults passing through the area. The deep cutting of rocks up to the depth of 28 m and removal of thick overburden will result in unstable conditions such as slippage of rock blocks, exposing weak joints with increased possibility of collapse of slopes during seismic events.	High

No	Issues	Observations	Significance of Impact
3	Geological Hazard	As deciphered from the Seismic-tectonic profile of the NCR Region, it is established that the active seismic faults do not pass through the proposed DFC alignment route. However, the possibility of weak zones such as faults, joints, shear zones could enhance rock-joint rupture hazards resulting from deep cutting and rock excavation work	Medium to High
4	Soil Liquefaction	In the valley region around Aravalli Hills, the area is dominated by shallow ground water levels (< 4 m), which may result in a reduced load bearing capacity of soil.	Low to Moderate
5	Groundwater Conditions	Since groundwater levels in hard rocky areas are more than 40 to 50 m and the deep cutting for DFC is restricted to 30 m, aquifer characteristics will not be affected. However, for ridge areas near Alwar which is dominated by high permeability sand dune areas, the deep excavation work for DFC project may result in changed ground water conditions in the area and may affect the groundwater flow. This has the potential to affect drinking water sources (open wells, dug wells, hand pumps etc.) in the area due to change in the recharge conditions. The deep cutting and excavation work of DFC Project may affect groundwater levels mainly during the construction activities. Some of the existing open wells, borewells in and around the hill area can be identified and used for groundwater levels and groundwater quality monitoring. Additional piezometers or observation wells are required for better understanding the baseline groundwater levels.	Low to moderate depending on the results of Site based Permeability tests at identified locations
6	Hydrogeology and Natural Aquatic System	The Sohna area was observed to include a number of spring and seepages in quartzite and inter-bedded schistose rocks; Sohna hot spring owes its origin to a deep seated intersection of faults. The directions of linear features are conspicuous by their presence. During construction activities, the existing freshwater spring near the DFC alignment route could be affected resulting in a disturbance to the natural set up, flow and discharge of the existing spring. This water spring acts as a source of drinking water as well as having thearupatic and religious values. If this natural spring is affected, this may affect water sources for some downstream villages.	Medium to High
7	Flora and Fauna	There is no forest area in the Aravalli eco-sensitive area. In Mewat district certain vegetation patches are on panchayat land. No forest area falls within the proposed alignment. - Impact on physical characteristics of the area due to erosion. - The impact on soil will be in terms of top soil erosion and its compaction due to location of labour camps, storage and movement of machineries and disposal of waste on the open ground.	

(3) Conclusions and Recommendations

Based on the studies and survey carried out in the Taoru Block of Mewat District and Tijara Block of Alwar District, the following recommendations are provided to be taken up by DFCCIL during different stages of the project viz. detailed engineering, pre-construction, construction and post-construction.

a) Geotechnical and Slope Stability Study

Due to the blocky nature of the joints in quartzite rock formation of sloping ridges of Aravalli, it is recommended to have a study made of rock slope stability particularly along the ridge facing Sohna-Rojka area as well as the narrow ridge corridor between the KMP Expressway and the extending rocky ridge between Khor-Guspethi village Section. The said study should be taken up by DFCCIL through suitable experts/institutes like Central Building Research Institute (CBRI) Roorkee, CSMRS, and GSI during the detailed engineering design stage.

b) Standard Penetration Test Borings

Standard penetration test borings, laboratory grain size analysis of soil samples to identify liquefaction potential particularly over shallow ground water table areas (areas with a groundwater table within 4 m of land surface) are to be taken up at pre construction stage. It is also proposed that the detailed study for assessment of liquefaction potential should also be taken up by DFCCIL during pre- construction stage.

c) Hydro-geological Investigation and Permeability Tests

Construction activity on the Aravalli ridge would involve rock excavation which may obstruct groundwater flow at various locations as the nature of fractures and joints in rock formations change. It is recommended that a detailed study be taken up for characterization and assessment of groundwater flow in the underlying aquifers to establish groundwater recharge rates and their mechanisms as well as changes if any in the post project scenario. These should be carried out by DFCCIL using hydro-geological expert and drillers by constructing test wells during the detailed engineering or pre-construction stages.

d) Safeguard of Ground Water Dependent Ecosystems

The area adjoining Sohna has some natural springs which are connected with deep seated fractures and tectonically linked with geological structures present at the surface and below the ground. These springs are both sources of drinking water as well as possessing therapeutic and religious values. Since the DFC alignment crosses KMP Expressway about 0.5 km north of one of the springs, utmost care will be required to avoid damage while construction, excavations and blasting so as not to disturb the natural setup and obstruct the spring flow and discharge. In view of this, it is proposed to conduct studies with an objective to work out strategies and technical measures to safeguard the discharge of the springs. Such a study should be taken up during the detailed engineering stage by DFCCIL in and around Khor and Sohna Villages.

e) Ground Water Use in the Construction Phase

Groundwater resources in almost all the administrative units including Gurgaon, Rewari, Faridabad of Haryana and Tijara Block, Alwar District of Rajasthan falling within the study area are already overexploited. It is strongly recommended to undertake detailed studies to establish the geochemical profile of the groundwater in the study area as well as the environmental impact of any further groundwater withdrawal on the overall groundwater regime of the area. Additionally, in order to address the sustainability the existing groundwater sources as well as partly meeting the construction requirements it is recommended that a comprehensive plan for rain water harvesting and artificial recharge to groundwater may be formulated by DFCCIL, wherever groundwater is extracted for construction purposes.

f) Hydrological Studies

The rocky hill unit divides the precipitation falling on the hills which flows down the slope through the piedmont zones and recharge the groundwater aquifers. Any development activities taken up in the foothills or in the piedmont zone may in turn adversely impact the hydrodynamics of groundwater recharge. The development work associated with the project, including construction and landscaping of the area around the proposed line of the corridor would alter the slope which will disturb the natural drainage system of the area. A detailed hydrological study may be taken up in the area at micro- watershed level to plan the diversions and the drainage system, as deemed necessary. The details of the study may be considered at the detailed engineering or pre- construction stage.

g) Groundwater Monitoring

In view of insufficient data available on basic groundwater parameters, it is recommended that an optimum number of purpose built ground water observation wells are constructed and a baseline dataset may be established for regular monitoring during construction stages. It would be advisable to ensure groundwater level monitoring through the construction period via specially built piezometer wells at designated sites. An optimal monitoring network would continue to monitor impacts on groundwater sources at a specified frequency by the DFCCIL throughout the pre- construction, construction and post-project periods.

h) Flora and Fauna

There is no forest area in the Aravalli eco-sensitive area. In Mewat district certain vegetation patches are on panchayat land. No forest area falls within the proposed alignment.

Tree cutting and vegetation clearing is expected to be an essential part of the construction of the corridor. Therefore, compensatory plantation in nearby areas will be initiated. Planning for the regular watering, nourishing and protection of the planted trees will ensure their effective restoration as part of the compensatory afforestation programme. In addition, an integrated management plan for mangrove areas will be developed.

S.6.4 Topography and geographical features

Topography and geographic features will not experience any major impact except in Bhatpada and Dhaniv forest area where tunnel construction has been proposed. In addition, certain impacts resulting from high embankments are expected as a result of the project. Since the alignment runs on a high embankment, there are local community access issues and anticipated storm water drainage problems during the operation phase of the project. These impacts will be minimized by providing adequate ROBs, RUBs, etc. During construction phase changes in topography are envisaged due to the clearing of land, felling of trees, cutting and filling, and due to construction. Filling and cutting of land will be required in the stretches where the track traverses through undulating topography. However, changes will be limited within RoW of the track hence overall impacts will be localized.

S.6.5 Soil erosion

The clearing of land, cutting of trees, excavation of borrow areas are likely to trigger soil erosion. The Movement of vehicles/machinery/equipment and work forces is also likely to cause soil erosion. Borrow areas will be required for the project. Most sections of the DFC are on embankments. The borrow areas are likely to cause soil erosion and affect agricultural areas. Appropriate measures for borrow area management should be taken. Debris may also be generated due to dismantling of structures. Oil spills from the operation of the diesel pumps and diesel storage, during transportation and transfer, parking places and diesel generator sets may also have potential negative environmental impacts. The operation of the emulsion sprayer and laying of hot mix on service roads could also have negative environmental impacts. Due to changes in land use, impact is envisaged on soil during the operation phase. However, the impacts are within the RoW.

S.6.6 Groundwater

(1) Impact Analysis

Associated with the tunnel construction at the Vasai Detour, hydrological conditions in the watershed area are likely to be affected with groundwater shifting. In Vasai Detour, an underground tunnel is planned to be constructed at the hill crossing the watershed. The planned railway formation level on the Mumbai side is higher than it is at the Delhi side and as a result groundwater levels are anticipated to be affected. Due to the alteration of groundwater flow, present flow to out-flow from the tunnel after construction, the water quality of groundwater is likely to be affected especially dissolved metal contents such as iron (Fe) in the water.

(2) Mitigation Measures

The formation level in the tunnel section will be considered by DFCCIL to minimize the impact on the hydrological conditions in each watershed resulting from seepage on both sides of the tunnel. Hydrological analysis in the area covering at least 500m from the tunnel is required and will be conducted by DFCCIL prior to the design. Correlation between rainfall and groundwater level (water discharge from the area) should be adequately analyzed based on monitoring over a longer period to clearly assess the impact. Geological structure investigation through field reconnaissance of surface condition and aerial photo analysis should be conducted prior to implementation. Water recharge to the local community should be considered to replace the groundwater used during construction. The water will be adequately treated and of the same or better quality as at present based on the water quality analysis which will be conducted prior to implementation.

S.6.7 Hydrological Situation

Embankment construction between two (2) tunnels in the valley-like condition at the undulating topographic feature in the hilly area is likely affect surface water flow and drainage in the area resulting in potential flooding upstream and water shortages downstream. Therefore adequate drainage systems to allow surface water flow in the watershed upstream of the railway construction area should be considered based on hydrological analysis of the area.

S.6.8 Coastal Zone

(1) Impacts Assessment

The DFC Corridor will have a negative impact on the general habitat and erosion in the area. During construction phase at bridge construction sites, mangrove clearing will be carried out. Forest areas in Pade and Kasarali Villages of Thane were found to possess mangrove vegetation. In Raigad District near JNPT and in areas beyond Panvel, mangrove forests are likely to be affected.

(2) Mitigation Measures

Protection alone is insufficient to reverse the trends in mangrove forest destruction. Even when disturbance is reduced, the altered soil conditions and limited natural dispersal mean that natural recovery can be very slow. More scientific means of restoring the mangrove vegetation need to be implemented. Mangrove restoration efforts should be made to return an area to a condition more closely resembling its original state, including restoring the full range of biological diversity and all the essential ecological processes. Developing a

monitoring programme to measure the success of restoration is important for effective implementation of the restoration programme.

S.6.9 Landscape

The construction of a railway embankment is likely to cause aesthetic changes to the landscape. Suitable landscaping and plantation activities, slope protection activities are envisaged to minimize the aesthetic impacts.

S.6.10 Global Warming

The Phase 2 Section is a part of the Western Corridor. As noted above, the DFC scenario is expected to emit less GHGs than the No-DFC scenario. Cumulative GHG emissions for 30 years (in million ton CO_2) for the Western corridors under the DFC and No-DFC scenarios are presented in the table below. Container and RO-RO are the two major commodities carried by the Western DFC, accounting for about 85% of total freight GHG emissions of this Corridor. Therefore, the phase 2 section plays a significant role in reducing global carbon emissions.

S.7 SOCIAL CONSIDERATION STUDY OF ESIA

Baseline survey and census study were conducted to get the information of the social status of the population of area falling in the proposed corridor. Impact and mitigation measures of land acquisition and resettlement have been separately discussed in details in the baseline survey, census report, and RRP

S.7.1 Land Acquisition and Resettlement

(1) Study Methodology

Based on the detailed design of the project corridor, the land acquisition requirement has been assessed through preparation of the Land Plans. As per the Land Plans for 14 districts, the Competent Authority (CA) has been notifying for land acquisition under Railway (Amendment) Act 2008 in the Phase 2 area. Based on the 20E notification or draft 20E (including Joint Measurement List or PAP List) published/to be published under the Act, No. of Villages Affected, No of Plots Affected and No of Titleholders were counted.

(2) Major Finding

Based on the 20E notification or draft 20E (including Joint Measurement List or PAP List) published/to be published under the Act, the land acquisition is required in 374 villages of these 14 districts, which is approximately 2,252 ha, as summarized in the Table S.7.1

Table S.7.1 Summary of Scale of Land Acquisition and Resettlement (Provisional)

Name of the District	No. of Villages Affected	No of Plots Affected	No of Titleholders
I. JNPT-Vadodara Section			
Raigad	41	248	976
Thane	95	1745	13,112
Valsad	37	443	3,003
Navsari	22	416	1,468
Surat	35	655	2,773
Bharuch	29	705	2,918
Vadodra	10	315	815
II. Rewari-Dadri Section			
Rewari	17	703	5,751
Alwar	13	512	3,710
Mewat	19	891	3,050
Gurgaon	9	294	1,630
Palwal	8	706	3141
Faridabad	28	1,421	6,911
G B Nagar	11	110	361
Total (I +II)	374	9,209	49,619

(3) Impact Assessment

The agricultural area will mainly be affected due to the proposed DFC alignment. Residential areas in rural as well as in semi urban and urban areas (mainly in JNPT-Vadodara) is also being affected. There will be loss of the agricultural land along the proposed corridor.

The land and property acquisition would be restricted to bare minimum required. Appropriate compensation would be awarded through the Rehabilitation and Resettlement Plan (RRP). Compensation and assistance package shall be planned in the RRP, separately from the ESIA.

S.7.2 Socio-economic Features

(1) Study Methodology

Secondary data relevant to the social environmental such as total population, Schedule Caste (SC) population and Schedule Tribe (ST) population was collected and analyzed.

(2) Major Finding

The summary of the district-wise socio-economic status of the affected villages is shown in Table S.7.2. The Schedule Caste (SC) population varies from 1.35% for Raigad district to 23.7% for Haryana district of the total population, and the relatively higher percentage is observed in Haryana state. On the other hand, Schedule Tribe (ST) population ranges from 0.0% for Mewat, Palwal, Rewari, Gurgaon, Faridabad and G. B. Nagar districts to 47.2% for Valsad district, and the relatively higher percentage is observed in Maharashtra

and Gujarat states. The literacy rate ranges from 40.8% for Mewat district to 72.0% for Valsad district. The lower literacy rate is observed in Haryana and Rajasthan states. Finally, the work participation rate varies from 28.3% for G. B. Nagar district to 54.0% for Alwar district. There is no district which average work participation rate is 50% or more.

Table S.7.2 District-wise Average of Socio-economic Features of the Affected Villages

District-wise Average	Total Population/village			SC population %	ST population %	Literacy %	Work Participation %
	Person	Male	Female				
Raigard	7,645	4,116 (53.84%)	3,529 (46.16%)	1.35	13.53	62.43	42.11
Thane	4,895	2,642 (53.98%)	2,253 (46.03%)	2.54	38.42	58.94	45.16
Valsad	6,626	3,589 (54.16%)	3,038 (46.82%)	3.60	47.21	65.69	41.46
Navsari	3,263	1,666 (51.07%)	1,596 (48.93%)	1.53	33.34	71.97	41.98
Surat	5,828	3,220 (55.24%)	2,609 (44.76%)	6.74	31.28	52.23	46.43
Bharuch	5,478	2,873 (55.45%)	2,605 (47.55%)	4.45	33.07	64.95	40.99
Vadodara	1,256	656 (52.20%)	600 (47.80%)	7.16	37.96	53.74	52.44
Alwar	1,222	644 (52.67%)	578 (47.33%)	16.22	0.40	49.71	54.02
Mewat	2,474	1,411 (57.04%)	1,063 (42.96%)	12.55	0.00	40.75	41.60
Palwal	3,421	1,865 (54.50%)	1,557 (45.50%)	21.16	0.00	49.69	33.62
Rewari	1,472	784 (53.25%)	688 (46.75%)	23.65	0.00	57.78	46.53
Gurgaon	4,611	2,452 (53.17%)	2,159 (46.83%)	19.97	0.00	49.58	43.52
Faridabad	2,985	1,607 (53.84%)	1,378 (46.16%)	22.27	0.00	48.56	39.88
G.B. Nagar	1,859	996 (53.61%)	862 (46.39%)	18.53	0.00	54.28	28.32

Note:

1. Raigard district: the data for new 6 villages is not available in Census of India 2001
2. Thane district: the data for new 6 villages is not available in Census of India 2001.
3. Valsad district: the data for Jora Vasan village is not available in Census of India 2001.

Source: Census of India 2001

S.8 SUMMARY OF PUBLIC CONSULTATION AND INFORMATION DISSEMINATION PROCESS

S.8.1 Objectives of Public Consultation Meeting

The Public Consultation Meetings for ESIA was conducted district-wise in all fourteen districts at two different stages in order to collect opinions and feedback of the public and to disseminate information on the project and ESIA study.

i) First Stage: At the time of environmental scoping in the initial stage of the ESIA study in the month of Nov 2010 (and supplemental PCM in Maharashtra in Feb 2011).

ii) Second Stage: The second stage was conducted in September 2011 to disseminate information about findings of draft ESIA study and probable mitigation measures to the general public.

S.8.2 Methodology of PCM

(1) Target Stakeholders

Participants included the PAPs, other villagers, Gram Pradhan, Village Patwari, Administrative officers, Forest officers and Railway officers.

(2) Method of Information Dissemination

Invitation letters in local languages were sent to the Gram Panchayats, Legislators, NGOs and Government Officers.

A handout containing information about the project and Draft ESIA Study in local languages (Hindi, Gujarati and Marathi) was distributed in potential affected villages. It was also stuck /pasted on the notice board of Panchayat office.

(3) Record of the Meeting

In order to duly incorporate the result into the report, information on participants and content of the meeting was recorded in each PCM. Beside, feedback form was distributed to collect further comments and suggestions from the participants.

S.8.3 Major Issues Discussed During the PCMs

Some major issues discussed along with suggestions provided by the people are described as follows:

a) Displacement and land acquisition

- Concern on removal of existing overhead electric cable lines in alignment route, underground water pipelines for irrigation, gas pipelines, sewerage lines etc.,
- Concern on loss of income due to land acquisition and concomitant livelihood impacts,
- Concerns on how to manage the transition between an agricultural livelihood to something else – alternative livelihood or employment options associated with loss of productive land,
- Displacement of squatters and their treatment.

b) Clarification on aspects related to alignment

- Width of land in ROW to be acquired by DFC Project,
- Confusion on published 20A or 20E Notifications due to different plot numbers, missing titleholder names, different village names due to alignment change and mismatch with revenue land records,
- Suggestions on shifting of alignment from main village habitation to at least 200 m or beyond and keeping safe distance from the houses,
- Provision of service roads on both sides of the alignment route and adequate ROBs/RUBs/FOBs to reduce hardships to farmers, and

c) Compensation and employment opportunities

- Discontent on the compensation rate: Compensation proposed to be paid by DFCCIL is 160% of the circle rate (official rate). There was a very high resentment as the rates being paid as compensation does not correspond with the market rates. Some area is more developed, has high fertile land, and has high quality of other environmental

attributes, so the land valuation is not uniform as compared to other areas in the same district,

- Demand for consideration of compensation rate as per the proposed New Land Acquisition Bill which is due to be passed within next six months. Moreover, long term benefits to be passed on to the farmers since Railways will continue to have profit for a longer period,
- Demand on acquisition of residual portion of land at the same compensation rate,
- Demand on realizing guidelines on providing jobs to one member of every land losing household. Employment should be given before land acquisition and not after construction of the project,
- Uniform rate for adjoining lands irrespective of they fall in different administrative boundaries,
- Demand on land-for-land, building-for-building, compensation for damaged crops (if any) or loss of productivity in nearby fields, and compensation for common lands to be addressed, and
- Demands for female and young people to have access to equal opportunities of employments as well as individuals to provide training opportunities to develop their skills.

d) Environment and health

- Suggestion on no use of top fertile soil from the nearby agricultural lands for DFC Project,
- Suggestion on implementation of afforestation work on both sides of the DFC line using local trees only. Not only afforestation should be done on both sides of railway line but all tress planted should be protected from illegal felling,
- Concern on deterioration of local water resources in terms of quality and quantity due to the DFC Project. Since many project area has high ground water table and surface rivers, no wastewater should enter surface and ground water sources,
- Concern on creation of unhygienic environment in and around the villages due to poor sanitation and stagnation of water along the rail line,
- Use of fertile agricultural lands for construction of yards or stockpiling of construction materials to be avoided,
- Noise and air pollution impacts: It might call for specific mitigation measures (like noise protection walls or a green belt as proposed by many stakeholders) or even for additional resettlement (moving people out of areas with intolerable noise levels).

e) Drainage conditions

- Suggestion of appropriate drainage along the rail line so that land along the alignment does not get affected due to water logging, and
- Concerns on shifting of existing water supply pipelines, electrical lines and sewerage lines: There are surface water bodies such as drains and canals joining the river bodies. Therefore cross drainage works such as bridges, culverts etc. were required.

f) Access to resources and community facilities

- Concerns on situation in which residential areas find themselves separated from agriculture fields or other community assets like temples, mosques, cremation

grounds, community centers etc., areas which were easily accessible before, or access to certain categories of land (e.g. pastures, sources of firewood or water), and

g) Socio-cultural

- Concerns on physical impacts on culturally meaningful sites or objects (occupation of land), or by influx of people with a different ethno-cultural background into an area inhabited by a minority population,
- Demand on constantly updating the status of the project and related social and environmental implications, and
- Demand on providing public consultation on gender, cultural, social, ecological subjects and above all compensation related financial issues throughout project phases.

S.8.4 Public Information Dissemination Process

The ESIA study findings are disseminated to the project affected persons, stakeholders and the implementation authorities so that preventive measures can be taken for the successful completion of the project. The information dissemination is implemented at two stages for the ESIA.

- The first stage of information dissemination was conducted at draft final ESIA.
- The second stage is implemented when the ESIA is finalized.

The process of information dissemination was arranged in a systematic, time bound and transparent manner ensuring widest possible public participation of the project. Methodology of the process in the first stage was as follows:

- The distribution of draft ESIA reports including summary in vernacular languages.
- Draft ESIA Report had been distributed to DFCCIL Head Office, 4 Chief Project Manager (CPM) offices of DFCCIL, 14 District Collectorate (DC) Offices and 17 Major Stations including Junction Stations along the proposed DFC alignment. Full Reports (Main and Appendix) were available there for public reviewing.
- Summary of the draft ESIA reports were distributed to Sarpanches of 374 Project Affected villages, 4 CPM offices, 14 DC Offices, and 17 Major Stations including Junction Stations along the proposed DFC alignment. On request of CPM Mumbai Office, copies of summaries in English and Marathi were also distributed to the Competent Authority of Raigad and Thane Districts, Chairman of JNPT in Mumbai, and CIDCO office in Raigad.
- Last date of sending comments was initially set as 26th September 2011 but since some distribution was made a little late after request from CPM Mumbai office, submission date was later extended to 9th October 2011, considering minimum 10-12 days for review by the public.
- Comments and opinions were accepted on draft ESIA report only in writing through direct delivery, fax, or post and email (dfc.phase2@gmail.com) to the respective CPM offices.
- After collection of all comments from CPM offices, it had been sorted out, summarized and incorporated in final ESIA.

S.8.5 Findings of Information Dissemination of Draft ESIA

Among 5 comments received (4 readable and 1 unreadable), only two comments pertaining to reduction of dust pollution during construction to avoid damage to crops in nearby fields and minimizing impacts on existing drainage channels are incorporated in the final ESIA report. These comments will be taken care of at the time of implementation period through mitigation measures and Environmental Management Plan.

Besides these, there are mainly comments related to higher compensation for land and utilities, employment, and other rehabilitation and resettlement issues. These specific issues will be dealt separately in RRP report and will be taken care of at the time of preparation of Rehabilitation and Resettlement Plan.

S.9 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

S.9.1 Pollution Control

The pollution will be generated due to movement of vehicles, and operation of light and heavy construction machineries during construction, and due to movement of trains and related facilities such as loading and unloading during operation. The pollution can be prevented or minimized by implementing suitable mitigation measures at appropriate stages of the project cycle. The mitigation measures are summarized in Table S.9.1.

Table S.9.1 Environmental Impacts and Mitigation Measures (Pollution Control)

No.	Potential Impacts	Mitigation Measures
1	**Noise and Vibration**	
Construction Phase		
	- Due to movement of vehicles, and operation of light and heavy construction equipment and machineries. - Higher noise and vibration level has some possibility to cause sleep disturbance and mental instabilities to the residents living adjacent to the proposed corridor.	- Notify the local people in case of blasting operations or similar construction activities associated with higher noise and vibration level. - Locate the quarry sites away from the residential areas and sensitive receptors. - Regularly maintain machinery and vehicles, with particular attention to silencers and mufflers, to keep construction noise levels to minimum. - Locate construction yards away from the settlement and sensitive areas. In case unavoidable, the time of the construction activities shall be limited. - Provide protection devices (ear plugs or ear muffs) to the workers operating in the vicinity of high noise generating machines.
Operation Phase		
	- Noise and vibration levels are likely to increase due to movement of high speed freight trains with double-decker carriages and related facilities such as loading and unloading.	- Suitably provide vegetative barrier in the buffer zone. - Erect noise barriers at appropriate locations such as residential areas and sensitive receptors. - Expand the right of way (buffer zone) as far as practicable as an effective method of reducing the noise and vibration impact. - Ensure and keep correct track geometry by advanced measurement, use of long welded rails and incorporation of new technologies for structures and rolling stocks to reduce noise and vibration levels.
2	**Water pollution**	
Construction Phase		
	- Wastewater from construction activities with suspended impurities. - Untreated wastewater disposal from the office	- Comply with all relevant water quality laws during the entire period of construction activity. - Ensure that no liquid is discharged from any

No.	Potential Impacts	Mitigation Measures
	camp or labor camp as well as sludge generated from the construction activities. - Increase of sediment load in the runoff from site roads and other exposed soil in the construction area would increase turbidity in receiving streams/water bodies. - Spillage and uncontrolled release of construction and toxic materials could also impact surface and ground water. - Slight change in hydrology and geomorphology of the stretch of water course directly affected by the temporary works at the site of new crossing.	construction site/activity without treatment. - Retain site drainage in purpose-built lagoons for enough time to allow most sediment to settle out before discharge to natural or urban drains or provide sediment traps in drainage system. - Cover stockpiled soil and other loose material with secure tarpaulins and drainage should pass from stockpile areas into settlement lagoons. - Collect and store used or waste oil in sealed damage-proof containers and may be sold to CPCB/ SPCB approved authorized recycler/ re-processor. - Provide proper sanitation facilities at the construction site to prevent health related problems due to water contamination.
3	**Air pollution**	
Construction Phase		
	- Deterioration of ambient air quality due to particulate matter such as dust, especially during dry conditions and gaseous emissions from construction equipment and vehicular traffic. - Some locations along the alignment route are notified as critically polluted areas.	- Consult the local pollution authorities, comply with relevant air quality laws and obtain necessary permissions at least for critically polluted areas before start of any construction related activities. - Maintain all construction vehicles to minimize vehicle emissions. - Payload area of the trucks or dumpers should be covered by tarpaulin when transporting soil and crush. Also, construction materials should be stored in covered go-downs or enclosed spaces. - Use adequate dust suppression measures such as regular water spraying on unpaved haul roads, vulnerable areas of the construction sites, during unloading from the truck/dumper, at the primary crusher feeder chute, the transfer points from one belt conveyor to another, etc. - All major construction machineries should be in-built with appropriate dust reduction measures.
4	**Waste Generation**	
Construction Phase		
	- Significant quantities of solid waste during the construction such as gravel, concrete, soil, steel, miscellaneous structures such as culverts, poles and cables, organic material such as cleared vegetation, timber, and waste food from labor camps. - In addition, some quantity of hazardous waste shall be generated such as waste oil, fuel, grease and chemicals from construction equipment and vehicle servicing.	- Comply with relevant laws pertaining to the management and disposal of solid waste and hazardous waste. - Before start of construction activities, all suitable disposal measures should be identified for solid waste and any other form of waste likely to be generated from the construction activities. - A designated solid waste disposal site should be secured away from human settlements. In addition, a disposal site should be away from water streams and any archaeological and historical monuments. - No dumping should be carried out on private property without written consent of the owner. - No dumping should be allowed on wetlands, forest areas, and other ecologically sensitive areas. - All areas designated for the storage of fuels, oils, chemicals or other hazardous liquids should have a dense base and surrounded by a bund to contain any spillage. These areas should be covered by a roof structure to minimize the potential for infiltration and contamination of rainwater. - Hazardous waste management plan should be prepared and implemented for disposal of waste oil, batteries and other hazardous materials.

No.	Potential Impacts	Mitigation Measures
5	**Disaster**	
Construction Phase		
	- Rewari-Dadri section is in the seismic zone IV as per seismic zoning map of India which makes the area susceptible to moderate to high intensity of earthquakes and is considered as High Risk Zone. - Since the Aravalli rocky hill ridge falls in seismic zone IV, deep rock cutting up to the depth of 28 m and removal of thick overburden could result in unstable conditions such as slippage of rock blocks, exposing weak joints with increased possibility of collapse of slopes during seismic disaster. - Embankment structure along the major part of the DFC corridor could trap rain water and cause flood around the project area. - Although Vasai detour is in seismic zone III (low intensity), the seismic activities at moderate level could enhance the rock-joint rupture hazard during rock cutting and excavation during construction of tunnel work.	- Appropriately incorporate seismic factors in the civil and structural designs of major structures in DFC project. - An engineering geologist should identify any slope instability potential among the uniform rock structure especially along the Aravalli ridge where deep rock cutting will be done during detailed engineering stage. - Provide adequate cross drainage channels along the DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding. - Although the geological succession of the Vasai detour area along with the topography indicates that the hill block is fit for underground tunnel as the minimum 25 m overburden height is available for closed loop to provide arch section of the tunnel, any unstable or rock-joint rupture hazard should be identified by an engineering geologist.

S.9.2 Natural Environment

The natural environment is contrasted with the built environment which is strongly influenced by human activity. Environmental degradation can be prevented or minimized by implementing suitable mitigation measures at appropriate stages of the project cycle. The present section envisages the likely impacts of the proposed freight corridor on the natural environment and suggests a range of mitigation measures. Mitigation measures are summarized in Table S.9.2

Table S.9.2 Environmental Impacts and Mitigation Measures (Natural Environment)

No.	Potential Impacts	Mitigation Measures
1	**Flora**	
Pre-Construction Phase		
	- Alignment passes through about 20 forest patches of Recorded Forest Area in Thane District with area of nearly 32 hectares and one forest patch in Gautam Buddh Nagar District with an affected land area of nearly 10 ha causing loss of trees and habitat.	- Assess alternatives and review design to reduce loss of forest land to the minimum. - Follow the procedure for obtaining clearance under the Forest Conservation Act (FCA), 1980 after due consultation with the Forest Department (FD). - Pay legally required compensation to FD to cover cost of compensatory afforestation program. - Comply with all stipulated conditions of Forest Clearance when granted.
Construction Phase		
	- Loss of flora due to felling of trees, herbs and shrubs within ROW linearly along the alignment route in both the forest and non-forest areas would adversely affect landscape locally, habitat fragmentation and loss, and may impact the conservation and preservation planning and status of the local State Forest Department. - Loss of private orchard farms in Dahanu area of Thane District will affect landscape, local conservation and soil erosion prevention status in this notified eco-sensitive area as well as economic loss to the local people. - Increased earth and rock extractions may affect	- Joint field verification with the respective State FD to avoid uncontrolled and indiscriminate tree felling. - Appropriate compensatory plantation using native species or pollution tolerant species with rate of replacement as per the State FD. For example, for Dahanu eco-sensitive area, ten trees for each tree cut. - Compensation for in private land should be based on fruit yield, timber and other economic values. - The need for wood as building materials for workers' temporary housing should be replaced with alternative eco-friendly building materials but if unavoidable, should only be bought from the sustainable source or authorized selling depots in the project area.

No.	Potential Impacts	Mitigation Measures
	or remove root structures and disrupt ecosystems. - Construction workers' use of local timber for small scale temporary housing or furniture and in particular for firewood and other small uses may have negative impacts - Deposition of fugitive dust on pubescent leaves of nearby vegetation could lead to temporary reduction of photosynthesis.	- Regular and proper water sprinkling near the site to minimize dust deposition on vegetation.
Operation Phase:		
	- Improper post-plantation care/maintenance as well as illegal felling of plantation along DFC track will offset all positive efforts by the project.	- Plantation along the ROW should be maintained properly as well as protected from illegal felling.
2	**Fauna**	
Pre-Construction Phase		
	- Fauna inhabiting the Recorded Forest Areas of Thane District and Gautum Buddh Nagar District may be affected by the construction/operation.	- Review design and make adjustments to ROW or alignment route to the extent feasible to reduce loss of Recorded Forest Lands to the minimum as well as to keep safe distance from the protected boundary of the notified forest areas.
Construction Phase		
	- Both terrestrial and avifauna may be affected by noise and vibration due to construction equipment and machinery as well as movement of construction bound vehicles. - Fauna may be impacted by destruction of habitats such as bird nests, breeding sites etc. along the new alignment route. - Construction workers having greater accessibility to the forest could lead to poaching activity in the forest areas along the corridor. - Increased sediment loads into major water bodies during bridge construction work may impact aquatic fauna due to temporary loss of habitat and reduced water quality.	- All major noise producing construction equipment/machineries should be fitted with acoustic control measures so as not to impact local fauna. - No construction yard should be set up in the forest areas. - Honking should be strictly prohibited in the forest area by the trucks and dumper used for the construction activity. - Construction schedule in such a manner to avoid heavy construction near forest areas during the winter season when migratory birds inhabit the area. - Minimize turbidity in the river water by activities such as major earth work for important bridges only during the dry period, care during construction of bridge piers for coffer dams.
Operation Phase:		
	- Division of habitats due to DFC line can affect faunal population range and distribution, ability to mate, connectivity between populations. - Impact on aquatic fauna in case of accidental oil spill and toxic chemicals release find its way into the water bodies.	- Take immediate actions for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents. - Provide crossing structures where the DFC line passes through the forest patches after discussing with the local Forest Department or local NGO to determine the location, frequency, basic design and number of crossing structures.
3	**Protected Areas**	
Pre-Construction Phase		
	- Alignment passes through reserved forest area between Sanjay Gandhi National Park (SGNP) and Tungareshwar Wildlife Sanctuary along parallel section, so wildlife may be disturbed by the construction/operation. - In Thane District, new DFC route will impact some mangrove areas which are notified as deemed reserved forests.	- Review design and make adjustments to ROW or alignment route or loop length of junction yards to the extent feasible to reduce loss of reserved forest land near protected area to the minimum. - Consult the State's Chief Wildlife Warden and other key officials and follow the procedure for obtaining clearance under the Wildlife Protection Act, 1972 for the protected area. - Consult State Forest Department (FD) and submit timely application for Forest Clearance (FC) under the Forest Conservation Act (FCA) for mangrove areas. - Comply with all stipulated conditions.
Construction Phase		
	- Mangrove areas with dominant species having conservation concern in the State of Maharashtra will be affected by construction activities. - Felling of some endangered flora species in the	- Compensate loss of mangrove vegetation by replanting at other mangrove sites after due consultation with the Forest Department and pay legally required compensation fees.

No.	Potential Impacts	Mitigation Measures
	ROW near SGNP, thereby adversely affecting conservation status and may lead to habitat fragmentation and loss. - Fauna may be impacted by destruction of water holes and habitats such as bird nest and breeding sites along the new alignment route near protected area.	- Compensatory plantation for endangered species in degraded forest land near SGNP as per the guidelines of the State Forest Department. - Develop lost water holes at strategic sites inside the forest areas to encourage wildlife movement inside the forest after due consultation with the SGNP Authority. - No earthen material or water from the springs present in the protected area should be used for the construction activity.
Operation Phase		
	- Potential direct impact of DFC trains hitting wildlife near protected area since DFC trains will be faster, more frequent and produce less noise.	- Incorporate some appropriate structures into the design such as underpasses, pipe culverts and/or other crossing structures as needed to allow wildlife to cross line safely.
4	**Hydrological Conditions**	
Construction Phase		
	- Natural drainage and recharge conditions near project sites could be affected due to blockage of drainage channels, deep rock cutting, tunnel activities, earth filling, land leveling and other construction activities. - The DFC line intersects both perennial and non-perennial drainage system at several places which has the potential to directly affect the drainage conditions of the area. - Increased incidence and duration of floods due to obstruction of natural drainage courses by the embankment.	- Consideration of provision of DFC track through via duct (elevated) instead of filled-in (embankment) in valley regions so that the existing surface and ground water flow is not altered. - No dumping of material into natural drains so as not to block or impede or alter drainage channels. - Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding. - Capacity of existing drainage works, cross drainage structures in the parallel section should be duly augmented, wherever necessary or river channel should be realigned such as between Navsari and Sachin stretch, to accommodate high discharges to avoid flooding of DFC line and formation of water pool. - Suitable drainage at construction site and camp should be provided to avoid formation of stagnant pool of water that lead to soil erosion, water logging and breeding of mosquitoes.
Operation Phase:		
	- Local drainage is likely to be affected due to formation of embankment along DFC alignment.	- Provision of longitudinal drains of sufficient capacity on both sides of the DFC track to accommodate increased run-off with an outfall in the nearby drainage carrying system.
5	**Topography and Geology**	
Construction Phase		
	- Impact on overall relief of the region due to DFC alignment passing through plain, rolling and hilly terrain. - Enhancement of rock-joint rupture hazard due to deep cutting and rock excavation work in hilly blocks along alignment. - Disfiguring of topography and disturbance to geological setting due to indiscriminate digging of borrow pits.	- Involvement of specialized engineering geologist to study rock-rupture hazards and bed rock geology along with characterization of weak zones in critical hill blocks such as Aravalli hills, Vasai detour. - Use of only identified borrow pits and quarry sites to avoid any disfiguring of topography. - Procurement of construction materials from the existing approved and licensed quarry sites only.
6	**Soil erosion**	
Construction Phase		
	- Loose soil for embankment preparation could result in silt run-off. - Loss of productive soil may result from uncontrolled opening up of borrow pits. - Loosening of top soil and loss of vegetative cover within ROW along the detour and parallel section due to excavation, land cut and back filling could increase soil erosion.	- Avoid cut and fill operation in the monsoon season. - Protect embankment slopes and exposed hill surfaces from low cost bio-engineering products. - Reuse top soil from the construction sites for construction of embankment to enhance growth of vegetation on the embankment surface and its consolidation. - Top soils of the borrow pit sites should be conserved

No.	Potential Impacts	Mitigation Measures
		and restored after excavation is over. - Use of fly ash and its products as a substitute to top soil
7	**Groundwater**	
Construction Phase		
	- Major part of project area especially in Rewari-Dadri and Gujarat section is vulnerable to ground water both in terms of quality and quantity due to overexploitation as far as dynamic ground water resources are concerned. - Uncontrolled use of ground water for concrete making, embankment compaction, dust suppression and other requirements during construction would put further stress on ground water resource in these areas. - The excavation work for construction of tunnel in Vasai Detour could affect ground water conditions.	- Use of only identified ground water sources by the Central Ground Water Authority based on estimated quantity and expected quality for construction use. - Prepare a comprehensive plan to conserve water using best practices along with artificial recharging mechanism.
8	**Landscape**	
Construction/ Operation Phase		
	- As long as the project implement appropriate mitigation measures to stabilize slopes, to prevent accelerated soil erosion, to grow vegetation on the cut faces and borrow pits, and to minimize impacts on existing vegetation, the project would cause no significant impacts on environmental aesthetics part of landscape.	- The quarry sites should be at least 500 m away from human settlements. - In case quarry sites are close to the freight corridor, trees and other vegetation should be left between the quarry/crushing plant sites and the freight corridor. The vegetation acts as good filters of dust as well as improving environmental aesthetics.
9	**Water Use**	
Construction Phase		
	- Impact on water use only during the construction phase and at yards and stations. Possible impacts will be on quality and quantity of surface and ground water.	- Use river water only after obtaining necessary permissions from the respective State Government authorities. - In case of no possibility for getting surface water during construction, tap ground water after obtaining necessary permission from the authorities concerned such as Central Ground Water Board. - The water courses should not be blocked while constructing the corridor, but suitable culverts and drains should be provided for the free flow of water. - Reduce wastage of the existing water resource to avoid possible impacts on the local population's water supply.

S.9.3 Social Considerations

The project has conducted detailed assessment of social aspects of the proposed dedicated freight corridor. All the villages along the freight corridor were considered for the study by collecting the required information from the affected population including displaced population using a structured questionnaire and other population who would be impacted in other ways too.

Table S.9.3 Environmental Impacts and Mitigation Measures (Social Environment)

Impacts	Status	Mitigation Measure
Local Economy	Local economy such as employment and livelihood will be affected due to land acquisition and involuntary resettlement.	Negative impacts on the local economy could be mitigated through the creation of new employment or livelihood opportunities related to the railway e.g. Jobs for priority PAPs as station staff, or maintenance staff, construction workers.

Impacts	Status	Mitigation Measure
Land Use and Utilization of local resources	Land use and utilization may be affected.	Restoration of agriculture land and orchards. Irrigation sources should be replaced.
Social Institutions (including regional severance)	Affected communities would be disturbed in terms of regional severance by construction work and new freight tracks and other related facilities.	Access to and connection with the community shall be secured by providing the alternative passage.
Socially vulnerable groups such as poor, indigenous and ethnic people	Socially vulnerable groups such as poor, indigenous and ethnic people may be affected.	Equitable opportunities for ethnic and vulnerable groups to participate in consultation processes and receive compensation or benefits. This may require printing of materials in different languages or use of interpreters.
Inequitable or unfair distribution of benefits and damages	PAPs may feel that industrial and commercial sectors will benefit.	Proper compensation and livelihood assistance shall be provided as per the compensation policy to be established in the RRP.
Historical and cultural heritage	Religious structures affected.	It should be handled with a sensitive approach and carefully resolved between project managers and village leaders/local authorities.
Local conflict of interests	PAPs feel that their interests are not being adequately taken care of by the state government/DFCCIL.	Efforts made to incorporate local/PAP interests into design, construction and operation phases. Requires careful facilitation and again effective participation may require translation/interpretation for fair representation. Also make clear compensatory benefits and what PAPs are entitled to and how to get it.
Sanitation	An issue with the advent of construction workers.	Proper sanitation facilities should be installed.
Hazardous (risk) infectious diseases such as HIV/AIDS	Could arise with influx of construction workers.	Mass awareness campaigns and distribution of condoms should be planned.
Accident	During construction phase large vehicles and equipment may cause accidents.	Handling and implementation should be taken care to avoid accident. During major excavations, locals must be informed.
Occupational Safety	During construction phase, large vehicles and equipment may affect safety.	Safety rules should be followed.

S.9.4 Other Environmental Issues

There are several other aspects which could result in significant impacts on environment in different phases of the project. These are listed below along with the mitigation measures.

Table S.9.4 Environmental Impacts and Mitigation Measures (Other Environment)

No.	Potential Impacts	Mitigation Measures
1	**Location of labour accommodation camps**	
Pre-Construction Phase		
	- Accommodation camps for workers can damage trees, habitats and landscape when built and affect water and air quality and cause social problems when in use.	- Carefully select camp locations to minimize loss of trees/habitats. - Locate camps away from inhabited areas and rivers or streams. - Design camps as per the local laws and guidelines.
2	**Temporary use of land**	
Pre-Construction Phase		
	- As land will be acquired temporarily for labour camps, stockpiles, borrow pits etc., it will be affected and polluted by works.	- Lease of land should be negotiated / agreed with owners. - Inform proposed use of land to the owners. - Reinstate land to owner's satisfaction after use.
3	**Labour Recruitment**	
Construction Phase		

No.	Potential Impacts	Mitigation Measures
	- Local people will benefit if employed in the contractor's workforce and this may help to compensate for disturbance by the works and reduce the size of labour camps.	- Give priority to employment of local people as skilled or unskilled workers based on their availability in vicinity of construction sites. - As far as possible, employ people affected by land acquisition and from disadvantaged households so as to provide temporary source of income.
4	**Borrow Pits and Quarries**	
Construction Phase		
	- Indiscriminate excavation for construction materials could adversely affect landscape, topography and drainage and increase vector borne diseases by encouraging mosquito breeding.	- Obtain all construction materials from existing licensed quarries as far as practicable. - If any new borrow areas are needed, adhere to necessary approval process, either internal or external, before any excavation. - Rehabilitate all those borrow areas and quarries which are affected by the DFC project activities after use in coordination with the local government departments.
5	**Archaeological Structures**	
Construction Phase		
	- Construction work may affect designated monuments or sites if carried out close to these areas and excavation could reveal and damage previously unknown remains.	- If construction work is carried out in the limits of prohibited are (within 100 meters) or regulated area (100-200 meters) of any designated heritage or archaeological sites and remains, permission should be obtained from the relevant authorities. The status of such structures should be checked with the archaeological department. - No building or structure of historical importance which has been in existence for more than 75 years should be demolished without informing the relevant authorities. - Do prescribed procedures for taking permission from the local authority or community before excavation of any burial ground, graveyard or Idgah.
6	**Health and Safety**	
Construction Phase		
	- Associated risks from accidents and incidents could affect health and safety of workers and others on site. - Since location of most of the construction sites will be away from the medical centers, improper first aid facilities on site could affect health and safety of workers and others on site.	- Strictly comply with relevant labour laws pertaining to the health and safety of workers, employees and others. - Provide all workers and staff with Personal Protective Equipment (PPE) appropriate to their job on-site. - Secure all construction sites with tamper-proof fence, with security lighting and regular security patrols. - Store and stack all materials and components safely in dedicated secure areas. - Do not use any paint containing lead or its products or material containing asbestos. - Smoking should be prohibited near areas of fire or explosion risk. - Ensure sufficient supply of potable water to all workers and employees on-site. - Ensure that first aid kits are available in all work areas, supplied with adequate material to treat common workplace injuries. - Provide dedicated transport at all work sites to take injured persons to hospitals if needed. - Keep record of all nearest hospitals and health centers at each construction sites. - Provide a regular medical facility at each labour camp with suitable qualified staff and equipment to treat minor ailments and injuries. - Establish an effective alarm system to warn track workers of approach of trains on IR lines. - Protect all electric sub-stations, high tension towers and other areas from electrocution risk by providing security fencing and lights, warning signs and security patrols.

No.	Potential Impacts	Mitigation Measures
7	**Accommodation camp management**	
Construction Phase		
	- Poor quality accommodation could affect workers physically, physiologically and psychologically, damage the natural environment and cause social problems at the camp and in host communities.	- Provide proper accommodation to all employees who are working a significant distance from their home. - Locate water storage tanks above ground and boreholes away from toilets/drains. - Provide clean and properly staffed and equipped canteen at all camps. - Provide separate accommodation and bathrooms for men and women. - Wastewater from the camps should be suitably treated and disposed away from the sites as per the applicable standards and guidelines. - Do regular spray of a mixture made from diesel and insecticides at all water stagnation areas to avoid mosquito breeding and spread of any vector borne diseases. - Provide garbage bins at suitable locations and ensure that each site is tidied and refuse taken to a licensed site regularly.
8	**Contractor's demobilization**	
Construction Phase		
	- The long term impacts of construction can be magnified unnecessarily if contractor demobilize without reinstating land they have occupied temporarily and clearing away debris and other waste.	- Remove all garbage, debris and hazardous materials from construction sites and deposed at licensed disposal sites. - Consult with owner of the site and leave any building, well or any structure if wanted by them. - Fill all trenches and remove all equipment, plant and materials from the site. - Compensate for reinstating the landscape and vegetation disturbed during construction activity.
9	**Severance**	
Operation Phase		
	- Where the DFC alignment is along detour route away from an existing IR, the operation of new line could disrupt people's activities if sufficient road and rail crossings are not provided.	- Where the DFC line crosses existing roads and major footpaths, appropriate structures should be provided such as rail flyovers, RUB, ROB, level crossings, pedestrian subways etc. with proper height and width to enable the crossings to continue.
10	**Public Safety**	
Operation Phase		
	- Risks of accidents and fatalities in the early stages of DFC operations since the DFC trains will be much faster and quieter and will be more pronounced in parallel sections.	- Provide proper warning signals, alarm system to warn people from oncoming trains. - Provide safety walls in accident prone areas. - Do initial awareness campaigns on safety instructions and precautions in nearest villages and communities along the alignment route. - Incorporate safety measures into the design to discourage people from gaining access to the DFC line.

S.10 SUMMARY OF ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

S.10.1 Environmental Management Plan Proposed in ESIA

The project will be executed in a stage-wise manner, Pre-construction (Planning/Design stages), Construction and Operation phases. The design stage will be concentrated on the alignment and ground-truthing of the entire project area. Acquisition of land is essential for the construction stage. The location for the borrow pits and quarry areas will be identified for the construction work.

Tables S.10.1, S.10.2 and S.10.3 summarize the main mitigation and management measures for significant impacts in Planning/Design, Construction and Operation phases. They provide mitigation/ management measures for significant impacts and an estimated for their implementation. They also identify the parties to incur the costs and implement the measures.

Table S.10.1 Environmental Management Plan during the Planning/Design Phase

No.	Identified negative impact	Mitigation/Management Measures	Organization	
			Planning and Implementation	Supervision and Responsible
1	Land acquisition and resettlement	- In accordance with the RRP and entitlement framework approved by DFCCIL. - Social Environmental Management Unit (SEMU) has to ascertain that any additional environmental impacts resulting from acquisition of land shall be addressed and integrated into the EMP and other relevant documents.	Parties should be determined in a separate RRP Study.	DFCCIL
2	Tree cutting and green belt development	- Avoidance of non-essential tree-cutting - Special care to be taken at the eco-sensitive areas like Dahanu area, Gulistanpur and Aravali region. - Green belt development at the container terminals and at the sensitive locations such as the residential areas.	Design Consultant and Contractor	DFCCIL
3	Crushers, and Concrete Batching Plants	- All construction plants will be sited sufficiently away from settlements and agricultural operations and commercial establishments. - Plants will be located at least 100 m away from the nearest dwelling preferably in the downwind direction. - Arrangements to control dust pollution including silica dust through provision of wind screens, water sprinklers, and dust extraction systems will be provided at all such sites. - Specifications for crushers, and concrete batching plants will comply with the requirements of the relevant emission control legislation. - Consent for the establishment and operation from statutory authorities shall be obtained before establishment and operation respectively.	Design Consultant and Contractor	Engineer and Supervisor Consultant
4	Construction Vehicles, Equipment and Machinery	- To be procured which conforms to the relevant Bureau of India Standard (BIS) norms. - The discharge standards promulgated under the Environment Protection Act, 1986 and Motor Vehicles Act, 1988 shall be strictly adhered to. - The silent/quiet equipment available in the market shall be used for the Project. Planning should avoid route alignment to avoid residential areas.	Design Consultant and Contractor	DFCCIL
5	Construction Water	- Ground /surface water as a source of water for construction requires necessary permissions which will be obtained from the respective State Irrigation Departments and State Ground Water Boards.	Design Consultant and Contractor	Engineer and Supervisor Consultant

No.	Identified negative impact	Mitigation/Management Measures	Organization	
			Planning and Implementation	Supervision and Responsible
6	Quarry area and Sand sites	- Procurement of construction materials for quarries will be finalized after assessment of the availability of sufficient materials, quality and other logistic arrangements. - Locations finalized and the necessary clearances should be obtained from the statutory agencies like the State Pollution Control Boards and from the Mining Department. - Planning of haul roads for accessing quarry areas will be undertaken during this stage. - The haul roads shall be routed to avoid agricultural areas as far as possible and will use existing village roads wherever available. - The sand will be procured from identified sand mines as far as possible. - Permission to be obtained from the statutory departments of the state.	Design Consultant and Contractor	Engineer and Supervisor Consultant
7	Borrow Areas	- The earth material is to be borrowed from select borrow areas, until the formal agreement is signed between landowner and the executing agency. - Locations finalized and the necessary clearances should be obtained from the statutory agencies like the State Pollution Control Boards and from the Mining Department. - Planning of haul roads for accessing borrow areas will be undertaken during this stage. - The haul roads shall be routed to avoid agricultural areas as far as possible and will use the existing village roads wherever available.	Design Consultant and Contractor	Engineer and Supervisor Consultant
8	Labour	- Preferably use unskilled labour drawn from local communities to maximize benefits to the local community.	Contractor	DFCCIL
9	Construction Camp	- Setting of the construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. - Location for stockyards of construction materials will be identified at least 300m away from watercourses. - The sewage and solid waste for the camp will be designed, built and operated.	Contractor	DFCCIL
10	Disaster	- The seismic factors should be appropriately incorporated in the civil and structural designs of major structures in DFC project. - An engineering geologist should identify any slope instability potential among the uniform rock structure along the Aravalli ridge where deep rock cutting will be done. DFCCIL should take up such study through suitable experts/institutes during detailed engineering stage. - Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.	Design Consultant and Contractor	DFCCIL

Note: SPCB: State Pollution Control Boards
*No separate EMP cost but in-built as part of Good Construction Practice

Table S.10.2 Environmental Management Plan during the Construction Phase

No.	Identified negative impact	Mitigation/Management Measures	Responsible Organization	
			Planning and Implementation	Supervision
1	Air pollution	- Monitor air pollution from excavation, dismantling activities and emissions from the vehicles and equipment used for construction. - Sprinkling of water at the dust prone areas will reduce dust emissions. - Equipment and trucks will be properly maintained at regular intervals. - Monitoring of air quality *No separate EMP cost but inbuilt as part of Good Construction Practice. However, sprinkling system for prevention of dust emission could cost Rs 300,000 per site	Contractor and Supervisor Consultant	DFCCIL
2	Noise	- Construction activities producing high noise levels should be done at different time intervals to curtail the noise levels. - The equipment used should have mufflers to reduce noise levels. All equipment should be properly lubricated. - The construction yards should be surrounded by barriers near the sensitive receptors. The plants absorb noise levels. - Avoid night time activities. Sensitivity to noise increases during the night time hours in residential neighborhoods. - Periodical inspection and effective maintenance of vehicle and equipment - Monitoring of Noise and Vibration Level	Contractor and Supervisor Consultant	DFCCIL
3	Clearing and grubbing	- If required, vegetation will be removed from the construction zone before commencement of construction after obtaining necessary permissions. - All works will be carried out such that the damage or disruption to flora other than in those areas identified for cutting is kept to a bare minimum. - Trees identified under the project will be cut only after receiving clearance from the Forest Department.	Contractor	DFCCIL
4	Disposal of debris from dismantling structures	- Debris will be separated into hazardous material, construction waste (concrete) and organic waste (bio-degradable). - Construction waste will be disposed of at the identified and approved locations. - No disposal will be permitted in the eco-sensitive areas. - Disposal will not be permitted into watercourses. - The disposal sites should be provided with drainage structures. - If solid wastes are to be deposited on private land then necessary prior permissions and agreements will be obtained	Contractor	DFCCIL
5	Stripping, stocking and preservation of top soil	- Stockpile will be designed such that the slope does not exceed 1:2 (vertical to horizontal), and height of the pile is restricted to 2 m. To retain soil and to allow percolation of water, silt fencing will protect the edges of the pile. - Stockpiles will not be surcharged or otherwise loaded and multiple handling will be kept to a minimum to ensure that no compaction will occur. - The stockpiles shall be covered with sheets or vegetation. - Proper drainage systems will be provided to prevent stagnation of water.	Contractor	DFCCIL
6	Traffic diversions and detours	- The temporary traffic detours will be kept free of dust by sprinkling water during the day time depending on weather conditions.	Contractor	DFCCIL

No.	Identified negative impact	Mitigation/Management Measures	Responsible Organization	
			Planning and Implementation	Supervision
7	Borrow areas and quarry sites	- Borrow areas and quarry sites should be away from human settlements. - The excavation of borrow should be specified as per the guidelines. - Access to the quarry operated area and borrow sites should be strictly controlled. - All workers at the quarry site will be provided with personal protective equipment. - All the haul roads are watered regularly to reduce dust emissions. - A vegetative barrier should be planted to surround the borrow area and quarry sites.	Contractor	DFCCIL
8	Transporting construction materials and haul road management	- Dumpers and trucks carrying the construction material should be spill-proof. - Trucks and dumpers should be properly maintained. - Water will be sprinkled on the haulage roads. - Strict speed limits will be followed at the settlement areas and on the haulage roads. - All the truck and dumper drivers will be properly trained.	Contractor	DFCCIL
9	Construction water and waste water from construction yard and labour camps.	- Monitoring of water quality - Water required for construction will be drawn from surface water bodies only after obtaining prior permission from the appropriate government departments. - If ground water is drawn then permission from the state ground water authority has to be obtained. - The wastewater from construction yard and labour camp should be treated before being discharged into surface water bodies to avoid siltation.	Contractor and Supervisor Consultant	DFCCIL
10	Siltation of water bodies	- Construction of silt fencing at the base of the embankment construction site and around the stockpiles at the construction sites. - The fencing will be provided prior to commencement of earthwork and continue until the stabilization of the embankment slopes on the particular sub-section of the freight corridor is completed. - Construction materials containing fine particles are stored in an enclosure such that sediment-laden water does not drain into nearby water bodies.	Contractor and Supervisor Consultant	DFCCIL
11	Slope protection and control of soil erosion	- Soil erosion and sedimentation can be minimized by constructing breast walls, retaining Walls, pilot bioengineering methods, dykes, sedimentation chambers, basins, fibre mats, mulches, grasses, slope, drains and other devices. After completion of embankment building, the embankment will be turfed for slope stabilization purposes. - Cascading drainage system will be provided for controlling of the erosion from the embankments.	Contractor	DFCCIL
12	Petroleum oil and lubricants	- POL products will be handled with special care. - The necessary permissions will be obtained for handling and use of the POL Products. - The used oil and lubricants will be sold to authorized parties. - The storage places for POL will have restricted entry. - Accidental spillage of oil and lubricant will be immediately cleared. - The trucks and dumpers will not be washed at the nearby water bodies, instead of that they will be cleaned in the construction yard and the waste water will be collected in a settling tank before it can be re-used for some other purposes like gardening etc.	Contractor	DFCCIL

No.	Identified negative impact	Mitigation/Management Measures	Responsible Organization	
			Planning and Implementation	Supervision
13	Public health and safety risks	- Barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access to the freight corridor except at designated crossing points. - The general public/local residents shall not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation. - Speed restrictions shall be imposed on Project vehicles and equipment when traversing areas with sensitive receptors (residential, schools, temples, etc.).	Contractor and Supervisor Consultant	DFCCIL
14	Environmental and social disruption from construction camp	- Hire as many local people as possible and train them. - Site construction camps should minimize adverse impacts by good management practices. - Implement malaria control, HIV/AIDS education. - Plan and carry out post construction site clean-up.	Contractor and Supervisor Consultant	DFCCIL
15	Risk from electrical equipment	- No material will be so stacked or placed as to cause danger or inconvenience to any person or the public. - All necessary fencing and lights will be provided to protect the public in construction zones. - All machines to be used in the construction will be kept in good working order, and will be regularly inspected and properly maintained.	Contractor	DFCCIL
16	Occupational safety to the labour	- All site workers will be provided with personal protective equipment such as safety shoes, helmets, ear plugs in high noise zones, eye shields and gloves to welders, distinguishing clothing or reflective devices. - Adequate potable water supply, washing facilities or showers at the workers' camps, toilets/sanitation facilities with proper flushing provisions - Monitoring and control of the working environment and planning of safety and health precautions should be performed as prescribed by national laws and regulations. - Adequate drainage at construction camps to avoid accumulation of stagnant water. - First aid room or station under the charge of qualified personnel - The drivers and operators of vehicles and materials handling equipment shall be medically fit, trained and qualified - Suitable scaffolds from the ground shall be provided for the work force, who are working at elevated heights, if a ladder is used proper foot holds and hand holds shall be provided on the ladder. - Safety provisions shall be brought to the notice of all concerned by displaying on a notice board at a prominent place at the work locations. - The contractor should take adequate measures for the control of malaria, typhoid, dengue, cholera etc. - There should be proper demarcation of work areas with sign boards showing the work areas. The signboards should be in local language. - Secure storage areas should be provided for flammable liquids, solids and gases such as liquefied petroleum gas cylinder, paints and other such materials in order to deter trespassers - Fire-extinguishing equipment should be provided at construction camps, asphalt plants, storage areas for combustible materials and other areas where fire hazards are found. Such equipment shall be properly maintained and inspected at suitable intervals by a competent person.	Contractor	DFCCIL

Table S.10.3 Environmental Management Plan during the Operation Phase

No.	Identified negative impact	Mitigation/Management Measures	Responsible Organization	
			Planning and Implementation	Supervision
1	Noise	- Noise barriers should be erected at appropriate locations such as residential areas and sensitive receptors which are adjacent to the corridor.	SEMU	DFCCIL
2	Maintenance performance	- Monitoring of the operational performance of the various mitigation/ enhancement measures carried out as a part of the project. - The indicators selected for monitoring include the survival rate of trees; utility of enhancement provision for relocated utilities, hand pumps and other relocated structures if any; status of rehabilitation of borrow areas; and noise barriers, which are proposed at different locations.	SEMU	DFCCIL
3	Monitoring environmental parameters	- Monitoring of noise levels at regular intervals along the sensitive locations. - Regular inspection of the entire corridor to clear any accidental spillages POL products. - Clearing of garbage and waste accumulation from the terminals.	SEMU	DFCCIL
4	Borrow areas and quarry sites.	- Incorporate adequate drainage and fill in borrow pits and quarries. Before doing the activity local concerns should be considered. The village authorities should also be consulted. - Maintain borrow pits and quarries by landscaping them after operation by growing native species. - All borrow areas are to be reclaimed properly and it should be restored to a level that is acceptable level to the land owner.	SEMU	DFCCIL
5	Green belt development	- Monitoring and maintenance of plantation - Green Belt would arrest the noise levels.	SEMU	DFCCIL
6	Training for the staff	- The training should be for all the executives regarding the environment and safety. - The process should for a minimum period for first six months.	SEMU	DFCCIL
7	Disaster	- Maintenance of cross drainage channels (longitudinal and median drains) should be carried out.	SEMU	DFCCIL

S.10.2 Environmental Monitoring Plan Proposed in ESIA

A monitoring plan normally involves two main types of activity:

Routine supervision of the work: Observation of the construction/operation work to ensure mitigation actions will be conducted during routine site inspections. This work will be conducted as general operation working/maintenance progress including daily work. (See Table S.10.4)

Environmental and social impact/mitigation monitoring: The monitoring to be conducted to determine the actual and social impact. (See Table S.10.5)

Table S.10.4 Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
1	Social impact	Planning/ Design phase	To ensure that the adverse impacts of land and property acquisition and resettlement are addressed and compensated	- Inventory of losses - Implementation of Rehabilitation and Resettlement Plan (RRP) - Public consultation	- Check notification & DFC Payment record	Monthly/Quarterly/biannual	SEMU technically assisted by Design Consultants	DFCCIL assisted Supervision Consultant
		Construction	To ensure that the adverse impacts of construction activities are minimized and mitigated	- DFCCIL will employ an external agency to address resettlement issues associated with the project.	- Check if the community has brought the problem to the notice of the Consultant and Client	Monthly	Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting
2	Crops and vegetation	Planning/ Design phase	To minimize the direct impacts on crop production and other vegetation	- Clearing of surface cover for construction for borrow pit, cutting trees and other important vegetation during construction should be minimized - Follow procedures with regard to spoil dumping - Replacement of topsoil and restoration of vegetative cover	- Interviews with local residents will also help in this matter.	Before commencement date	Design Consultant	DFCCIL and Supervision Consultant
3	Impacts on freight corridor design	Planning/ Design phase	To ensure that the recommendations given with the conditional approval by the DFCCIL and followed by design consultant	- ROB and RUB have been designed - Existing irrigation, protection measures have been identified.	- Check final design drawing and original plan	Before the commencement of construction activities	Design Consultants	DFCCIL assisted Supervision Consultant
4	Air Pollution	Construction	To minimize air pollution from freight corridor construction	- Watering on earthen surfaces especially in the settlement areas - All construction vehicles should be maintained in good condition to minimize emissions.	- Check watering as per the frequency given in the EMP. - Proper implementation can be achieved by site inspection along with interviews with local residents.	Weekly One check	Contractor	DFCCIL

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
5	Noise and vibration	Planning/ Design phase	To minimize the noise and vibration level resulting from freight corridor To control noise pollution from exceeding tolerable levels on embankment sections taking into account the increase in traffic volume	- Establishing standards and regulations for noise levels for various equipment used at the site - Strict enforcement of regulations. - Awareness programs	- Determination of critical sites and methods of mitigation during the construction period.	Monthly/ As necessary	Design Consultants	DFCCIL assisted Supervision Consultant
		Construction	To minimize the noise and vibration level resulting from road traffic, To control noise pollution from exceeding tolerable levels on embankment sections taking into account the increase in traffic volume	- All road construction vehicles must have working mufflers and be maintained in good condition - Noise barriers should be established around the yard near residential area and sensitive receptor during the activities such as blasting and pile driving.	- Check that the Contractor is performing mitigation measures. - This can be achieved by interviewing the locals and site inspection.	A monthly inspection of the construction yards must be carried out.	Contractor	DFCCIL
		Operation	To minimize the noise and vibration level resulting from rolling stock	- Maintenance of the rail, sound barrier as wall as well as equipment rolling stock	- Visit site and compare with Normal situation	Periodical	SEMU	DFCCIL assisted Supervision Consultant
6	Water quality	Planning/ Design phase	To control the impacts on the quality of surface and groundwater	- Maintain existing concentrations of chemicals sediments and water at specific locations. - Design appropriate mitigation measures	- Check final planning and approve if proposal suitable	Before the commencement of construction activities	Design Consultants	DFCCIL assisted Supervision Consultant

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
		Construction	At the bridge construction areas	- Avoiding chemical discharge and spills in soil and water at specific locations like bridge construction areas. Design appropriate mitigation measures	- Visit site and check drain provision/ functioning	During the construction stage a weekly site inspection is necessary for the proper assessment of the site.	Contractor	DFCCIL assisted Supervision Consultant
7	Oil spills and hazardous wastes	Construction	To avoid and minimize oils spills and spills of other hazardous wastes	- Establish standards for safe handling, storage and transport to avoid spills - Establish emergency response and containment/ clean up procedures	- Check the mitigation measures. - A fortnightly inspection is necessary until the completion of the project.	One check	Contractor	DFCCIL
8	Spoil Disposal	Construction	To ensure adequate disposal options for spoil	- Identify sufficient locations for disposal sites and design disposal sites in the contract	A monthly inspection of the disposal sites along with the review of the design plan is a better way of assessment.	Weekly	Contractor	DFCCIL
9	Construction Waste Disposal	Construction	To minimize the impacts from the disposal of construction Waste	- Preparation and implementation of waste management plan based on Estimating the amounts of construction waste	Interviews with local residents will also give a proper assessment of the issue.	Weekly	Design Consultants and Contractor	DFCCIL
10	Land slide and soil erosion	Planning/ Design phase	To minimize landslides resulting from excessive erosion of slopes and water ways with corresponding silting of the eroded soil.	- Maintaining proper vegetation cover and erosion protection - Constant surveillance as part of routine maintenance	Visit site and Check land plans, alignment	Site visits, one check	Design Consultants	DFCCIL
		Construction	Constructed embankments could be a source of silt if not protected from erosion by rain fall	-Work plan: excavate and embankment mainly in dry season	A site inspection along with the review of the design plans is necessary.	During construction and specially during rainy seasons	Contractor and Supervision Consultant	DFCCIL

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
11	Loss of or Damage to Religious places and eco-sensitive areas.	Planning/ Design phase	To minimize damage to religious sites and eco-sensitive areas	- Avoid encroachment on religious and eco-sensitive areas in planning the alignment	Check encroachment on religious and eco-sensitive areas	- Before and during construction phase	Design Consultant, DFCCIL	DFCCIL assisted Supervision Consultant
12	Earthworks operation	Construction	To ensure that the earthworks are safe and do not have adverse environmental impacts	- Use appropriate designs and size of drainage structures in accordance with designs approved by the client, - Structural stabilization of drainage system - Hauling material to be carefully transported to designated dumping areas	- Ensure the contractor performs detailed design and instability checks - Check if erosion or instabilities were observed. - The conditions at the site can be observed by a site inspection along with review of the design plan.	Before commencement date of construction	Contractor and Supervision Consultant	DFCCIL
13	Traffic safety	Planning/ Design phase	To avoid and minimize traffic accidents during construction	- Make traffic marking such as sign boards - Observe speed limits - Safe loading and covering of materials being transported - Planning of transport routes	Visit site and Check around traffic situation and construction plan	- Before commencement date of construction	Contractor	MoEF, DFCCIL. State Ministries, PMC and Supervision Consultant.
		Construction	To avoid and minimize traffic accidents during construction	- Traffic sign boards for proper movement of construction vehicles, - limit speed of vehicles - Safe loading and covering of materials being transported - Planning of transport routes	Checking the traffic problems at the construction site.	Monthly	Contractor and Supervision Consultant	DFCCIL
14	Disturbance to flora	Construction	To minimize direct impacts on vegetation Prevent damage to vegetation outside RoW	- Prohibit vegetation cutting outside Row - Record Row , Check no cutting out side	Inspect RoW boundary and adjacent area	Weekly / Monthly	Contractor and Supervision Consultant	DFCCIL

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
15	Disturbance to fauna	Construction	To minimize direct impacts on fauna. This applies in the case of Gulisthanpur and at Arawali region and at Eco-sensitive areas in Maharashtra	- Consultation with Forest Department Authorities and Department of Wildlife. - No construction camps or quarries in wildlife habitat areas eg. Ecosensitive areas - Avoiding alignment of route with sensitive habitats of important species, keystone tree species, conservation areas etc. - No hunting, poaching, or unnecessary habitat destruction - Training for staff working in wildlife areas (or at least briefings)	Visit site and check the proposed alignment and construction area	Monthly	Contractor and Supervision Consultant	DFCCIL
16	Plantation	Operation	Growth of development trees	-	- The number of trees surviving during each visit shall be compared with the number of sapling plant - Record the growth of plantation	Assess growth every year for initial five years	SEMU	DFCCIL
17	Mangroves	Construction	The impact on the mangroves should be minimized. This should be observed in the State of Maharashtra	- Avoidance of mangroves in the alignment - Not to encroach into the mangrove areas. - Disposal of construction waste material should be strictly restricted - No storage should be allowed near the sensitive areas.	Visit site and check the proposed alignment and drain/waste material around mangroves	Monthly	Contractor and Supervision Consultant	DFCCIL Supervised by District Authorities (Maharashtra), SPCB, State Environment Department,

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
18	Loss or Damage of cultural sites or religious places	Construction	To avoid or minimize damage to cultural sites or religious places.	- Avoid alignment encroachment to the cultural site - Local population will also be consulted if there are any religious place	Interviews with local residents will also give a proper assessment of the issue.	Before and during construction. Monitoring should be done once in six months.	Contractor/ Subcontractor and Supervision Consultant	DFCCIL
19	Construction labour force and its impacts	Planning/ Design phase	To minimize impact on workers	- Establish minimum standards for construction workers camp layout and housing provision, provide sanitary facilities and insect control particularly as related to Malaria and other vector borne diseases	- Check construction workers camp layout and equipment	Before the start of construction work As necessary	Constructor	DFCCIL
		Construction	To minimize impact on workers during construction	- Conduct special briefing on site training on environmental requirements and safety for the workers. - Strictly instruct workers not to interfere in local affairs	- Check the Contractors are following the Mitigation measures - Check with the communities and construction staff if any conflict has occurred, if yes find out reason. - This can be achieved by regular site inspections. The frequency should be once in fifteen days.	Weekly	Constructor	DFCCIL assisted Supervision Consultant and SPCB inspecting
20	Work camp Operation	Construction	To ensure that the operation of work camps does not adversely affect the surrounding environment and residential areas	- Identify sufficient locations for disposal sites and design disposal sites in the contract - The location shall be approved by the consultant	During construction and after completion of the works. The inspection should be planned once every two months throughout the project period	Monthly	Contractor and Supervision Consultant	DFCCIL

Table S.10.5 Environmental Monitoring Plan – Impact and Mitigation Monitoring

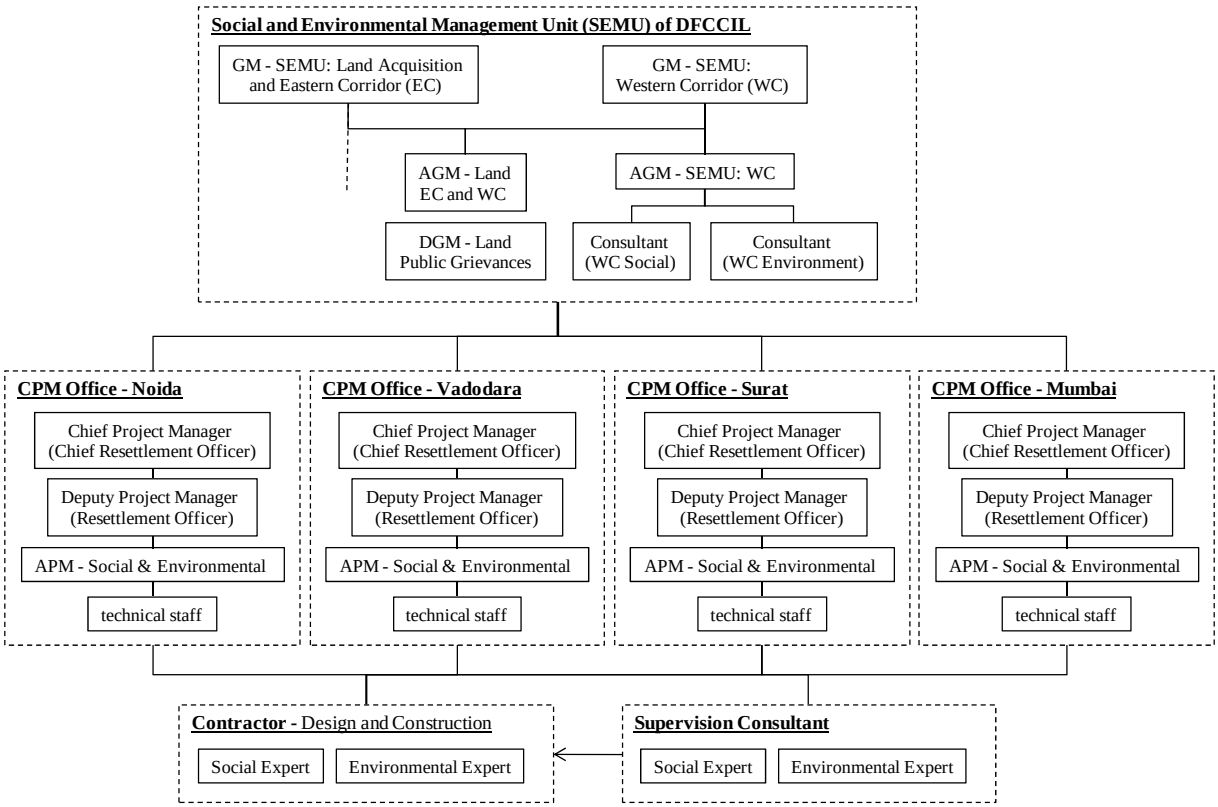
No.	Environment Component	Project Stage	Environmental Monitoring Program				Institutional Responsibility	
			Parameters	Methodology	Location	Duration /Frequency	Implementation	Supervision
1	Air pollution	Construction	PM_{10}, $PM_{2.5}$, CO, SO_2, NO_X, Lead	Analysis as specified in the National Ambient Air Quality Standard	At construction sites in sensitive and critical areas along alignment. Final decision shall be taken in consultation with SPCB.	24 hours or 8hours (CO), at least once in every season (once in 3 months) except monsoon for minimum 3 days. The frequency of monitoring will depend on the sensitivity of locations as well as extent of construction activities.	Construction Contractor through MoEF Approved Laboratories	DFCCIL assisted Supervision Consultant and SPCB inspecting
2	Noise and Vibration	Construction	Noise level in dB (A) and Vibration in dB	Ambient Noise level is measured with the noise level meter according to the Noise (regulation and control) rule. Ambient Vibration level is measured with vibration level meter according to international standard.	Next to identified sensitive receptor along alignment basically near predicted points, major construction site in any inhabited areas as well as the operational areas like crusher units and batch mixing plants	Hourly records, for 24 hours for minimum 3 days, 4 times a year (preferably in each season)	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting
		Operation	Noise level in dB (A) and Vibration in dB	Noise level emitted from rolling stocks is measured with noise level meter according to international standards. Vibration level emitted from rolling stocks is measured with vibration level meter according to international standard.	Next to identified sensitive receptor along alignment basically near predicted points	Monthly during first operation year, Once a year	SEMU	DFCCIL
3	Water quality	Construction	See Note	Sampling and analysis as per Standard Methods for Examination of Water and Wastewater	Surface water: at two point of (upstream and downstream) 14 Important Rivers	Monthly during construction periods near the river	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting
					Ground water: location shall be decided by SPCB	Monthly during construction/excavation periods		
					Drinking water and waste water: each labour camps	Weekly		

No.	Environment Component	Project Stage	Environmental Monitoring Program				Institutional Responsibility	
			Parameters	Methodology	Location	Duration /Frequency	Implementation	Supervision
4	Ground water level	Construction	ground water level	Measurement of ground water level	Dahanu Taluka and Aravalli site. The location shall be decided by SPCB	Before construction monthly During construction/excavation periods continuous	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting
5	Land slide and soil erosion	Construction	Surface status of ground modification	Contractor report implementation of the measures for land slide and soil erosion preservation	A site inspection along with the review of the design plans if necessary.	Rainy seasons.	Construction Contractor	DFCCIL and Supervision Consultant.
6	Plantation	Construction	No. of railway side plantation	Progress of measures suggested as part of the strategy is to be reported.	Along the side of the track	Comparison should be done for every six months	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting
7	Borrow Area	Construction	Borrow areas redevelopment	Location of borrow areas have to be finalized from identified lists and parameters indicative of environment in the area has to be reported. Undertaking site visit to determine how many borrow areas have been rehabilitated in line with the landowners request and to their full satisfaction	Identified borrow areas	4 times a year (preferably in each season)	Construction Contractor	DFFCIL assisted Supervision Consultant and SPCB inspecting

Note: Odor, conductivity, pH, DO, BOD, TDS, TSS, oil and grease, chlorides, sulphates, total nitrogen, total phosphate, coli forms and heavy metals
SPCB: State Pollution Control Board

S.10.3 Institutional Framework of Implementation of EMP and EMoP

Organizational structure for implementation of EMP and EMoP is shown in Figure S.10.1. The responsibility for implementation and supervision of the EMP and EMoP is vested with the Social and Environmental Management Unit (SEMU) of DFCCIL, respective CPM offices, Supervision Consultant, and Contractors.



Source: Modified from the Environmental and Social Management and Monitoring Plan (ESMMP) for Phase 1 Section of the Western Corridor, NK Consortium, April 2011.

Figure S.10.1 Organizational Structure for Implementation of EMP and EmoP

S.11 CONCLUSIONS AND RECOMMENDATIONS

Major findings of the ESIA study have been provided in Table S.11.1.

Table S.11.1 Major Findings from the ESIA

Item	Issue	Findings	Responsible organization	Remarks
Alignment Route				
Rewari-Dadri • Detour	Alignment route	It moves near settlements areas in Bukharpur, Faridabad, and Lakhuwas, Gurgaon	• Survey agency • DFCCIL	Fencing to be installed to avoid accident.
JNPT-Vadodara • Parallel with existing track • Detour	Alignment route	In Gujarat, it will disturb the productive cultivable land in detour section. In parallel section, ROW was noted 20-30 m in semi-urban areas, which will have high impact of vibrations and noise	• Survey agency • DFCCIL	ROW to be decided with approach of long term planning, not with the immediate settlement issues.
Pollution Control				
Air Pollution	Minor impact during construction phase	The construction work would emit some amounts of air pollutants, so it requires a regular monitoring and sprinkling at the dust prone areas	Contractor under the supervision consultant.	Mitigation measures to be implemented as and when it is required
Water Pollution	Minor impact during construction phase.	• The construction yards and the labour camps are the worst offender, unless some proactive measures are taken • The best way of handling is to provide soakage pits and settling tanks. The waste water to be regularly monitored. The ground water sources along the construction yard should be tested for the bacterial load.	Contractor under the supervision consultant.	A regular water quality monitoring shall be conducted.
Noise and Vibration	Major impact near residential areas and sensitive receptors	• Construction activities emit a large extent of noise and vibration levels. • The contractor should give an awareness campaign for the locals about the likely impacts. • Suitable mitigation measures to be implemented at the time of operation.	Contractor under the supervision consultant.	• Mitigation measures to be implemented at the time vibrating roller usage, compaction, and blasting activity. • Necessary precaution measures to be implemented at the site.
Ground Water Table	• No impact • Precaution to be taken near tunnel and bridge construction sites.	The nearby wells around the quarry and borrow pits should be regularly monitored as there will be fluctuation of the water table.	Contractor under the supervision consultant.	-
Soil	• No impact • Precaution should be taken for waste disposal and soil erosion.	• Erosion due to vegetation clearance • Waste dumping	• DFCCIL • Contractor under the supervision consultant.	-
Natural Environment				

Item	Issue	Findings	Responsible organization	Remarks
Tree Cutting	All trees falling under the ROW will be cut.	• The extent of tree cutting can be curtailed by afforestation. • Native plant species should be selected for afforestation.	• Department of Forest • Department of Horticulture	• The tree cutting should be minimised to the maximum extent as possible. • Compensatory afforestation of native tree species.
Tree Cutting	Forest area encroachment	• Encroachment to be restricted. • The eco-sensitive areas like mangroves to be preserved and rehabilitated.	• Department of Forest • Department of Wildlife	• It better to avoid the forest and eco-sensitive areas to the maximum extent as possible.
Flora and Fauna	No major impact	The proposed corridor is not affecting any dense forest area or habitat of endangered species.	-	-
Social Environment				
Land acquisition	Compensation cost evaluation	During land acquisition, some portion of agricultural land will be bifurcated and may not be of any use for the PAP.	• Ministry of Railways • DFCCIL • District administration	• Compensation to be provided for damaged land as well, if in case it is not being acquired.
PAPs	The proposed intervention will not give direct profit to PAPs.	Different categories of PAPs have their own issue of concern.	• DFCCIL • District administration	• Problem is more severe in semi urban areas for loss of residential house. • Small land holding PAPs with no other source of income need support on livelihood recovery.
Vulnerable people	About 14% vulnerable persons will be affected; this includes elderly people more than 11%.	Elderly people, unmarried girls, and widow may have serious issue.	• DFCCIL • District administration	Awareness of wisely utilization of the compensation should be given to the vulnerable persons.
Loss of agricultural land and properties	Major impact	• The land and property acquisition should be minimum. • Give proper value for the lost property.	• DFCCIL • District administration	The land and property acquisition should be minimum.
Impacts to religious places	Religious structures are coming in RoW, and those coming near alignment will have impact due to vibration and noise.	The religious places should be avoided or relocated after considering the public opinion.	• DFCCIL • The local communities should be taken into consideration while handling this religious matter.	It is being a sensitive issue and it requires a careful handling.
Rehabilitation and Resettlement	Livelihood recovery for PAPs	RRP is required.	DFCCIL	Baseline Survey and Census will generate base for Rehabilitation and Resettlement Plan.
Sensitive Receptor	Major impacts to the public facilities such as school, hospital and religious places	To develop avoidance mechanism near Sensitive receptor.	DFCCIL	-

CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

The Indian Railways constitute a critical component of India's transport network, both for passenger as well as freight services. It is the fourth busiest railway in the world in terms of total traffic unit kilometres carried.[1] Though railways are cost effective and also environment friendly, yet capacity and efficiency constraints in the freight segment have, over the years, led to a significant shift from railways to road transport. The road transport which saw an increase in investments since the late 1990s, advanced more rapidly than railways, and now accounts for about 65% of the freight market and 90% of the passenger market in India, and those shares are growing. However, increases in the price of oil, with its associated energy security issues, escalating concerns about greenhouse gas (GHG) emissions has emphasized on developing low carbon infrastructure and energy efficient transport system. Considering the ever increasing freight traffic movement between the metros and their respective hinterlands, Indian Railways has initiated the development of Dedicated Freight Corridors (DFC) in the country. The implementation of the DFC is expected to generate two major impacts on the freight movement within the country: shift of freight from road to the low carbon intensive mode rail transport and inherent improvement in energy efficiency of freight rail through adoption of improved technologies. At the same time, this will restore the railways' competitive edge in the market.

The four routes that form a Golden Quadrilateral connecting Delhi, Mumbai, Chennai and Kolkata account for 16% of the railway network's route length, but they carry more than 60% of India's total rail freight. The existing trunk routes of Mumbai-Delhi on the Western Corridor and Kolkata-Delhi on the Eastern Corridor are highly saturated with capacity utilization varying between 115 to 150%. The surging power needs requiring heavy coal movement, booming infrastructure construction and growing international trade has initially led to the approval of the Dedicated Freight Corridors along the Western and Eastern Routes by the Government of India to fulfil the demand of additional capacity of rail freight transportation. In the Twelfth Five Year Plan (2013-2018), the Planning Commission, Government of India has set an infrastructure investment target of USD 1 trillion. This is 9-10% of expected GDP. Augmentation of transport systems, particularly of the rail network, will play a crucial role in this infrastructure development and hence, support India's growing economy which is at present levelled as the second fastest in the world.

Under these circumstances, the Ministry of Railways (MoR) established the Dedicated Freight Corridor Corporation of India Limited (DFCCIL), a Special Purpose Vehicle (SPV), to undertake planning and development, mobilization of financial resources, and construction, maintenance and operation of the DFC. DFCCIL was incorporated as a company under the Companies Act 1956 on 30th October 2006. This company is now actively engaged in the implementation of Computerized Multi Modal High Axle Load Dedicated Freight Corridor Project between Delhi-Mumbai under the Western DFC Corridor and Ludhiana-Delhi-Kolkata under the Eastern DFC Corridor.

As planned, the Western DFC is designed to carry a total freight line of 37.7 million tonnes in fiscal year 2013-2014, which would increase to 140.4 million tonnes in 2033-34. The Western DFC has two broad streams of traffic, one, between the terminal nodes at either end, Jawaharlal Nehru Port Trust in Mumbai and Dadri in Uttar Pradesh including

[1] Traffic-km are passengers-km plus freight ton-km

Tuglakabad in Delhi, and the other, the traffic entering from branch line feeder routes at the various junction points en route. Creation of rail infrastructure on such a scale, unprecedented in independent India, is also expected to drive the establishment of industrial corridors and logistic parks along its alignment. The Western DFC will mainly cater to containers, fertilizer, POL[2], coal, salt and cement. The corridors have been planned with an axle load of 32.5 tonnes for bridges and sub-structures and 25 tonnes for track structure with a design speed of 100 km/h. Predominantly, double line corridor (except where single line is justified on traffic considerations) is planned with electrification and advanced signalling system. Implementation of the DFC projects will result in reducing the carbon intensity of India's transport sector. The GHG emissions under DFC scenario will be primarily coming only from electricity consumption in locomotives during freight movement and fossil fuel and electricity usage in support infrastructure of DFC.

Figure 1.1.1 Phase wise Map of Western Corridor

[2] POL: It refers to all products related to Petroleum, Oil and Lubricants

The Western Corridor has been divided into 2 phases, in which Phase 1 covers corridor between Vadodara and Rewari and Phase 2 includes Jawaharlal Nehru Port (JNPT) in Mumbai - Vadodara and Rewari - Dadri as well as a single line from DFC mainline near Faridabad to Tuglakabad (Figure 1.1.1). The Western Corridor is being financed by JICA for a total length of 1,483 km. It is planned that construction work will be completed in 4-5 years between 2012 and 2016. Commercial operation is planned to be started from December 2016.

1.2 OBJECTIVE OF ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY

According to the Indian Government's environmental impact assessment Notification issued by the Ministry of Environment and Forests, New Delhi on 14th September, 2006 under the Environment (Protection) Act, 1986, railway and bridge construction projects do not require conducting Environmental Impact Assessment (EIA) studies and obtaining Environmental Clearance (EC) from the Ministry of Environment and Forests (MoEF). However, considering the scale, nature and extent of activities envisaged as part of the DFC Project, a detailed Environment and Social Impact Assessment (ESIA) Study, including preparation of an Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP), is conducted in order to mitigate potential negative environmental and social impacts for the Phase 2 of the Western Corridor.

The overall objective of the ESIA study for the DFC Project based on the finalized alignment is to ensure that all potential environmental and social issues or concerns associated with various project components are addressed and integrated into the project's planning and design at an early stage in order to formulate the DFC Project in a more sustainable and effective manner. This will result in downstream costs and delays associated with unanticipated problems during project implementation and hence, better decisions could be made.

The specific objectives of the ESIA study are to:-

- Identify, assess, and evaluate potential environmental and social impacts to be considered in the Phase 2 of the Western Corridor and recommend specific mitigation, management, and monitoring measures to avoid, offset or minimize the impacts.
- Formulate an implementable EMP and EMoP integrating the technically and economically feasible measures to avoid the identified impacts and an appropriate monitoring and supervision mechanism to ensure its implementation.
- Recommend suitable institutional mechanisms to monitor and supervise effective implementation of EMP and EMoP.

The ESIA study consists of pollution control study, natural environmental study, social impact study, public consultation, impact identification and assessment, preparation of mitigation measures, preparation of environmental and social management, and monitoring plan.

1.3 ESIA STUDY AREA

Phase 2 of the DFC Western Corridor between JNPT-Vadodara and Rewari-Dadri passes through two districts in Maharashtra, five districts in Gujarat, five districts in Haryana, one district in Rajasthan, and one district in Uttar Pradesh. In addition, a single line connection

(called as "TKD" line) of 19 km long is to be branched out from the DFC mainline near Faridabad District to Tuglakabad area of Delhi. The affected project areas along with the length of alignment are as shown in Table 1.3.1.

Table 1.3.1 Affected Areas of Phase 2 of the DFC Western Corridor

Section	State	Districts	Length of Alignment
JNPT-Vadodara	Maharashtra	Thane, Raigad	420 km
	Gujarat	Vadodara, Bharuch, Surat, Navasari, Valsad	
Rewari-Dadri (including TKD line)	Rajasthan	Alwar	145 km including TKD: 19 km
	Haryana	Faridabad, Gurgaon, Rewari, Palwal, Mewat	
	Uttar Pradesh	Gautam Buddh Nagar	
	Delhi	Tuglakabad	

Nearly 70% of the alignment length in JNPT-Vadodara section has been kept parallel to the existing lines. However, it is entirely on a new alignment route from Rewari to Dadri. For providing connection to Tuglakabad ICD, a single TKD line is partly on detour route and partly parallel to the existing Delhi-Mathura line.

Some basic information on key parameters pertaining to the natural and social environment in Phase 2 of the DFC Western Corridor is shown below.

Table 1.3.2 Natural and Social Environment along Phase 2 of the DFC Western Corridor

	Rewari -Dadri	JNPT-Vadodara
Affected States (No. of Affected Villages by District)	(1) Uttar Pradesh: 11 villages in Gautam Budh Nagar District, (2) Haryana: 81 villages in Rewari, Mewat, Palwal, Gurgaon and Faridabad Districts, (3) Rajasthan: 13 villages in Alwar District	(1) Gujarat: 133 villages in Valsad, Navsari, Surat, Bhauch and Vadodara Districts, (2) Maharashtra: 136 villages in Raigad and Thane Districts)
Recorded Forest Area and Protected Area	(1) DFC passing near the reserved forest on foothill of Aravalli Hill in Mewat District towards Sohna side in Gurgaon (2) DFC passing for nearly 1.5 km within reserved forest in Gautam Budh Nagar District, Uttar Pradesh	(1) DFC traversing through nearly 20 small forest patches in recorded forest areas in Thane District. (2) DFC passing through three to four mangrove areas in Thane District. (3) DFC passing within the buffer area (Reserved Forest) and near the range boundary of the Sanjay Gandhi National Park in Thane District. (4) DFC passing within the buffer area but away from the range boundary of the Tungareshwar Wildlife Sanctuary in Thane District.
Legally Protected Eco-sensitive Area	(1) DFC passing a geo-physical sensitive area near Aravalli Hill Range in Alwar District in Rajasthan and Mewat District in Haryana.	(1) DFC traversing through ecologically fragile Dahanu area of Thane District in Maharashtra.
Important Rivers	(1) DFC crossing Yamuna River at the border between Faridabad District, Haryana and Gautam Buddh Nagar District, Uttar Pradesh (2) DFC crossing Hindon River in Gautam Budh Nagar District, Uttar Pradesh	(1) Thane District, Maharashtra State: 1) South Vaitarna River, 2) North Vaitarna River, and Ulhas River (2) Valsad District, Gujarat State: 1) Daman Ganga River, 2) Par River, and 3) Auranga River (3) Navsari District, Gujarat State:

	Rewari -Dadri	JNPT-Vadodara
		1) South Kaveri River, 2) North Kaveri River, 3) Ambika River, 4) N. Poorna River and 5) Mindhola River (4) Tapi River in Surat District, Gujarat (5) Narmada River in Bharuch District, Gujarat

Source: Final Report of the Preparatory Survey for Dedicated Freight Corridor (Phase 2) (February 2010) and Environmental and Social Impact Mitigation Measures Study (ESIMMS) (2007-2008) and as amended on the basis of ESIA Survey (2010-2011)

1.4 ESIA STUDY REPORT STRUCTURE

This ESIA study report comprises of 12 chapters as follows:

The Introduction chapter (Chapter 1) briefly presents project background, objectives of ESIA study and provide an overview of the study area. Chapter 2 describes the project description, salient features of the proposed project and proposed alternative alignments. Chapter 3 focuses on the Indian environmental legislations applicable to the project along the proposed corridor and the necessary statutory clearances likely to be obtained by the executing agencies. It also highlights the clearance procedures involved for the execution of the project. An overview of the existing environmental conditions along the project corridor is discussed in Chapter 4. This has covered all components related to physical, natural, and socio-economic environment. Scoping results of the ESIA study is detailed in Chapter 5.

The pollution control aspects, natural environment and social considerations are presented in Chapters 6, 7 and 8, respectively together with the various environmental parameters along the corridor with the relevant primary data generated during two different seasons on the river water quality, natural environment, and data independent of seasonal variation on the land use, sensitive receptors, and baseline surveys along with the secondary information collected from various statutory agencies of state governments. The public consultations conducted at various districts of the six states and the affected population's responses are presented in Chapter 9. The proceeding of the public consultation meeting and the brochures prepared and the presentation made are also discussed in this chapter. Mitigation measures for identified environmental impacts due to the proposed project activities and its components are presented in Chapter 10.

Environmental Management and Monitoring Plans in Chapter 11 focus on the implementation of mitigation measures at various stages of the project to curtail adverse impacts including a detailed monitoring plan for a safeguard of the environment with a time frame for the monitoring activities. As conclusion, Chapter 12 summarises project impacts and suggested mitigation measures for the project including pollution control, natural environment, and social aspects.

1.5 CONTACT DETAILS

(1) Project Proponent

Ministry of Railways (MoR)
(Railway Board)
Government of India
Rail Bhavan, Raisina Road, New Delhi – 110 001

(2) Project Implementing Agency

Dedicated Freight Corridor Corporation of India Limited (DFCCIL)
(Under Ministry of Railways)
Fifth Floor, Pragati Maidan,
Metro Station Building Complex,
New Delhi – 110 001
(Tel: 91-11-23454700
Fax: 91-11-23454701)

(3) CPM Offices of the DFCCIL

1) CPM Office Mumbai:
7th Floor, New Administrative Building, Central Railway, D.N. Road
Mumbai – 400 001, Maharashtra
Tel: 91-22-22634184
Fax: 91-22-22634184

2) CPM Office Surat:
4th Floor, Aruns-1, Near Iscon Mall,
Dumas Road, Piplod,
Surat – 395 007, Gujarat
Tel: 91-261-2633250
Fax: 91-261-2633250

3) CPM Office Vadodara:
13-14, 17-18, Panorama Complex,
3rd Floor, R. C. Dutt Road, Alkapuri,
Vadodara – 395 007, Gujarat
Tel: 91-265-2326024
Fax: 91-265-2326027

4) AGM Office Rewari-Dadri:
"Star House", First Floor, A-102, Sector-4,
Noida, Uttar Pradesh
Tel: 91-120-4309720
Fax: 91-120-4134554

CHAPTER 2
OUTLINE OF THE PROJECT

CHAPTER 2 OUTLINE OF THE PROJECT

2.1 LOCATION OF THE PROJECT

Phase 2 of the DFC Western Corridor runs from JNPT to Vadodara on the Western part and Rewari to Dadri on the Northern part of the country. In addition, a single line connection (called as "TKD" line) is to be branched out from the DFC mainline near Faridabad District to Tuglakabad ICD in Delhi. The corridor passes through the states of Maharashtra, Gujarat, Rajasthan, Haryana, Uttar Pradesh, and Delhi. The total length of the freight corridor of Phase 2 is approximately 565 km. Figures 2.1.1 and 2.1.2 show the location of the project alignment in JNPT-Vadodara and Rewari-Dadri sections, respectively.

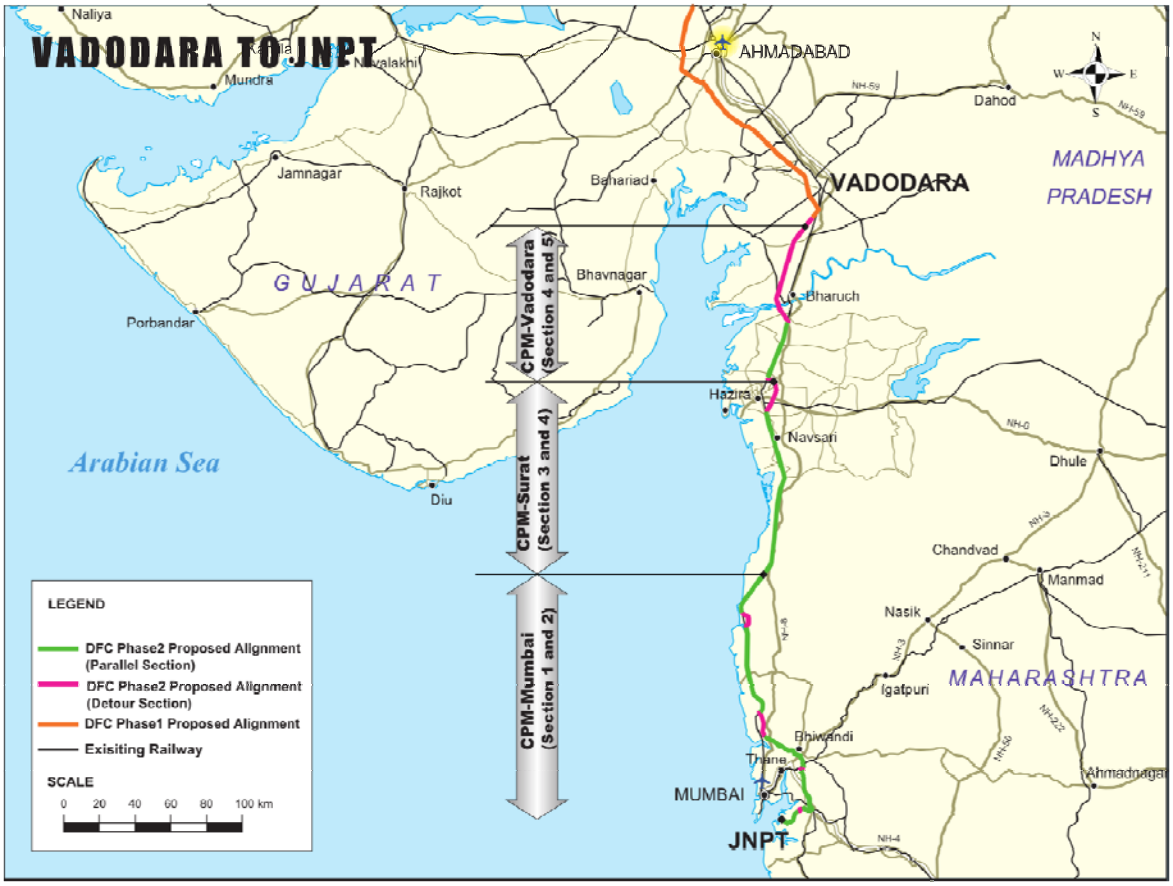


Figure 2.1.1 Location of the JNPT to Vadodara Section

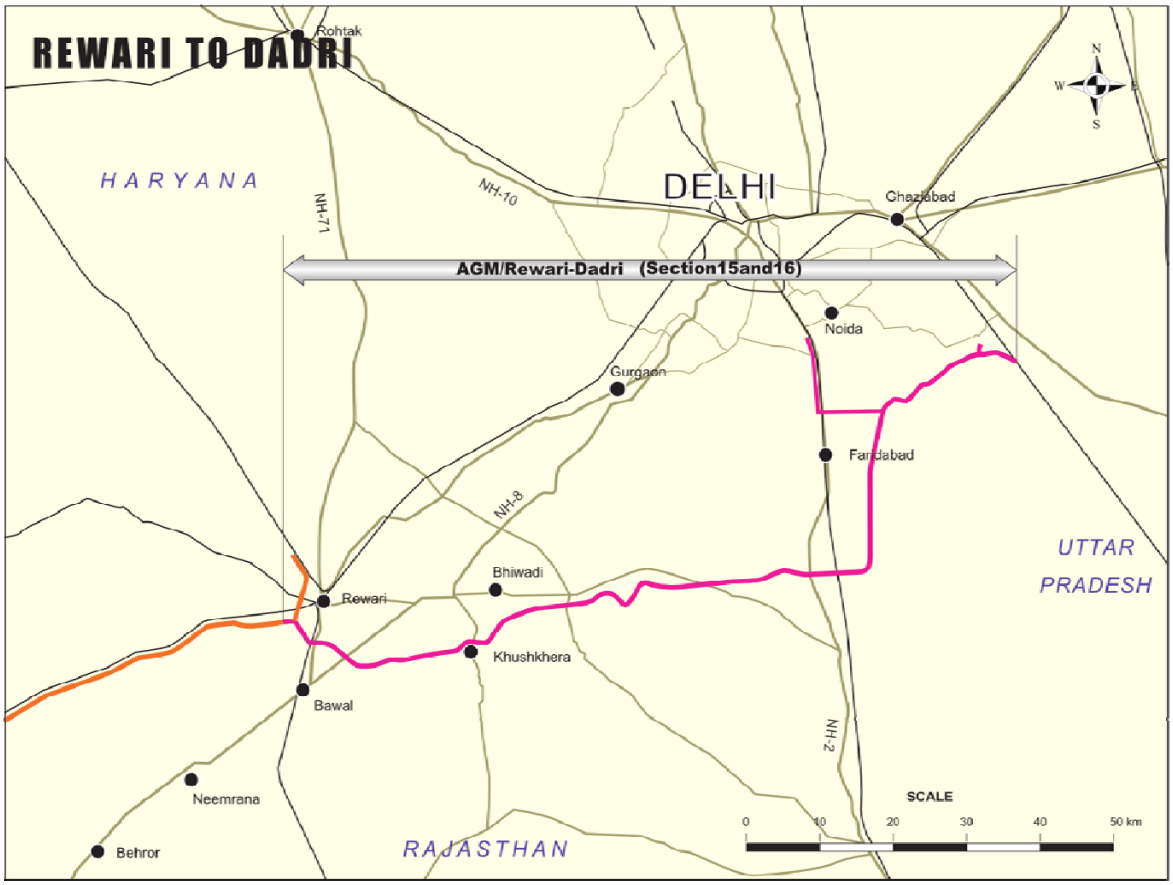


Figure 2.1.2 Location of the Rewari to Dadri Section

2.2 SCOPE OF THE PROJECT

The Phase 2 of the Western Corridor is planned to run from the JNPT in Mumbai to Vadodara and from Rewari to Dadri including a single line connection of approximately 19 km long from the DFC mainline near Faridabad District to Tuglakabad area of Delhi forming a part of the Western Corridor. The corridor shall be predominantly double line (except where single line is justified on traffic considerations) with electrification and advanced signaling system facilitating running of freight trains at higher speeds up to 100 km/hour. The track sub structure like formation, bridges etc. shall fit for 32.5 tonne axle load whereas the track structure shall fit for 25 tonne axle load to provide infrastructure fit for heavy/long haul operation up to trailing load of 13,000 tonnes and train lengths of up to 1,500 meters. The provision of grade separators with all existing rail/road infrastructure i.e. ROB/RUBs at important level crossing gates shall be provided to avoid any detention to either road or rail traffic. Higher schedule of dimensions (SODs) and maximum moving dimensions (MMDs) shall be included in the design in order to run wider stock, double stack containers and newly designed wagons so as to have improved payload to tare ratio.

The DFC project will restore the Indian Railways' competitive strength in the freight transportation market and emerge as the major low carbon and energy efficient transport system in the country. It will drive the establishment of industrial corridors and logistic parks along its alignment and play a crucial role in supporting India's growing economy.

Project scope evaluated subject to the ESIA is shown in Table 2.2.1.

Table 2.2.1 Project Scope for ESIA

		Section	
		JNPT-Vododara	Rewari-Dadri
Length of Alignment		420 km	145 km (Including TKD: 19 km)
Tunnel		1 (540 m)	-
Junction Station		3 (JNPT, Kharbao, Gothangam)	3 (Pirthala, Dadri and TKD)
Cross Station[*1]		9 (Nilje, Palghar, Gholvad * Navsari, Joravasan * Sanjali, Varediya)	2 (Dharuhera and Mewat)
Railway Flyovers		7	2
ROB		58	19
RUB		145	95
Total Bridges over rivers	All Bridge	701	72
	Important Bridge	13	2
Substation		60 km distance[*3]	60 km distance[*3]

Note: 1.Additional Cross Station is under planning.
2. The depot plans are not included in the Phase 2 section.
3. The distance is referred to Phase 1 data.

2.3 DESIGN CONSIDERATIONS FOR ROUTE ALIGNMENT

Two of the most important considerations in selecting the route for a proposed freight corridor are the physical features of the area and how these features relate to the geometric design controls. Physical features that affect route selection include topography, ground (soil) conditions, and the surrounding land use. Potential environmental impacts posed by construction of a new corridor are considered. At the first place, the topographic, geologic and soil maps as well as available aerial photographs of the areas were reviewed.

Typically, several preliminary maps are drawn and showing various alignments. The selection of an alignment takes a trial and error approach, as the proposed alignments are checked for compliance with the horizontal and vertical control criteria. The selection of the final alignment is based on a comparison of various factors such as costs, and environmental and social impacts. For selecting a good alignment, the following major factors were considered.

Obligatory Points: The obligatory or controlling point governs the alignment of a railway track. The following obligatory points force the railway track to deviate from its shortest route.

- Important cities and towns: Whenever a railway track is constructed, it is desirable to set up the places of social and commercial importance. The deviation of the alignment from its shortest route depends upon the importance of the town, its commercial importance and physical features of the area.
- River crossings: Construction of bridge over river involves heavy expenditures. The alignment is decided in such a way that it crosses the rivers at suitable sites where cost of construction of bridges is the least.
- Hill passes: Whenever the alignment of railway track is laid across a ridge line, it is generally laid through the pass or saddle to avoid excessive cutting/filling or boring of the tunnels.

- Site of tunnel: It should be ensured that minimum numbers of tunnels are only excavated in mountainous regions and if possible, the tunnels should be avoided.

A compromise could be made between the cost of construction and savings obtained by shortening the route.

Traffic: Before deciding the track alignment, the traffic growth, its position, nature and amount were estimated, and then a space for future extension was considered.

Gauge: As the width of the gauge increases the initial cost of construction, the load of carrying capacity of the track, the speed of the goods train, the alignment of the track and the gauge were selected with due regards.

Geometric Standards: To achieve profit in construction and maintenance cost, the following points need special consideration for finalizing the alignment.

- *Gradients:* General gradient should be provided for attaining the economy in operation costs. As far as possible, it should not exceed the ruling gradient. A steep gradient increases the cost of operation considerably. Gradient with less than 3% are for normal railways and greater than 3% for mountain railways.
- *Radii of Curves*: The cost of operation due to curve resistance increases inversely with the radii of the curve i.e. for a small curve, the cost of operation is more and vice versa. For this reason, the curves with maximum radii needs to be provided while finalizing the alignment. Curves near railway stations and bridges should also be avoided. Use of reverse curves was avoided. If reverse curve needs to be introduced, then a minimum of 35 m straight portion of the track must be inserted in between the two arcs of opposite contra flexure so that sudden change of super elevation from one side of the rail to the other is avoided.
- *Bridge Sites*: As far as possible large bridges were provided at right angles to the river flow. If it is not possible to avoid a curve at bridge, the track alignment near the bridge was provided at least a straight portion of 30-meter-length.
- *Hauling capacity of locomotives*: The alignment should be decided keeping in mind that hauling capacity depends upon gradient, speed, loading and method of operation.
- *Freight charges*: The distance between two stations should be kept bare minimum since operation cost increases with distance.

Topography of the areas: The designer considers conditions that may require a sudden change in alignment. For example, areas that would necessitate connecting long straight sections with sharp curves should be avoided. Areas that are subject to floods or avalanches make the construction difficult, expensive and/or unsafe.

The alignment is influenced by terrain. In general, the terrain or topography of an area is classified as level, rolling or mountainous land. In level terrain, selection of the alignment is influenced by factors such as the cost of right-of-way, land use, waterways that may require expensive bridging, existing roads, railroads, and sub-grade conditions. In rolling terrain, a number of factors need to be considered, including: grade, curvature, depths of cut and heights of fill, drainage structures, and number of bridges.

2.4 ALIGNMENT

2.4.1 Detour Alignment

The detour alignment for DFC corridor has been largely designed to detour heavy settlement in order to avoid large-scale involuntary resettlement. In addition, there are other factors also based on site conditions such as topography, design criteria constraints for providing detour alignment. Since, the major part of detour in Western DFC corridor traverse through cultivated agricultural land, the project is addressing the task of acquisition of land, structures and other immovable properties together with issues of livelihood and social disturbance. Table 2.4.1 shows the major design considerations for detour alignment.

Table 2.4.1 Detour Alignment Pattern of Phase 2 of the Western Corridor

S. No.	Parameters	Details	
1	Alignment	JNPT-Vadodara	Rewari-Dadri
2	Approximately Length	121 km	137 km (Including TKD line, 11 km)
3	Ruling Gradient	1 in 200 (5/1000)	
4	Steepest Gradient in Yards	1 in 1200 (0.83/1000) 1 in 400 (2.5/1000) exceptional case	
5	Gauge	1,676 mm	
6	Max Speed	100 km/hr	
7	Bank width for double line	13.5 m	
8	Slope Embankment	2H: 1V	
9	Cutting width for double line	20.9 m	
10	Slope of cutting	1:1	0.25:1 to 1:1
11	Blanketing	0.60 m depth	
12	Max degree of curvature	2.5 degree curve (700 m radius)	
13	Distance between two tacks of DFC	6.0 m (TKD line is single line)	
14	Between existing track and DFC	8.0 m (6.0 m in exceptional cases)	
15	ROW	Min: 11 m in Pasodra Max:109 m in Waki	Min: 16 m in Khajuriwas Max:167 m in Jhatta

2.4.2 Parallel Alignment

Parallel alignment has been planned in the JNPT-Vadodara section and in TKD line from Faridabad to Tuglakabad. The parallel alignment will be confronted with relocation of illegal slum dwellers, encroachers or squatters who presently reside within and around the railway stations and shall be subjected to compensation and resettlement due to improvement of the stations under the DFC project. This chapter has highlighted some critical parallel sections in Maharashtra and Gujarat Section which needs special attention from the point of view of rehabilitation and resettlement. Table 2.4.2 shows the design considerations for parallel alignment in JNPT-Vadodara section.

Table 2.4.2 Parallel Alignment Pattern for Phase 2 of the Western Corridor

S. No.	Parameters	Details	
1	Alignment	JNPT-Vadodara	Rewari-Dadri
2	Approximately Length	299 km	8 km (TKD line)
3	Ruling Gradient	1 in 200 (5/1000)	
4	Steepest Gradient in Yards	1 in 1200 (0.83/1000)	
5	Gauge	1,676 mm	
6	Max Speed	100 km/hr	
7	Max degree of curvature	2.5 degree curve (700 m radius)	
8	Distance between two tacks of DFC	6.0 m	Single line
9	Between existing track and DFC	8.0 m (6.0 m in exceptional cases)	
10	ROW	Min: 4 m in Kopar Max: 184 m in Vapi	Min: 10 m in Mewara Max: 10 m in Mewara

2.4.3 Alignment from Mahim JN to Vasai RD

The proposed alignment has been planned parallel to the existing line. The alignment from Mahim JN Station to Vasai RD Station had two options about the alignment; one was along the existing sea side railway route, another was along the east inland route. The inland route passes close to the Sanjay Gandhi National Park. However, it is difficult to select sea side route since highly crowded urban residence along the existing railway line does not allow enough ROW for the DFC. Therefore, the inland route was selected to avoid negative impact by huge scale of the involuntary resettlement.

2.5 RELEVANT FACILITIES

For DFC, JNPT-Vadodara section has three junction stations and nine crossing stations between JNPT to Makarpura (Sections 1, 2, 3, 4 and 5). Rewari-Dadri section has a total of three junction stations and two crossing stations. Details of other utilities such as Road Over Bridge (ROB), Road Under Bridge (RUB), etc., have been specified in Tables 2.5.1 and 2.5.2.

Table 2.5.1 Utilities Planned for JNPT - Vadodara

	JNPT- Bhilad (Maharashtra)		Bhilad-Makarupura (Vadodara) (Gujarat)		
Section	Sectiojn1	Section2	Section3	Section4	Section5
Alignment	JNPT-Vaitrarna	Vaitrarna - Bhilad	Bhilad - Sachin	Sachin - Bharuch	Baruch - Makarpura
CPM	Mumbai	Mumbai	Surat	Surat/ Vadodara	Vadodara
Junction Station Total 3	2 JNPT, Kharbao	0	0	1 Gothangam	0
Cross Station Total 9	1 Nilje	3 Palghar, Gholvad *	3 Navsari, Joravasan *	1 Sanjali	1 Varediya
Railway Flyovers	4	0	0	2	1
Total ROB	20	3	26	9	0
Parallel Existing	12	3	2	1	0
New	5	0	24	8	0
Detour New	3	0	0	0	0
Total RUB	33	11	4	44	53
Span≥12.2 m	12	1	0	4	2
Span<12.2 m	21	10	4	40	51
Total Bridges over rivers	211	148	164	88	90
Important Bridge	1	2	8	2	0
Major bridge	30	21	22	25	34
Minor bridge	180	125	134	61	56

Note: Additional Cross Station is under planning.

Table 2.5.2 Utilities Planned for Rewari - Dadri Section

Parameters	Value	
Section	Section 15	Section 16
Alignment	Rewari-Dadri (West)	Rewari-Dadri (East)
AGM	Rewari-Dadri	Rewari-Dadri
Junction Station Total 3	0	3 Pirthala, Dadri and TKD
Cross Station Total 2	2 Dharuhera and Mewat	0
Railway Flyovers	1	1
Total ROB (Detour)	15	4
Total RUB	44	51
Span≥12.2 m	5	0
Span<12.2 m	39	51
Total Bridges over rivers	38	34
Important Bridge	0	2
Major bridge	6	12
Minor bridge	32	20

2.6 PROJECT PLANNING

2.6.1 Examination of Alternatives

(1) Overall Examination of Alternatives

The specifications of the line are commensurate with high axle load and double-stacked container transportation. In the early stage of project planning four options were discussed as given below.

- Construction of New Freight Lines (Alt.1),
- Construction of New Passenger Lines (Alt.2),
- Improvement of Existing Lines (Alt.3)
- Without Project (Zero Option)

The process of alternative study was as follow:

Setting of alternatives	To identify functions and purposes of respective alternatives and define routes of respective alternatives.
Evaluation of merits and demerits of each alternative	In order to recognize the peculiarities of each alternative, merits and demerits of respective alternatives are evaluated qualitatively.
Preliminary (first stage) evaluation by comparison of demand and capacity	The future demand (using tentative figures) and the line capacity are compared and consideration is made on whether or not the alternative can meet the demand. It shall be noted that since study on the line capacity is not complete at this stage, the evaluation is done using provisional figures regarding line capacities in this report.
Second stage cost evaluation	The cost of each alternative is estimated and evaluated

Based on the study, the following results were turned out:

- Improvement of the existing line can not satisfy the future traffic demand in 2011 from the viewpoint of line capacity.
- The DFC is the most advantageous from the viewpoint of line capacity.
- Improvement of existing line is the most advantageous from the viewpoint of construction cost, and the DFC follows it.
- Improvement of the existing line has an advantage to other two alternatives from the viewpoint of social impacts.

From the above evaluation results, it was concluded that the DFC route is the optimum option among three alternatives. Keeping this in mind, a new DFC is proposed throughout the Western Corridor. The main point in examination of alignment has been:

- DFC line Parallel to the existing line
- DFC line Detouring the existing line

The factors which determine the selection between parallel and detour alignments are:

- Flexibility on availability of land width for minimum ROW (even for developing facilities)
- Social considerations for Rehabilitation and Resettlement measures
- Environmental Impacts
- Security for Future expansion
- Cost of construction

(2) Examination of Detail of Alternatives

1) Examination of Detour Alignment

Detour alignment has been mainly proposed to avoid major disturbances to the building structures as well as to the population residing close to the existing track. Site topography and technical design criteria constraints near the existing track are the other factors which also resulted in proposing detour alignment. In Phase 2, the entire mainline section of Rewari-Dadri is a complete detour. For providing connection to Tuglakabad ICD, a single TKD line is partly on detour route and partly parallel to the existing Delhi-Mathura line. In JNPT-Vadodara section, detour has been largely considered (Table 2.4.1) to avoid heavily built-up areas involving major rehabilitation problems of large number of people and difficulties in land acquisition even on high cost as well as difficulties in execution of the project in heavily built-up area. Detour routes have been carefully planned so as to minimally affect fertile agricultural land though complete avoidance is not possible. In such cases, each farm owner shall be suitably compensated as per the approved compensation package plan. Other environmental aspects associated with a new detour route shall be suitably addressed through appropriate mitigation measures.

Table 2.6.1 shows an indicative comparison of the relative difficulty levels of the key parameters for the detour and parallel alignments applied in urban and rural/semi urban areas falling within DFC Western Corridor.

Table 2.6.1 Impact on Urbanised and Rural/Semi Urban Area of the Proposed Corridor

Parameters	Urbanized Areas		Rural/ semi urban	
	Detour	Parallel	Detour	Parallel
Flexibility on availability of land width for minimum ROW (even for developing facilities)	More	Less	More	More
Ease of implementing Rehabilitation and Resettlement measures	Easy	Difficult	Easy	Easy
Associated Environmental Impacts	Less to Medium	More	Less	Less
Security for future expansion	More	Very Less	More	More
Cost of construction	High	Very High	Medium to High	Low

Table 2.6.2 shows alternatives for the detour alignments in JNPT-Vadodara section within DFC Western Corridor.

Table 2.6.2 Alternatives for Detours in JNPT-Vododara Section

S. No	Detour	Number of Alternatives	Selected Alternative	Reason of the selection
1	Kunde Vahal Detour	3	Alternative 3	- Sharp curve of the existing IR track - Main habitation of Kunde Vahal Village getting bifurcated by DFC track - Avoidance of metal quarry mountainous site
2	Detiwali Detour	1	Alternative 1	-Heavy built-up area in and around Dativali Station - Marshy area near Ulhas Creek - Many sharp curves of the existing IR track
3	Vasai Detour	1	Alternative 1	- Large scale built up area at 3 stations at Vasai Road, Nalasopara and Virar on existing IR track - Illegal settlers on railway land at these 3 stations - Marshy area near Vaitarana River - Difficult to rebuild 3 ROBs as the area is fully developed around them
4	Dahanu Detour	2	Alternative 2	- Difficult to rebuild ROB near Dahanu Road Station as the area is fully developed - Dahanu Road Station is already developed as a yard for suburban services and any access for DFC track is not feasible - Number of on-going construction activities in and around existing track leading to and from Dahanu Road Station - Existing IR track in Dahanu area is surrounded by swampy area and number of salt pans
5	Surat Detour	3	Alternative 3	- Large number of illegal slum dwellers within and around railway land along existing railway track between Udhna Junction and Surat Junction - Unsuitable site conditions for constructing bridge on Tapi River on this route - Expansion of Surat City Development on the eastward side and towards DFC track
6	Bharuch Detour (a part of Sanjali Nadiad Detour)	1	Alternative 1	- Heavy built-up area of Bharuch and Ankleshwar City - Number of industrial units close to existing IR track in Ankleshwar - Existing bridge at Bharuch is passing through the main city and an additional bridge cannot be built here

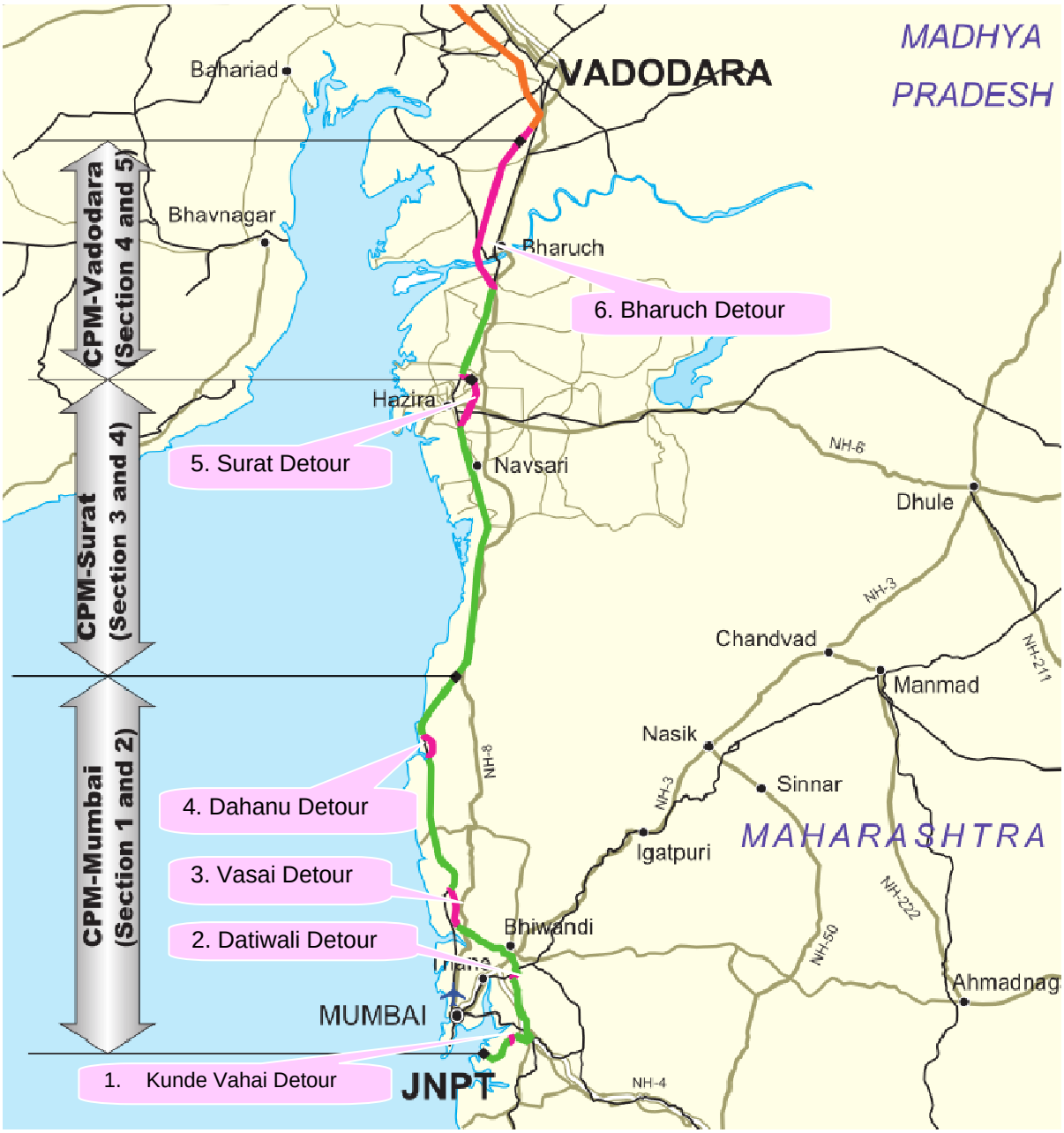


Figure 2.6.1 Location of Alternatives for Detours in JNPT-Vadodara Section

From the above qualitative evaluation, it was concluded that providing detour alignment is considered better than redeveloping difficult stretches in parallel alignment. The detail examination of the detour sections are discussed below:

i) Kunde Vahal Detour

The "Kunde Vahal detour" of total length of approximately 3 km is proposed between Jasai and Panvel Stations which will run on the west side of the existing Central IR track. The proposed detour alignment will start at Bambavi Village and end at Dapoli Village in Panvel Tehsil, Raigad District. The selected alternative alignment will traverse the site area adjoining metal quarry mountainous site and agricultural field, and will cross over the Dapoli-Targarh State Highway, major stream (Nala) and some shallow ponds. The detour route has been aligned away from the main habitation area and will pass between outer boundary of Kunde Vahal Village and Ovale Village.

The need for detour route arose because of technical constraint since the existing IR track in the section has a sharp curve of a radius of 350 m (5^o) which is against the design criteria specified for DFC alignment such as curve radius of 700 m (2.5^o). The two major issues which came into considerations while selecting the alternatives to the proposed detour alignment included avoidance of metal quarry mountainous site and minimizing resettlement at Kunde Vahal Village. The DFC project considered the following three alternatives (Figure 2.6.1) based on site conditions and design criteria for DFC alignment.

Alternative 1: To smoothen out the radius of curve, it was proposed to provide detour of the length of 3.45 km from outside of the village. Avoidance of metal quarry mountainous site, however, was impossible. The existing mountain in the area is presently being developed as metal quarry site and day by day, they are cut. It was also considered to provide tunnel alignment, on seeing the extent of quarrying operation in the area, it was, however, concluded that these mountain would be vanished by the time DFC project come in the stage of the construction. Moreover, this proposed alignment route was also traversing through a large area of agricultural land.

Alternative 2: Another alternative was suggested that the proposed alignment with an open cut to cross over the already degraded mountain would pass through Kunde Vahal Village i.e. 50 to 65 m away from the existing IR track in a stretch of 400 to 500 m. However, many of the existing habitation in the Kunde Vahal Village were getting affected significantly and entail the major issue of rehabilitation and resettlement. Further, the local community in the village was completely getting affected due to a division of village into two parts by DFC embankment. Since the excavation work in the metal quarry site was under various stages of development, it was anticipated that this activity would interfere in the development of DFC Corridor.

Alternative 3: Another alternative was further studied critically to overcome limitations of the above mentioned options. It was considered to keep alignment route with a total length of 2.30 km which would pass along the edge of metal quarry mountainous site and between outer boundary of Kunde Vahal and Ovale Villages as shown in Figure 2.6.1. This alignment route was finally selected as it gives many advantages – reduced length of detour alignment, minimal effect on loss of agricultural land, minimal effect on resettlement issue, minimal interference of quarrying operations on DFC activities, and other social and environmental benefits. However, this route will affect Electrified High Tension Towers (HTT) line in the area which probably needs to be relocated and shall be decided on further examination of the alignment route during the detailed engineering stage.

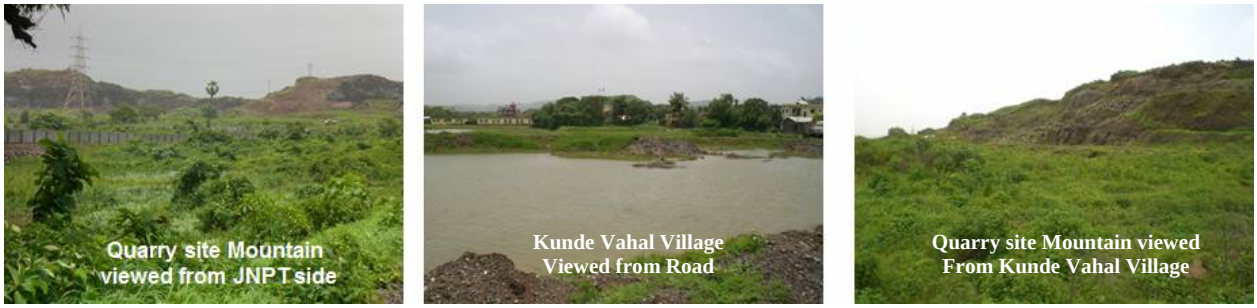


Photo 2.6.1 Current Field Situation of the Kunde Vahal Detour

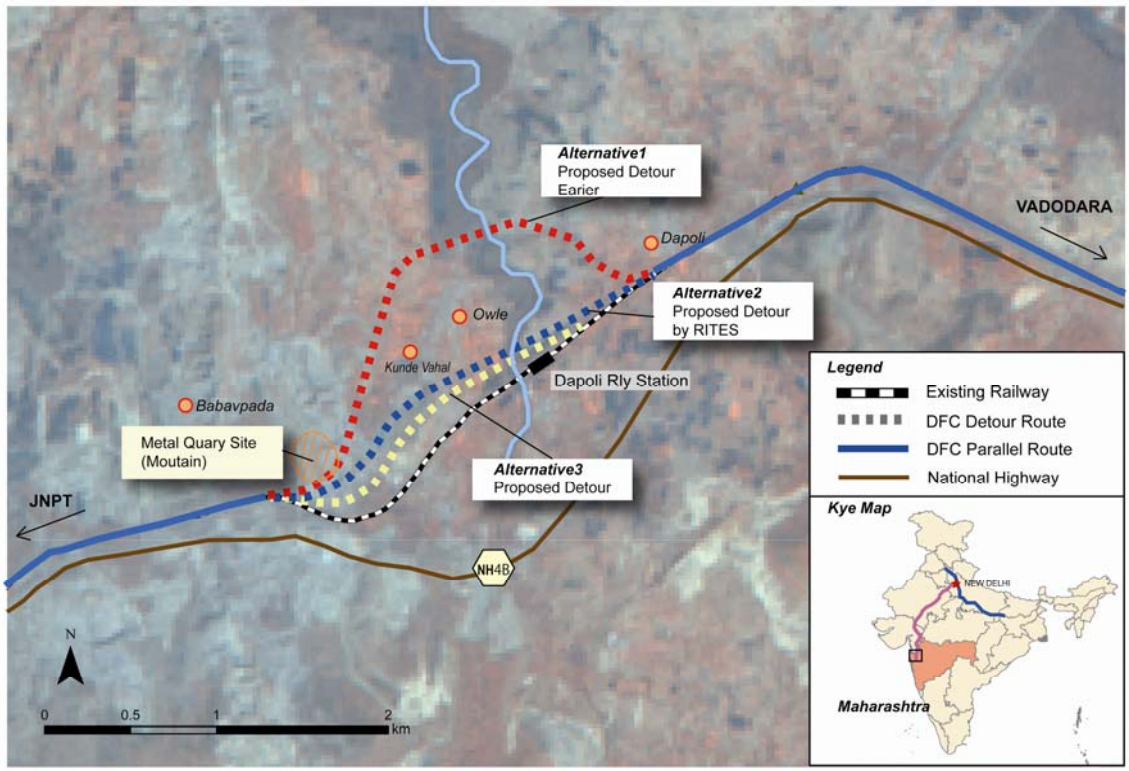


Figure 2.6.2 Alternatives for the Kunde Vahal Detour

ii) Datiwali Detour

The project will provide the "Datiwali detour" of a total length approximately 5 km between Nilje and Kopar Road Station on the east side of the existing Central IR track. The proposed detour alignment will start at Katai Village and end at Ayre Village in Kalyan Tehsil, Thane District. Other villages falling on the detour route are – Usarghar, Betavadi, Bhopar and Nandivali. The proposed Datiwali detour will take off after crossing existing IR station at Nilje and before Datiwali Station. After traversing through undulating terrain with mainly wasteland area, land covered with only scanty vegetation and some agricultural fields (Photo 2.6.2), the detour alignment will cross six tracks of Diva-Kalyan main line through flyover and become parallel on the east side along the Diva-Vasai Road branch line of Central Railway towards Juchandra Station.

The DFC project considered only one alternative (as shown in Figure 2.6.2) to the parallel alignment based on site conditions, technical constraint, and design criteria for DFC alignment.

Only Alternative: This detour route is needed to avoid built up area in and around Datiwali Station, marshy area near Ulhas creek, and many sharp curves of existing IR track. Considering that the parallel alignment would be confronted with a number of difficulties, it was decided to provide detour route which had an added advantage of reduced length of alignment. No existing village habitation will be affected by this detour route. In the parallel alignment immediately after detour and south of Ulhas River, it is proposed to provide reinforced vertical wall near the built up area where embankment will be approximately 10-meter height.

Photo 2.6.2 Current Field Situation of the Datiwali Detour

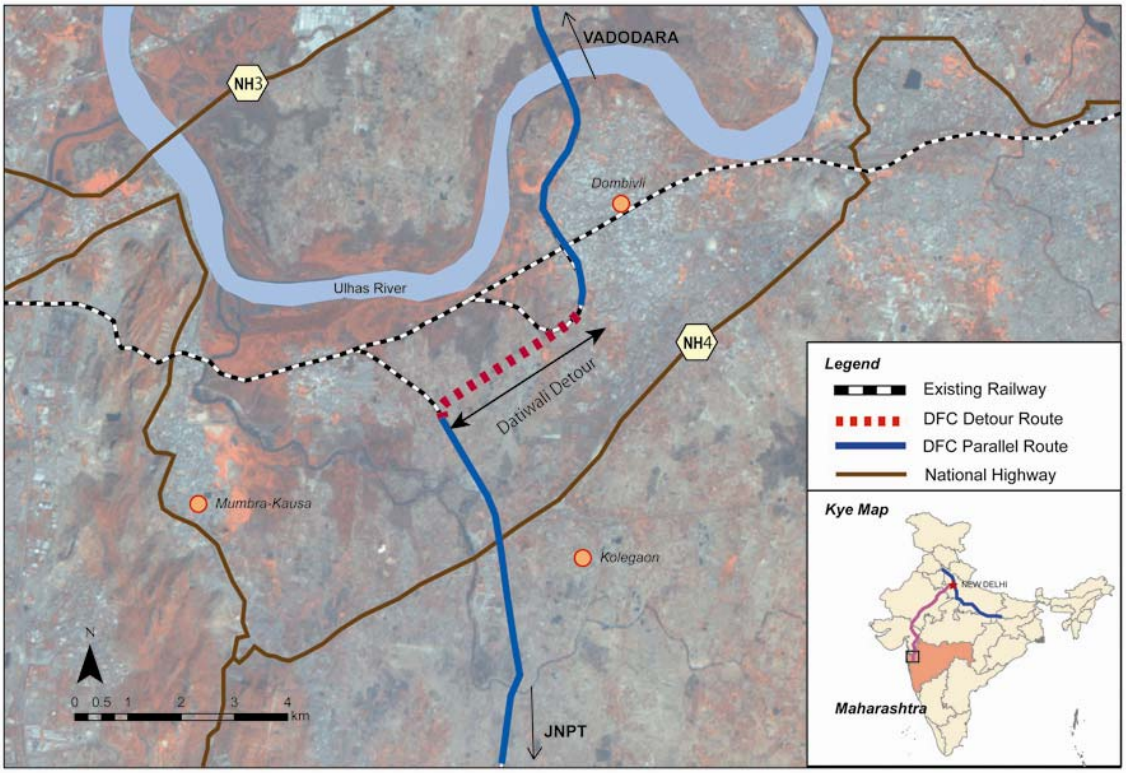


Figure 2.6.3 Alternatives for the Datiwali Detour

iii) Vasai Detour

The "Vasai detour" of a total length approximately 18 km will be provided between Juchandra and Vaitarana Stations to overcome a wide array of problems. Vasai detour will avoid a number of built up areas in between these stations at Vasai Road, Nalasopara and Virar in particular. In the surrounding area of Vaitarana River, there is marshy land. There are lots of development activities along the existing Railway track. Also, there are three Road over Bridges (ROB) which will have to be rebuilt. It is extremely difficult to rebuild these ROBs as the area is fully developed.

The detour route which is proposed in the project will involve construction of one closed tunnel having a length of 540 m on a straight alignment and falling in forest Villages Bhatpadi and Shirgaon of Vasai Taluka in Thane District. Initially, it was planned to build another closed tunnel of a length 160 m at a distance of 1.5 km from the first tunnel (towards Juchandra Station) but stone cutting activities for last one year have totally opened up this particular hill. As a result, the need for constructing any closed tunnel is now precluded and will now only be an open cut construction.

The parallel alignment was found not feasible due to a large scale built up area at three stations at Vasai Road, Nalasopara, and Virar in particular where is on the south of Ulhas River. The construction of residential buildings is on-going nearby to these three stations. To minimize the number of resettlement, it was found to provide a full scale of detour.

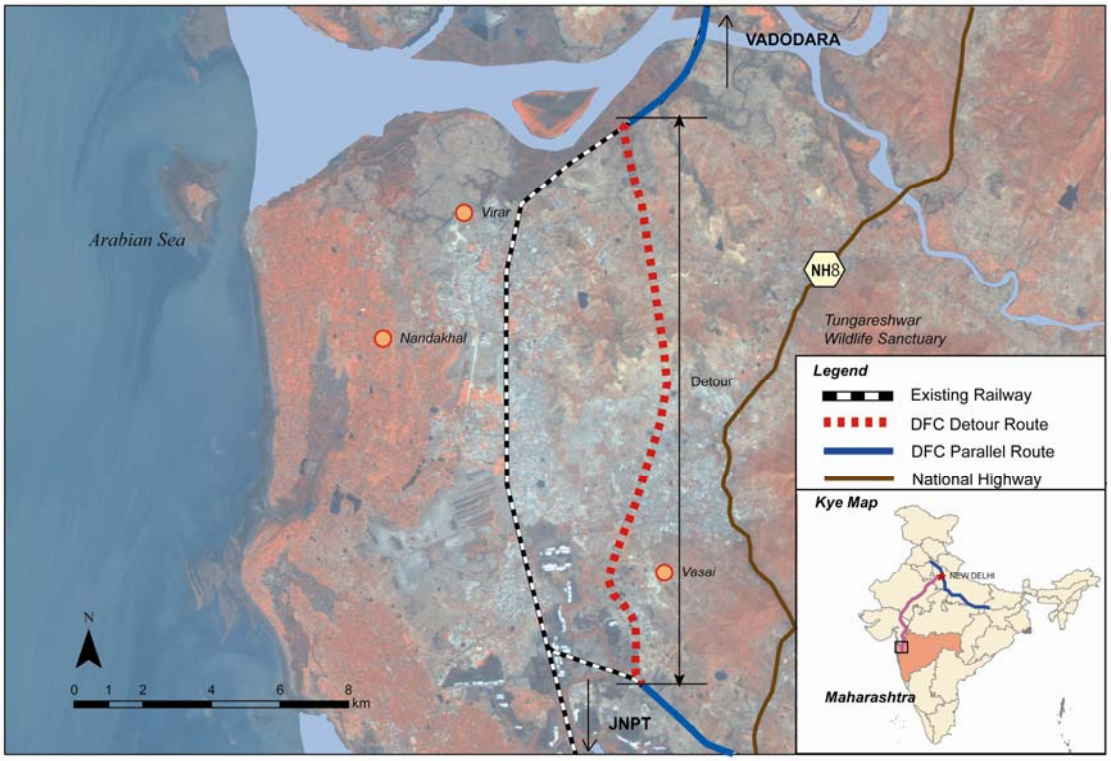


Figure 2.6.4 Alternatives for the Vasai Detour

iv) Dahanu Detour

The "Dahanu detour" of a total length approximately 12 km will be provided to by-pass dense built-up area around existing Suburban Dahanu Road Station of Indian Railways. Dahanu is a coastal city and a municipal council in Thane District on the western coast of Maharashtra State. It is located in 120–kilometre-north of Mumbai. The proposed detour alignment will start at Aagwan Village and end at Ambewadi Village in Dahanu Tehsil, Thane District. Other villages falling on the detour route are – Saravali, Patilpada, Manfod, Junnarpada, Nandore, Dahanu, Kasar and Waki. The detour route will traverse through cultivated land, green area, small orchard farms, some marshy area, and rivulets (Photo 2.6.3). The proposed detour will also be likely to affect some existing private structures.

The alignment in Section 2 between Vaitarna and Bhilad will be mostly running parallel to the existing IR track on the east side except for a detour at Dahanu Road Station. The need for this detour route emanated mainly from social, environmental, and topographical constraints. Two alternatives were considered to the parallel alignment (Figure 2.6.4) to avoid present conditions along the existing railway line.

Alternative 1: Initially, it was planned to provide detour of length of 7 km around Dahanu Road Station due to the following two reasons.

Firstly, there exists a ROB near Dahanu Road Station which is difficult to re-construct as the area is fully occupied by residential buildings and the traffic on this ROB is so heavy that it is not possible to suspend traffic on ROB during re-construction period.

Secondly, as part of the augmentation of the Suburban services, a new goods shed has been constructed on the south east side of the Dahanu Station and in the north there will be EMU terminal with circulating area in the east. As a result, it will not be possible to have any access for the DFC tracks through the yard. Moreover, many new construction activities are on-going in the area adjoining the station and also along the existing western railway line before and after Dahanu Station.

Alternative 2: It was found that the above alternative had some limitations. The southern part of Dahanu Road Station or the eastern side along the existing railway line has swampy area and also surrounded by a number of salt pans. As a result, this part of area was found not suitable for providing DFC alignment as it would need extensive soil stabilization measures for proper foundation treatment to run heavy load DFC trains.

It was, therefore, decided to extend detour route on the southern end by another 5 km to avoid both swamp area and salt pans. Overall efforts were made to select appropriate alignment route for detour so as to minimally affect existing vegetation and habitation area in Dahanu but in view of the DFC design criteria, some area having matured trees will be affected. The project will compensate the loss of trees by adopting pre-afforestation measures which will be done in consultation with the Dahanu Taluka Environmental Protection Authority (DTEPA).

Photo 2.6.3 Current Field Situation of the Dahanu Detour

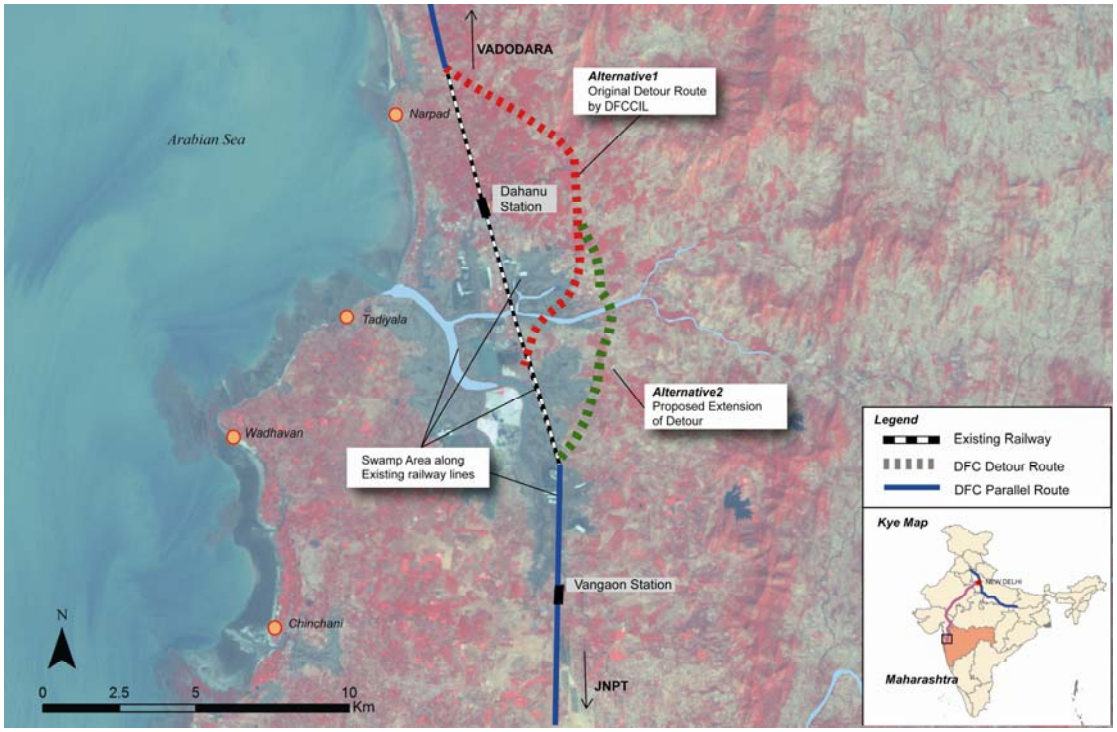


Figure 2.6.5 Alternatives for the Dahanu Detour

v) Surat Detour

The "Surat detour" of a total length of approximately 21 km is proposed between Sachin and Gothangam Stations of Indian Railways. The alignment in Section 4 will be running parallel to the existing Indian Railway alignment on the east side from Sachin Station to Bhedvad Station. From Bhedvad Station onwards, the DFC alignment will take deflection and run parallel to the existing Udhna feeder railway line and take full detour route near Devadh Village. After flying over the Udhna – Jalgaon branch line of Indian Railways, this detour route will extend up to Gothangam Station. The detour will traverse through plain terrain and mostly through cultivated agricultural fields, and en route also cross over NH6 and Tapi River.

This detour route was necessary to avoid heavily built up area of Surat City and Udhna Yard besides providing a suitable crossing on Tapi River. The three alternatives were considered based on site conditions, technical constraint and design criteria for DFC alignment. These are: Alt.1 – Parallel Route, Alt.2 – Full detour from Sachin to Gothangam, and Alt.3 – Detour at Northern part and parallel with the feeder line.

Alternative 1: It was considered to provide a parallel route along existing railway track. Considering a large number of illegal settlement along existing railway track between Udhna Junction and Surat Junction, it was, however, found that this option was not feasible. In case this alternative is implemented, it would require a large scale of resettlement plan for illegal slum dwellers and would invite a lot of social issues. Also, site conditions were not found conducive for construction of important bridge on Tapi River on this route.

Alternative 2: Another alternative was considered to provide full detour from Sachin to Gothangam. In this alternative, there is no settlement along the alignment route but the entire route would traverse through cultivated agricultural fields. However, expansion of Surat City development on the eastward side and towards the DFC line would pose a serious challenge to this alignment option.

Alternative 3: Another alternative was considered to provide parallel route of 4 km along the existing feeder line before taking a full detour route at Northern part. In this alternative, there is no settlement along the alignment route. Considering the further expansion of Surat City to the eastward side, this alternative would give some advantage as compared to the Alternative 2 but addressing the entire issue would be difficult due to long and high embankment of DFC detour on the east side. It is also being considered to provide viaduct structure after parallel line to the feeder route toward Tapi River Bridge but the cost-benefit analysis is under consideration.

Photo 2.6.4 Current Field Situation of the Surat Detour

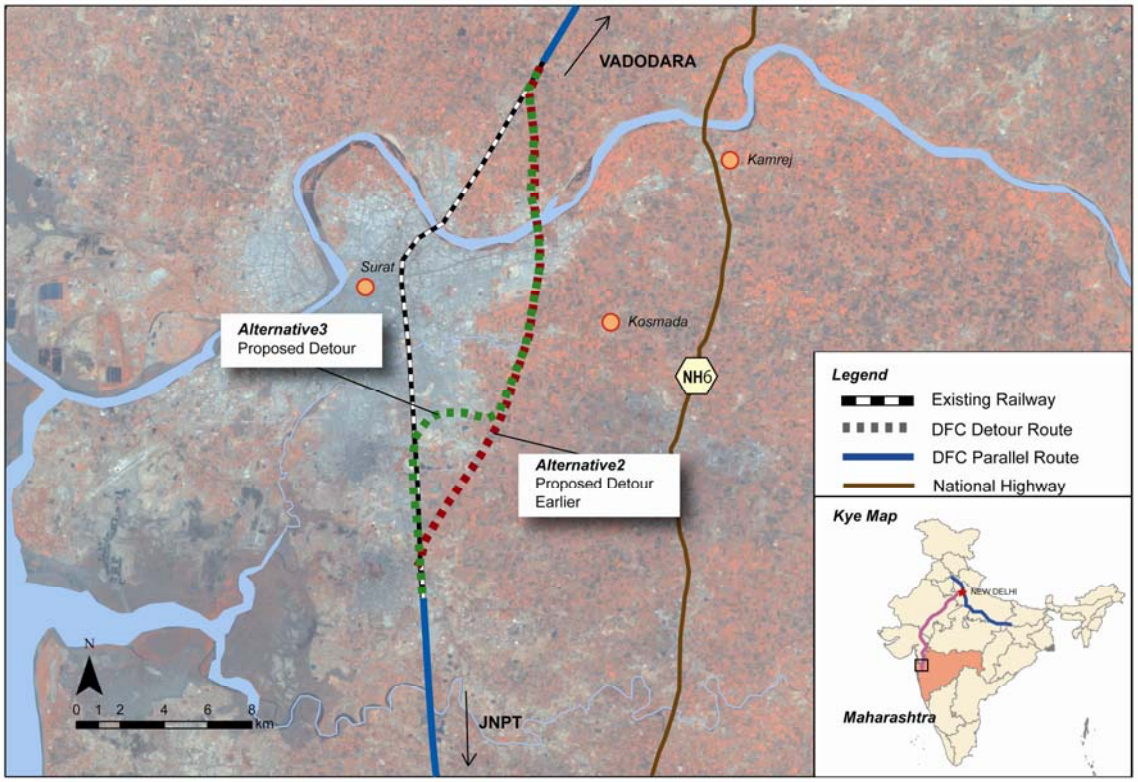


Figure 2.6.6 Alternatives for the Surat Detour

vi) Sanjali Nadiad Detour

The project will provide a complete detour route of length approximately 30 km between Sanjali and Varediya in Section 4 and of length approximately 30 km between Varediya and Makanpura in Section 5. The proposed alignment from Gothangam Station (end of Surat Detour) would run parallel to the existing track on east side up to Sanjali. The alignment crosses Mumabi-Delhi mainline of Indian Railways on north of Sanjali Station by a flyover and then runs along the detour route on west side of existing track till the end of Phase 2 alignment in JNPT-Vadodara Section.

It was necessary to provide a diversion beyond Sanjali Station to avoid heavily built-up area of Bharuch and Ankleshwar City and provide proper crossing over Narmada River (Figure 2.6.6). Ankleshwar is the main industrial town of Gujarat and many industrial units exist close to the existing railway line. At Bharuch, the existing bridge is passing through the heart of town and an additional bridge cannot be built here. The detour alignment will cross over rail line of Bharuch-Dahej by a flyover. En route, the alignment will also cross many State Highways such as Bharuch-Dahej Road, Ankleshwar-Hashot Road, Bharuch-Jambursar Road.

The detour alignment in this stretch passes mostly through plain terrain, cultivated agricultural land, and wasteland. In general, the type of soil in this section is clayey with patches of black cotton, morrum and sandy soil.

The alignment in Section 5 also runs on a detour route and traverse through mainly farm lands covered with clayey soil having patches of sandy soil and black cotton soil.

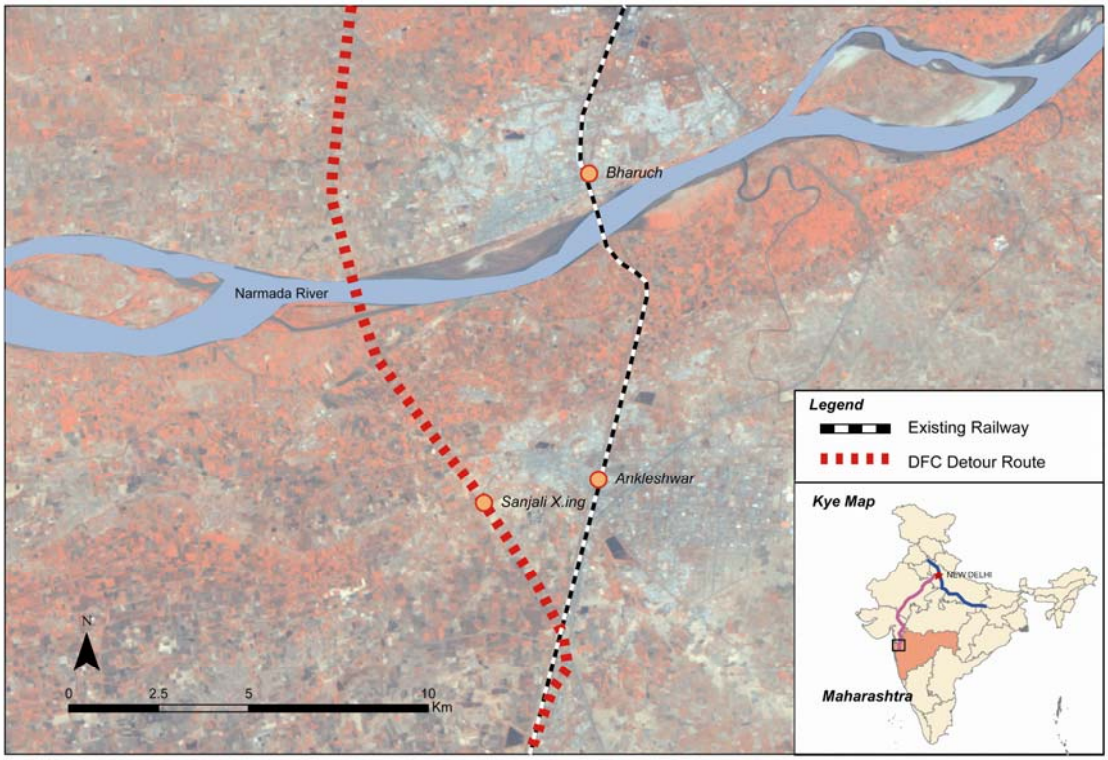


Figure 2.6.7 Alternatives for the Bharuch Detour (a part of Sanjali-Nadiad Detour)

The alignment between Rewari and Dadri will be entirely on a new line since it is not possible to follow parallel alignment due to heavy built-up area, high settlement and a large number of industrial units close to the existing IR track. The topography of the entire section is mostly plain except a small portion of stretch near Aravalli Hills. The detour alignment in this stretch passes mostly through cultivated agricultural land, barren land, and wasteland. The alignment on en route will cross over Yamuna River, Hindon River, irrigation canals and eight lane Noida Expressway. DFC will take the alignment along the contours of the Aravalli Hills near Mewat District and will involve deep rock cutting up to a depth of 30 m.

The project has also proposed to construct a single line from the DFC mainline near Faridabad District to Tuglakabad ICD.

2) Detail Examination of Parallel Alignment

Less urbanized areas have more land width available for ROW near the existing railway track. Even minor rehabilitation and resettlement of illegal settlers who have settled within or near railway land is cost effective as compared to adopting an option of detour route. All possible environmental impacts such as drainage, tree cutting, noise and vibration in parallel alignment could be easily addressed. Also the cost of the project is considerably reduced even after including cost of compensation for resettlement. Hence for the less developed areas near the existing IR tracks, the alignment is preferably considered for parallel alignment. The detail examination of some of the critical parallel sections in Maharashtra and Gujarat section is discussed below:

i) Panvel Parallel Alignment

The main consideration of providing Panvel parallel alignment between Dapoli Station and Kalamboli Station was to avoid detour route passing through legally protected Matheran Eco-sensitive zone on east side of Panvel city. Also, there were strong objections from the local people and community on the detour route. Accordingly parallel alignment was considered based on wide number of options. The selected alignment route is primarily parallel except having a small portion of detour route in the form of bulb like loop (Figure 2.6.7). The parallel alignment deflects away (towards north) from the existing track of IR after flying over JNPT-Panvel double line and thereafter fly over Panvel-Mangalore (Konkan Railway) line. The alignment then takes a bulb like loop before again crossing Panvel-Karjat track by a flyover and then runs parallel to the existing alignment before coming to Panvel Yard. The main purpose of providing loop was to lower the formation level at the Matheran ROB in order to avoid rebuilding of the ROB. This has also avoided taking the elevated track near the existing buildings, heavy built-up area along the existing line near Panvel Station. The introduction of loop has increased the length of alignment which would mean an additional construction cost, recurring maintenance cost and longer lead time for freight trains.

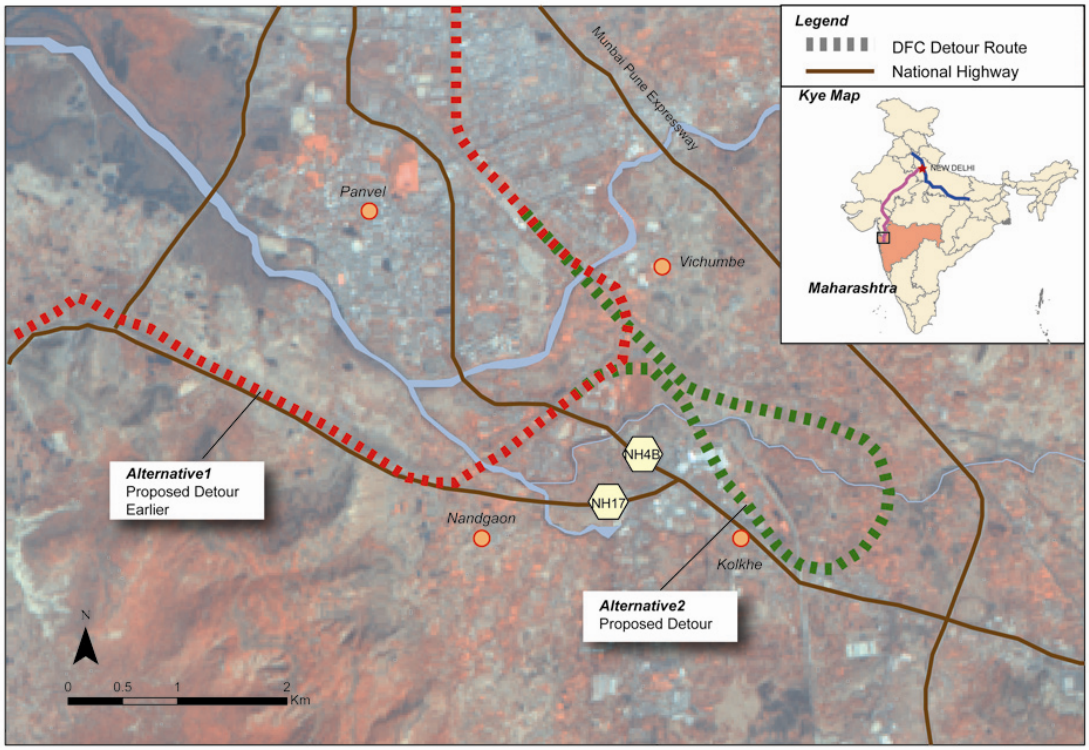


Figure 2.6.8 Panvel Parallel Alignment

ii) Dombivli Parallel Alignment

Dombivli parallel route is located on the south of Ulhas River and is in Kalyan Tehsil of Thane District. Immediately after the end of Dativali Detour, the proposed DFC alignment will run parallel on the east side of the existing Diva-Vasai Road branch line of Central Railway up to Juchandra Station of IR. The existing rail line in Dombivli area passes through the built-up area with high rise residential buildings along the route on both sides. There is a Central Railway under-crossing at Dombivli area and the possibility of constructing embankment towards road side is impossible (Photo 2.6.5).

Initially, it was considered to have the possibility of taking detour on the west side of the existing city along Ulhas River. Alternatively, after working on different options, it was decided to keep alignment parallel to the existing IR track. Instead of providing embankment, it was planned to acquire minimum ROW with 25 m width and construct a reinforced vertical wall to secure DFC alignment from encroachment or resettlement activities. Moreover, it was also decided to cross over the existing crossing lines of Diva-Kalyan main line of Central Railway by high embankment with around 10 m height.

Photo 2.6.5 Current Field Situation near Dombivli Parallel

iii) Saphale-Palghar-Boisar Stations Parallel Alignment

Most of the alignment in Section 2 is parallel except detour in Dahanu. On this parallel route, the project alignment crosses number of existing stations such as Saphale, Kelve Road, Palghar, Umroli, and Boisar in Palghar Tehsil of Thane District. There are many illegal settlements, especially near Saphale, Palghar and Boisar Stations. Most of the illegal occupants have settled within the IR land and posing serious challenge to the implementation of DFC project.

The project considered two options for dealing with the issue of these slum dwellers or encroachers or squatters. One option is to provide via duct structure above the station area without relocation of illegal settlers. The other option is to compensate these illegal dwellers for their buildings and also some additional payment to relocate by themselves. The second option has been found to be more cost and time effective. The socio-economic profile of these squatters is being covered in baseline survey and census and accordingly, the details of suitable compensation will be integrated in the RRP report.

iv) Vapi-Valsad-Navsari-Sachin Parallel Alignment

The entire Section 3 between Bhilad to Sachin is parallel to the existing IR track on the east side. The proposed alignment passes through number of existing stations such as Vapi, Udvada, Pardi, Valsad, Dungri, Bilimora, Amalsad, Ancheli, Vedchha, Navsari, Maroli and Sachin. In this section, the alignment will cross over number of important rivers. At certain locations between Navsari and Sachin stretch, river channel is running along the existing IR track and it will be necessary to provide slope protection works to protect DFC track from flooding.

There will be number of ROBs in this stretch which needs to be rebuilt. The alignment is proposed to have elevated track on viaducts while passing through Valsad Yard. Navsari Station will require resettlement activities before constructing DFC alignment.

2.6.2 Finalized Project Plans

The finalized DFC project details showing the parallel and detour alignments have been attached in the report as Appendix-3.

(1) Detour Alignment

Table 2.6.3 shows the summary of finalized detour alignment and details.

Table 2.6.3 Summary of Planned Detours under Phase 2

Name of Detour	Between IR Stations	Approximately Length (km)	Main Reasons for Provision of Detour
Kundevahal Detour	Jasai and Panvel	3	- Sharp curve of the existing IR track - Main habitation of Kunde Vahal Village getting bifurcated by DFC track - Avoidance of metal quarry mountainous site
Panvel Loop (In between Panvel Parallel)	Dapoli and Kalamboli	3	- Avoidance of rebuilding of Matheran ROB - Avoidance of any consideration of detour route which has to pass through Matheran Eco-sensitive zone - Avoidance of taking elevated tack near existing buildings, heavy built up area - Avoidance of electric transmission lines
Dativali (Diva) Detour	Nilje and Kopar Road	5	- Heavy built-up area in and around Dativali Station - Marshy area near Ulhas Creek - - Many sharp curves of the existing IR track
Vasai Detour	Juchandra and Vaitarna	18	- Large scale built up area at 3 stations at Vasai Road, Nalasopara and Virar on existing IR track - Illegal settlers on railway land at these 3 stations - Marshy area near Vaitarana River - Difficult to rebuild 3 ROBs as the area is fully developed around them
Dahanu Detour	Dahanu Road	12	- Difficult to rebuild ROB near Dahanu Road Station as the area is fully developed - Dahanu Road Station is already developed as a yard for suburban services and any access for DFC track is not feasible - Number of on-going construction activities in and around existing track leading to and from Dahanu Road Station - Existing IR track in Dahanu area is surrounded by swampy area and number of salt pans

Name of Detour	Between IR Stations	Approximately Length (km)	Main Reasons for Provision of Detour
Surat detour	Sachin and Gothangam	21	- Large number of illegal slum dwellers within and around railway land along existing railway track between Udhna Junction and Surat Junction - Unsuitable site conditions for constructing bridge on Tapi River on this route - Expansion of Surat City Development on the eastward side and towards DFC track
Sanjali –Nadiad	Varediya and Makarpura	60	- Heavy built-up area of Bharuch and Ankleshwar City - Number of industrial units close to existing IR track in Ankleshwar - Existing bridge at Bharuch is passing through the main city and an additional bridge cannot be built here
Rewari-Dadri (Mainline)	Rewari to Pirthala and Pirthala to Dadri	126	- Heavy built-up area, high settlement and a large number of industrial units close to the existing IR track - Inadequate provision of land width for ROW - Limitations at Tuglakabad Station Yard to cross DFC line with double stack containers
Rewari-Dadri (TKD line)	Faridabad and Tuglakabad	11	None
Total		258	

(2) Parallel Alignment

The lengths of the sections having parallel alignment details are outlined in Table 2.6.4.

Table 2.6.4 Summary of Planned Parallel Sections under Phase 2

Parallel Sections	Length (km)	Name of Critical Parallel Section
JNPT-Bhilad (Sections 1 and 2)	156	1. Panvel Parallel in Panvel Tehsil, Raigad District 2. Dombivli Parallel in Kalyan Tehsil, Thane District 3. Saphale-Palghra-Boisar Station Parallel in Palghar Tehsil, Thane District
Bhilad- Itola (Sections 3, 4 and 5)	143	1. Vapi-Valsad-Navsari-Sachin Parallel in Gujarat
Rewari-Dadri (TKD line)	8	None
Total	307	

CHAPTER 3
APPLICABLE ENVIRONMENTAL LAWS, POLICIES AND GUIDELINES

CHAPTER 3 APPLICABLE ENVIRONMENTAL LAWS, POLICIES AND GUIDELINES

Environmental Protection cannot be isolated from the general issues of development. To achieve progress in all spheres of human development, economy, technology, industrial production, infrastructure development, and health care should balance with environmental protection. Over the years, together with spreading of environmental consciousness, there has been a change in the traditionally held perception that there is a trade-off between environmental quality and economic growth as people have come to believe that the two are necessary complimentary.

Comprehensive environmental legislation has grown in the country since 1970. The Environmental Legislation helps to plug in gaps and protect environment while developing various project associated with the development of the country. The laws implementation will help in sustainable development and protects the human health and property as well. The Ministry of Environment and Forests (MoEF) and the State and Central Pollution Control Boards together form as the regulatory and administrative core sector.

There are many important environmental legislations which are directly relevant to the proposed Dedicated Fright Corridor (DFC) Project between JNPT to Vadodara and Rewari to Dadri. While some legislation are applicable before the execution of the project in terms of getting clearances/permissions from the statutory authorities before the implementation of the project, and some needs to be followed at the time of implementation of the project.

3.1 APPLICABLE NATIONAL POLICIES AND REGULATIONS

3.1.1 The Environment (Protection) Act, 1986

This act was enacted with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities [under section 3(3)] charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. Under this Act, the Central Government is empowered to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time, the Central Government issues notifications under the EPA for the protection of ecologically-sensitive areas or issues guidelines for matters under the EPA. The Act was last amended in 1991.

3.1.2 EIA Notification, 2006 and Amendments

The Environmental Impact Assessment Notification issued by the Ministry of Environment and Forests, Government of India is governing all developmental interventions that are taking place in the country. This notification was initially issued by the MoEF in 1994 and later amended in 2006 based on re-engineered process. The purpose of this notification is to impose restrictions and prohibitions on the expansion and modernization of any activity or proposing a new project as specified in Schedule I in any part of India unless environmental clearance has been accorded by the Central Government or State Government in accordance with the procedure specified in the notification.

According to the latest EIA Notification, railway and bridge construction projects do not appear in the list of Schedule 1 and as such, are exempted from the environmental clearance process.

3.1.3 The Indian Forest Act, 1927

The Indian Forest Act, 1927 was enacted after repealing the Indian Forest Act, 1878 for the purpose of consolidating the law relating to forests, the transit of forest produce and the duty leviable on timber and other forest produce. The Act makes various provisions for conservation of forests and also provides for the State Government to constitute any forest land or waste land as reserved forest which is the property of Government or over which the Government has proprietary rights, or the whole or any part of the forest produce of which the Government is entitled. The preamble and other provisions of the Forest Act are wide enough to cover all categories of forests like reserved forests, village forests, protected forests, etc.

3.1.4 Forest Conservation Act, 1980 and its Amendments

This Act provides for the conservation of forests and regulating diversion of forestlands for non-forest purposes. When any project falls within forestlands, prior clearance is required from the relevant authorities under the Forest (Conservation) Act, 1980. The respective State Governments cannot de-reserve any forestland or authorize its use for any non-forest purposes without approval from the Central Government.

The forest authorities conduct a cost-benefit analysis to assess the loss of forest produce, loss to environment vis-à-vis benefits of project. Compensatory Afforestation scheme is prepared to compensate loss of vegetation. The forest authorities identify the degraded forestland of twice the area of the affected land to develop compensatory forest. Once the submitted proposals are reviewed, they forward the proposals to the Principal Chief Conservator of Forests and to the State Secretariat. The State Government recommends the proposals for further processing and approval to the concerned Regional Offices of the Ministry of Environment and Forests in case the total forest area affected is less than 40 ha, otherwise the proposals go to the MoEF at the Central level. The detailed procedure for obtaining clearance under FCA is given in Appendix 8. The current situation with regard to the process of obtaining clearance for DFC Phase 2 Project is mentioned below:

- For Gulistanpur Reserved Forest in Gautam Buddh Nagar District of U.P., the submitted application is being reviewed at the District Forest Department. Once all additional information such as details of tree survey, utility maps for all affected structures within ROW and others is submitted by DFCCIL, the District Forest Department will recommend application to the MoEF Regional Office in Lucknow for Stage I Approval. It is expected that it may take nearly 3-4 months for obtaining Stage I Approval from now. Immediately after Stage I Approval, DFCCIL will have to deposit legally required compensation fee to the Forest Department to cover cost of compensatory afforestation, at Net Present Value (NPV), felling of trees and its transportation before final approval will be granted by the State Forest Department.

- For all forest patches in the Recorded Forest Areas in Thane District of Maharashtra, consolidated proposal has been submitted to the Forest Department. Reconciliation survey has also been completed along with the Forest Department for all forest patches. Action on FCA approval for forest and mangrove areas will start once the clearance under the Wildlife Protection (WPA) Act, 1972 has been granted for the Sanjay Gandhi National Park. It is expected that it may take nearly 3-4 months for obtaining Stage I Approval under FCA from now.

3.1.5 Forest Conservation Rules, 2003 and its Amendments

According to the Forest (Conservation) Rules, 2003 as amended up to February 2004, the project requires forestry clearance if forest land acquisition is involved. In case of forest land, if acquisition is less than 40 ha (other than mining project), decision will be taken by RCCF, and if acquisition is more than 40 ha, the proposal will be sent to Ministry of Environment and Forests for their approval.

3.1.6 Supreme Court Orders on Forest Conservation and Protected Areas (in the Thirumulpad Forest Case), 1996 and 2000

The Supreme Court began by reinterpreting the meaning of "forest" as defined in the Forest Conservation Act, 1980. The Act essentially requires the Central Government approval for conversion of forest land to non-forest purposes. Till 1996, the Forest Conservation Act was assumed to apply only to reserved forests. The Supreme Court said the Act applied to all forests regardless of their legal status or ownership. It also redefined what constituted "non-forest purposes" to include not just mining but also operation of sawmills. But it did not stop at reinterpreting the law for the cases at hand. The Supreme Court ordered all such non-forestry activities anywhere in the country that had not received explicit approval from the Central Government to cease immediately. It also suspended tree felling everywhere, except in accordance with working plans approved by the Central Government.

By virtue of the Supreme Court's order dated on13th of November, 2000, no Forest, National Park or Sanctuary can be de-reserved without the approval of the Supreme Court.

No non-forest activity is permitted in any National Park or Sanctuary even if prior approval under the Forest (Conservation) Act, 1980 has been obtained.

The interim order dated on 14th of February, 2000 prohibited the removal of any dead or decaying trees, grasses, drift wood etc. from any area comprising a National Park or a Sanctuary notified under Section 18 or 35 of the Wildlife (Protection) Act, 1972.

It was also directed that if any order to the contrary has been passed by any State Government or other authorities, the operation of the same shall be stayed. In order to advise the Supreme Court on the various issues concerning forest and wildlife conservation, the Central Empowered Committee was set up as an authority under Section 3 (3) of the Environment (Protection) Act, 1986 to adjudicate on forest and wildlife related issues.

3.1.7 The Biological Diversity Act, 2002 and its Rules, 2007

This Act was born out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity, 1992 which recognizes the sovereign rights of states to use their own Biological Resources. This Act provides for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto. As per the provision of Act, certain areas which are rich in biodiversity and encompass unique and representative ecosystems are identified and designated as biosphere reserve to facilitate its conservation. All restrictions applicable to protected areas such as National Park and Sanctuaries are also applicable to the reserves.

3.1.8 The Wildlife (Protection) Act, 1972 and its Amendment, 2003

The Act was enacted with the objective of effectively protecting the wild life of the country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act provides for protection to the listed endangered flora and fauna and ecologically important protected areas. It empowers the Central and State Governments to declare any area as a wildlife sanctuary, national park or closed area. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The detailed procedure for obtaining clearance under WPA is given in Appendix 8. The clearance procedure has to be followed for the SGNP under WPA due to the following criteria:

- During the XXI meeting of the Indian Board for Wildlife held on 21st January 2002, a "Wildlife Conservation Strategy-2002" was adopted wherein point No.9 envisaged that "lands falling within 10 km of the boundaries of National Parks and Sanctuaries should be notified as eco-fragile zones under section 3(v) of the Environment (Protection) Act and Rule 5 Sub rule (viii) & (x) of the Environment (Protection) Rules." The delineation of eco-sensitive zones are site specific and relate to regulation, rather than prohibition, of specific activities. Further, the National Wildlife Action Plan (2002-2016) has also indicated areas outside the protected area as vital ecological corridor links to prevent isolation of fragments of biodiversity. MoEF has also issued guidelines for declaration of eco-sensitive zones around National Parks and Wildlife Sanctuaries on 9th February 2011 in pursuance to the decision taken by the National Board for Wildlife.

- For Sanjay Gandhi National Park in Thane District of Maharashtra, although the proposed DFC alignment route passes through the reserved forest area outside the range boundary of the Protected Area, the provision of above mentioned criteria is attracted in case of DFC project resulting in requirement for clearance. As a result, DFCCIL has already submitted proposal for obtaining clearance under WPA. The proposal has already been scrutinized and forwarded to the PCCF, State Board of Wildlife in Nagpur, Maharashtra. From here, the application will come for further scrutiny to the National Board of Wildlife in MoEF's Regional Office in Bhopal. It is expected that it may take nearly 2 - 3 months for obtaining final clearance after approval from the Central Empowered Committee of the Hon'ble Supreme Court of India.

3.1.9 The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and its Rules, 2007

This Act recognises the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited and provided a framework for their right. This Act became effective from 1st January, 2008. According to this Act, the proposals submitted under the Forest (Conservation) Act, 1980 for diversion of forest land that non-forest purposes are required to enclose evidences from the respective State Government or the concerned Gram Panchayat. It supports that settlement of rights (if any) under FRA, 2006 will be initiated and completed or bearing on operationalization of the FRA before the proposals are granted for the final approval. NOC under FRA is required by DCF before forwarding the submitted application to the Nodal Officer.

For forest patches both in Thane District, Maharashtra and Gautam Buddh Nagar District, U.P., DFCCIL is in process to give application to the District Revenue Officer with a copy to the District Collector to check rights for tribal or forest dwellers in the plots affected by the DFC Project. Once this has been checked by the District Revenue Officer, he will give

his report to the District Collector who will issue NOC to be used for FCA clearance. It is expected that this NOC will be obtained by DFCCIL soon.

3.1.10 Noise Pollution Regulation and Control Rules, 2000

As a result of considering the deleterious and psychological effects of the noise pollution on human well-being, the rules for noise pollution came into force in 2000. According to the provisions of the Rules, a person could make a complaint to the designated authority in the event that the actual noise levels exceed the ambient noise standards by 10 db (A) or more as compared to the standards prescribed in the Schedule of the Rules. The designated authority will take action against violator in accordance with the provisions of these rules or other laws in force. The above rules are applicable at the time of the execution of the project. The equipment used during the construction should have acoustic enclosure.

3.1.11 Air (Prevention and Control of Pollution) Act, 1981

This Act provides for the prevention, control and abatement of air pollution. It is applied when air polluting activity in an air pollution control area or when emissions of any air pollutants into the atmosphere exceed the standards set by the Central and State Boards.

3.1.12 Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act, 1974 resulted in the establishment of the Central and State level Pollution Control Boards which responsibilities include managing water quality and effluent standards, as well as monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of certain facilities.

3.1.13 Railways (Amendment) Act, 2008

The Railways Act, 1989 was amended in 2008, which is called the Railways (Amendment) Act, 2008 (RAA 2008). The RAA 2008 provides land acquisition process and procedures for the special railway projects such as DFC, including valuation method of land compensation. The amendments include insertion of following clauses:

- 7A (competent authority) means any person authorized by the central Government by notification, to perform the functions of the competent authority for such area as may be specified in the notification;- 29A (person interested) – (i) all persons claiming an interest in compensation to be made on account of the acquisition of land under this Act; (ii) tribals and other traditional forest dwellers, who have lost any traditional rights recognized under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; (iii) a person interested in an easement affecting the land; and (iv) persons having tenancy rights under the relevant State laws;

- 37A (special railway project) – means a project, notified as such by the Central Government from time to time, for providing national infrastructure for a public purpose in a specified timeframe, covering one or more States or the Union territories;

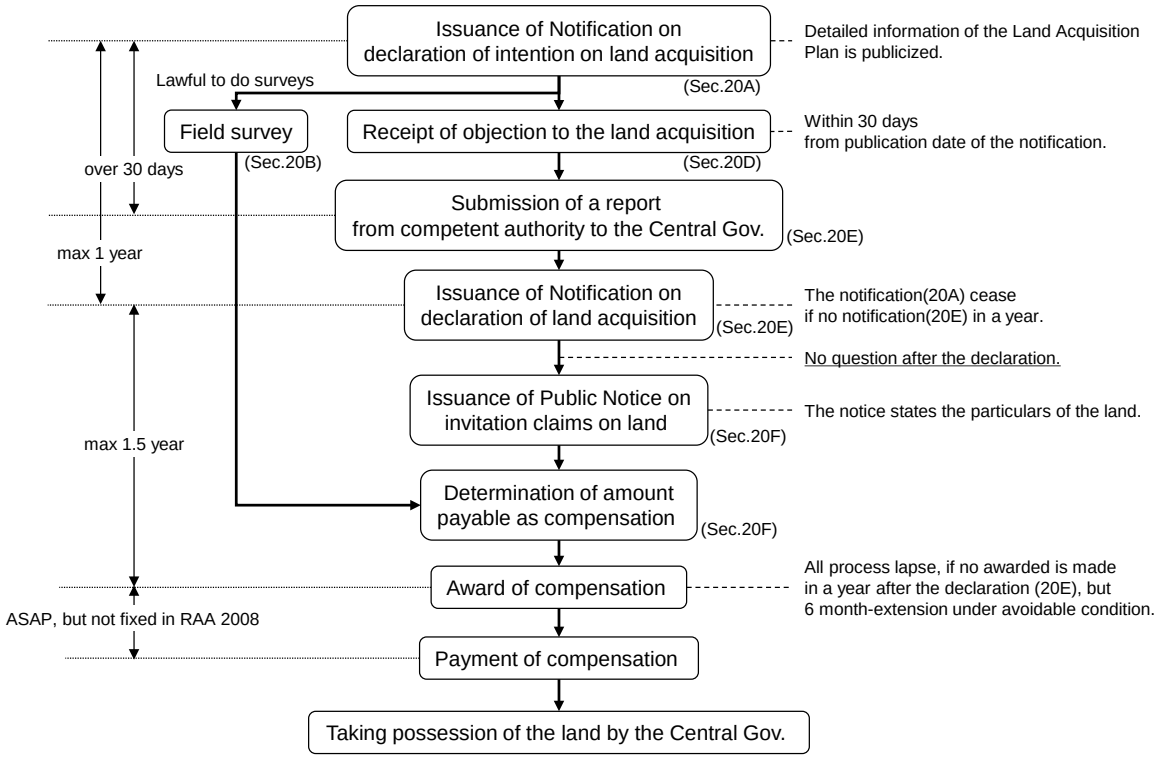
- Chapter IVA – Land Acquisition for a Special Railway Project.

The main elements of Chapter IVA are shown below:

Table 3.1.1 Main Element of Chapter IVA - Land Acquisition for a Special Railway Project, Railways (Amendment) Act, 2008

Section		Description
20A	Power to acquire land, etc.	Declaration of intention to acquire land which required for execution of a special railway project. This is the first notification and empowers the competent authority to cause the substance of the notification.
20D	Hearing of objections, etc.	Objections must be made by interested persons within 30 days from the date of publication of the notification under sub-section (1) of section 20A.
20E	Declaration of acquisition	On publication of the declaration under sub-section (1), the land shall vest absolutely in the Central Government.
20F	Determination of amount payable as compensation	Amount to be paid as compensation shall be determined by an order of the competent authority. The competent authority shall make an award under this section within a period of one year from the date of publication of the declaration.
20G	Criterion for determination of market value of land	• The competent authority shall adopt the following criteria in assessing and determining the market-value of the land - (i) the minimum land value, if any, specified in the Indian Stamp Act, 1899, for the registration of sale deeds in the area, where the land is situated; or (ii) the average of the sale price for similar type of land situated in the village or vicinity, ascertained from not less than fifty per cent of the sale deeds registered during the preceding three years, where higher price has been paid, whichever is higher. • The competent authority shall, before assessing and determining the market value of the land being acquired under this Act - (a) ascertain the intended land use category of such land; and (b) take into account the value of the land of the intended category in the adjoining areas or vicinity, for the purpose of determination of the market-value of the land being acquired. • In determining the market-value of the building and other immovable property or assets attached to the land or buildings which are to be acquired, the competent authority may use the services of a competent engineer or any other specialist in the relevant field, as may be considered necessary by the competent authority. • The competent authority may, for the purpose of determining the value of trees and plants, use the services of experienced persons in the field of agriculture, forestry, horticulture, sericulture, or any other field, as may be considered necessary by him. • For the purpose of assessing the value of the standing crops damaged during the process of land acquisition proceedings, the competent authority may utilize the services of experienced persons in the field of agriculture as he considers necessary.
20I	Power to take possession	To surrender or deliver possession thereof to the competent authority or any person duly authorized by it in this behalf within a period of 60 days of the service of the notice.
20N	Land Acquisition Act 1 of 1894 not to apply	Nothing in the LA Act, 1894 shall apply to an acquisition under this Act.
20O	Application of the National Rehabilitation and Resettlement Policy (NRRP), 2007 to persons affected due to land acquisition	The Provisions of The NRRP, 2007 For The Project Affected Families, Notified By The Government of India In The Ministry of Rural Development vide number F.26011/4/2007-LRD, dated the 31st October, 2007, shall apply in respect of acquisition of land by the Central Government under this Act.

Flow of the land acquisition process under the RAA 2008 is shown below.



Source: Prepared based on the RAA 2008

Figure 3.1.1 Flow of Land Acquisition Process under the Railways (Amendment) Act, 2008

3.1.14 Land Acquisition Act, 1984 and its Amendment

In India, land is acquired by the Government for a public purpose under the principles of eminent domain, that is, the Government has the first right for land. Land is acquired by Government most commonly under the Land Acquisition Act of 1894 modified in 1984. The amendment of 1984 extended the scope of the definition of public purpose and some of its norms related to time, amount and procedures of compensation. However, the Act in essence remains unchanged. The Act is applicable to the whole of country except the State of Jammu and Kashmir. The land needed for the DFC project will be acquired under the LA Act of 1894 and compensated as per the provisions of Act unless decided otherwise by the Government. Land acquisition under the Act on an average takes two or three years. However, there is a provision of emergency clause under the Land Acquisition Act. This clause is not invoked to acquire land. The compensation as per Land Acquisition Act includes the award amount, 30% solatium and interest of 12% from the date of U/s 4A. The valuation of trees and other immovable properties on the land is compensated based on the rates decided by the competent authority in consultation with concerned departments for the purpose of payment of compensation.

3.1.15 Other Relevant Acts

(1) Ancient Monuments & Archaeological Sites & Remains Act, 1958

The Archaeological Survey of India administers the Ancient Monuments and Archaeological Sites and Remains Act, 1958 to provide for prohibited and regulated areas around monuments of national importance. According to this act, the area falling within 100 m radius from the peripheries of the protected monument is declared as prohibited

area and to the extent of 200 m as a regulated area. No development activity is permitted within a 100 m radius and for the radius between 100 to 200 m, construction could be made only in accordance with the terms and conditions of the licence granted by the Director General of the Archaeological Survey of India. Conservation for the designated protected monuments/sites/remains is addressed by the existing legislation. (However, there are several cultural properties in the project area that are not "protected", but are of significant cultural or religious value to the local community. No procedure exists at present for conservation of these "smaller" cultural properties.)

(2) Ancient Monuments & Archaeological Sites & Remains (Amendment and Validation) Act, 2010

This act has been enacted to amend the Ancient Monuments and Archaeological Sites and Remains Act, 1958 by inserting provisions for validation of certain actions taken by the Government under the principal act and came into force on January 23, 2010. This amended Act has to be interpreted together with the principal act of 1958. The limits of prohibited area and regulated area around the monuments, archaeological sites and remains declared by the Central Government as protected have been specified in the principal act as 100 m and 200 m, respectively. These limits may be further extended on the basis of gradation and classification of the monuments, archaeological sites and remains to be done by the National Monument Authority (NMA), which is to be constituted by the Government under this amended act. The act has also specified the composition, functions and responsibility of the Authority.

As per the provisions of this act, no permission for construction of any public projects or any other nature shall be granted in the prohibited areas of the protected monument and protected area. However, permission for repair and renovation could be granted on the recommendation of the NMA, subject to the condition that the building or structure is pre-1992 or permission for construction or reconstruction of such building or structure was granted by the Archaeological Survey of India. In respect of regulated area, permission may be granted for construction, reconstruction, repair and renovation on the basis of recommendation of the NMA duly taking into account heritage bye-laws which shall be prepared in respect of each protected monument and protected area.

(3) Cultural Environment Related Act, 1958

As a result of growing interest in cultural heritage in the nation, both government agencies and NGOs concerned with the preservation and conservation of this heritage. The Archaeological Survey of India under the Ministry of Culture is the primary organization for the archaeological researches and protection of the cultural heritage of the nation. A maintenance of ancient monuments and archaeological sites and remains of national importance is main concern of the organization. It regulates all archaeological activities in the country as per the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958 as well as Antiquities and Art Treasure Act, 1972.

(4) Regulation / Act governing Vibration

There is no prevailing regulation/standard in India governing train induced ground vibrations. Regulations/standards prevailing in other countries such as USA, Japan, and Sweden, etc. have been reviewed and compared with the findings of vibration monitoring in its respective chapter. Vibration Regulation Law in Japan issued by Ministry of the Environment, Government of Japan stipulates to preserve living environment and contribute to protection of the people's health by regulating vibration. As per this law, standards for vibration emitted from specified construction works and limits for motor

vehicle vibration have been provided for different land use pattern. As per USA Federal Transit Administration, the criteria for environment impact from ground-borne vibration are based on the maximum root-mean- square vibration levels for repeated events from same source. Experience based on international standards provides a good foundation for predicting and controlling annoyance from ground-borne vibrations in residential areas as well as interference with vibration- sensitive activities.

(5) Public Liability Insurance Act, 1991 and its Amendment, 1992

This act imposes on the owner the liability to provide immediate relief in respect of death or injury to any person or damage to any property resulting from an accident while handling any of the notified hazardous chemicals. This relief has to be provided on a "no fault" basis. Owner handling hazardous chemicals has to take an insurance policy of an amount equal to its "paid up capital" or up to Indian Rupees 500 million, whichever is less. The policy has to be renewed every year. New undertakings have to take this policy before the commencement of the activity. The owner also has to pay an amount equal to its annual premium to the Central Government's Environment Relief Fund (ERF). The payment under the Act is only for the immediate relief; owners shall have to provide the final compensation, if any, arising out of the legal proceedings.

(6) National Green Tribunal Act, 2010

The National Green Tribunal has been established on October 18, 2010 under the National Green Tribunal Act, 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. It is a specialized judicial body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues. The Tribunal is not bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by the principles of natural justice. The Tribunal's dedicated jurisdiction in environmental matters is to provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same.

(7) National Green Tribunal (Practices and Procedure) Rules, 2011

The procedure for hearing applications, appeals and other matters under the National Green Tribunal Act, 2010 has been laid down in National Green Tribunal (Practice & Procedure) Rules, 2011 notified vide Government of India Notification dated 4th April 2011. The rules specify the minimum composition of tribunal for hearing an application or appeal, circuit powers of the Chairperson to delegate powers to a judicial member of the Tribunal, procedure for filing application or appeal, place of filing and hearing of appeal, functions of registrar of tribunal, procedure for relief and compensation, procedure for documentation of case and other procedural and administrative matters related to the Tribunal. The Selection Committee comprises of persons of high repute and experts in their field and recommendations of the candidates for appointment as members in the NGT are based purely on merit.

(8) Applicable Cross-Sectoral Laws

There are a number of laws that are cutting across all sectors and development process of the country. Some of these are directly relevant especially during the construction stage and are listed below.

Table 3.1.2 Applicable Cross-Sectoral Laws

Applicable GOI Acts	Year	Objective
Minimum Wages Act	1948	As per this act, the employer is supposed to pay not less than the minimum wages fixed by appropriate Government.
Child Labor (Prohibition and Regulation) Act	1986	This Act prohibits employment of children below 14 years of age in building and construction industry covering Railway.
The Labors Act	1988	The health and safety of workers employed in construction work etc.
The Factories Act	1948	Health and safety considerations for workers
Workmen's Compensation Act	1923	This act provides for compensation in case of injury by accidents arising out of and during the course of employment.
Contract Labor (Regulation and Abolition) Act	1970	This act provides for certain welfare measures to be provided by the contractor to contract labor.
The Building and other Construction Workers Act	1996	All the establishments who carry on any building or other construction work and employ 10 or more workers are covered under this Act. The employer is required to provide safety measures at construction work site and other welfare measures such as canteens, first-aid facilities, ambulance, housing accommodation for Workers near the workplace etc.

3.2 APPLICABLE GUIDELINES AND POLICIES/STRATEGIES

3.2.1 JICA Guidelines for Environmental and Social Considerations, April 2010

Japan International Cooperation Agency (JICA) considers environmental and social considerations as environmental impacts on air, water, soil, ecosystem, fauna and flora as well as social impacts including involuntary resettlement and respect for human rights of indigenous people and so on. Environmental Impact Assessment by JICA means evaluating environmental and social impacts that projects are likely to have, analyzing alternative plans and preparing adequate mitigation measures and monitoring plans in accordance with laws or guidelines of the recipient governments.

While project proponents etc. bear the ultimate responsibility for the environmental and social considerations of projects, JICA supports and examines appropriate environmental and social considerations undertaken by project proponents to avoid or minimize development projects' impacts on the environment and local communities, and to prevent the occurrence of unacceptable adverse impacts. JICA thus promotes sustainable development in developing countries. In these guidelines, JICA has created clear requirements regarding environmental and social considerations, which project proponents must meet. JICA provides project proponents with support in order to facilitate the achievement of these requirements through the preparation and implementation of cooperation projects. JICA examines undertakings by project proponents in accordance with the requirements, and makes adequate decisions regarding environmental and social considerations on the basis of examination results.

3.2.2 JBIC Guidelines for Confirmation of Environmental and Social Considerations, 2002

JBIC established "Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations" on April 1, 2002, as unified guidelines of two environmental guidelines applied to International Financial Operations and Overseas

Economic Cooperation Operations respectively. The Guidelines has been implemented from October 1, 2003.

JBIC Guidelines give guiding principles related to environmental consideration by JBIC in its appraisal of a project. They also give the environmental matters to be considered and environmental measures to be prepared by the recipient country in the planning and preparation stages of a project. Projects have been categorized into three basic categories A, B and C depending upon extent of involvement of significant environmental and social issues similar to other funding agencies such as World Bank and ADB.

As per JBIC guideline, projects must, in principle, be undertaken outside protected areas that are specifically designated by laws or ordinances of the government for the conservation of nature or cultural heritage (excluding projects which primary objectives are to promote the protection or restoration of such designated areas). Projects are also not to impose significant adverse impact on designated conservation areas.

JBIC guidelines focus on participation by stakeholders as local community inhabitants who will be affected by the project. They require the project executor to solicit stakeholders' participation from the project planning stage. The checklist to be confirmed by JBIC now includes social considerations pertaining to resettlement, indigenous people and women. Also more strengthened than in the previous guidelines is a provision on information disclosure. JBIC is required to make public such items as the category classification of the project prior to loan approval.

Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which the project is planned. For projects with a potentially large environmental impact, sufficient consultations with stakeholders, such as local residents, must be conducted via disclosure of information from an early stage where alternative proposals for the project plans may be examined. The outcome of such consultations must be incorporated into the contents of the project plan; appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor and ethnic minorities, all of whom are susceptible to environmental and social impact and who may have little access to the decision-making process within society.

Involuntary resettlement and loss of means of livelihood are to be avoided where feasible, exploring all viable alternatives. When, after such examination, it is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.

People to be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by the project proponents, etc. in timely manner. The project proponents, etc. must make efforts to enable the people affected by the project, to improve their standard of living, income opportunities and production levels, or at least to restore them to pre-project levels.

Appropriate participation by the people affected and their communities must be promoted in planning, implementation and monitoring of involuntary resettlement plans and against the loss of their means of livelihood.

3.2.3 Other Donors' Guidelines for Environmental and Social Considerations

In addition to JICA, other international donors such as the World Bank (WB) and the Asian Development Bank (ADB) are planning to finance the DFC Project for the other

sections in the Eastern Corridor. While each donor applies their own environmental policy for the project, environmental and social considerations should be well harmonized in adequate matter not to cause deviation among the railway sections under the same project on the environmental and social considerations.

Major safeguard policies and environmental guidelines for those donors are shown below:

1) WB

- Operational Policy 4.01 and Bank Procedure 4.01 (OP/BP 4.01): Environmental Assessment, 1999
- OP/BP 4.04: Natural Habitats, 2001
- OP/BP 4.36: Forests, 2002
- OP/BP 4.11: Physical Cultural Resources, 2006
- OP/BP 4.12: Involuntary Resettlement, December 2001
- OP/BP 4.10: Indigenous Peoples, July 2005
- Environmental Assessment Sourcebook, 1991 (updated chapter by chapter)

2) ADB

- The Bank's Policy on Environment, November 2002
- The Bank's Policy on Involuntary Resettlement, August 1995
- The Bank's Policy on Indigenous Peoples, April 1998
- Operations Manual on BP: Environment Considerations, September 2006
- Operations Manual on BP: Involuntary Resettlement, September 2006
- Operations Manual on BP: Indigenous Peoples, September 2006
- ADB Environmental Assessment Guidelines, 2003
- Handbook on Resettlement: A Guide to Good Practice, 1998

3.2.4 The National Environmental Policy (NEP), 2006

The National Environmental Policy (NEP), 2006 is a response to national commitment to clean environment mandated in the Indian Constitution and is intended to mainstream environmental concerns in all development activities. NEP recognizes environmental degradation as a major causal factor in enhancing and perpetuating poverty particularly among the rural poor. One of the key objectives of NEP is to integrate environmental concerns into policies, plans, programmes and projects for economic and social development. This policy has evolved from the recognition that only such development is sustainable, which respects environmental and ecological constraints. In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

3.2.5 National Forest Policies

The Ministry of Food and Agriculture formulated the National Forest Policy to be followed in the management of State Forests in the country long time back in 1952. However, forests in the country have seriously degraded over a period of time. As a result, the Forest Policy was revised in 1988 to review the situation and to evolve a new strategy of forest conservation. The principal aim of new Forest Policy is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which is vital for sustenance of all life forms, human, animal and plant. The derivation of direct economic impact must be subordinated to this principal aim. The policy envisages in enhancing the forest coverage of the country to 33% of total geographical area of the country.

3.2.6 National Rehabilitation and Resettlement Policy, 2007

The National Rehabilitation and Resettlement Policy, 2007 (NRRP 2007) for Project Affected Families (PAFs) have been prepared by the Department of Land Resources, Ministry of Rural Development, and Government of India. The policy stipulates the minimum benefits to be ensured for persons displaced due to acquisition of land for public purposes. The objectives of the Policy are shown below:

- to minimize displacement and to identify the non-displacing or least-displacing alternatives;
- to plan the Resettlement and Rehabilitation of project affected families (PAFs), or project affected households (PAHs), including tribal and vulnerable households;
- to provide improved standard of living to PAFs or PAHs; and
- to facilitate a harmonious relationship between the requiring body and PAFs.

The Policy is applicable to projects displacing 400 or more families *enmasse* in plain areas, or200 or more families *enmasse* in tribal or hilly areas, Desert Development Programme (DDP) blocks, areas mentioned in Schedule V and Schedule VI of the Constitution of India. However, the basic principles of policy can be applied to rehabilitation and resettlement of PAFs regardless of the number of PAFs. The policy provides specific measures for vulnerable and poor groups. As of now there is no law on rehabilitation and resettlement in the country. The Rehabilitation and Resettlement Bill 2007 (Bill No. 98 of 2007) has been introduced in the Lower House (Lok Sabha) of the Indian Parliament.

3.3 OTHER RELEVANT RULES, NOTIFICATIONS AND STANDARDS

3.3.1 Fly Ash Utilisation Notification, 1999 and its Amendment, 2003

As per the provisions of the Fly Ash Notification, 14th September 1999 as amended up to 17th August 2003, under the Environment (Protection) Act, 1986, it is mandatory that every agency, person or organisation shall utilise fly ash for construction of roads or flyovers or embankments or any other construction activity from the thermal power plants located within a radius of 100 kilometres of the construction site. This Notification recognizes that it is necessary to protect the environment, conserve top soil and prevent the dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land. It is envisaged that by effective implementation of the requirements of this Notification, the need for the excavation of top soil for manufacture of bricks shall be restricted and the utilisation of fly ash in the manufacture of building materials and in construction activity shall be promoted.

3.3.2 Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 and its Amendments

The management of hazardous waste is a complex set of rules which together combine to form the legal regime. The objective of these rules is to ensure environmentally sound management of all hazardous materials and to enable recovery and/or use of useful materials from hazardous waste destined for final disposal. Under these rules the definition of hazardous waste is divided into two definitions: hazardous waste and hazardous material. The rules establish the responsibility for the safe and environmentally sound handling of environmental waste by any ‘occupier’ of hazardous waste. An occupier is a person who has under his charge, any plant or factory producing hazardous waste or who holds hazardous waste. ‘Recycling’ is defined as reclamation or reprocessing of hazardous waste in an environmentally sound manner for the original purpose or for other purposes.

'Reuse' means the use of a hazardous waste for a purpose of its original use or other use. Hazardous waste held by an 'occupier' must be sent or sold to a recycler or re-processor who is authorised to dispose of it in the proper manner.

Furthermore, a person engaged in the generation, processing, treatment, package, storage, transportation, use, collection and destruction, conversion, offering for sale and any occupier must obtain an authorization from the respective State Pollution Control Board.

3.3.3 Coastal Regulation Zone Notification, 2011

The Coastal Regulation Zone (CRZ) Notification, 2011 which has replaced the Coastal Regulation Zone Notification of 1991 regulates development activities along coastal stretches. The recent Notification has specifically included the following:

- The definition of CRZ has been widened to include the land area from "High Tide Line" (HTL) to 500 m on the landward side, as well as the land area between HTL to 100 m or width of the creek, whichever is less, on the landward side along tidal influenced water bodies connected to the sea. The CRZ also includes, for the first time, water area up to 12 nautical miles in the sea and the entire water area of a tidal water body such as creek, river, estuary without imposing any restrictions of fishing activities. Thus, the main change in the scope of regulation has been to expand the CRZ to include territorial waters as a protected zone.

- Hazard Mapping Mechanism: The 1991 Notification does not take into account the coastal hazards including the impact of the sea level rise. The hazard mapping based on tides, waves, sea level rise and shoreline change are included and provisions to give adequate safeguards to infrastructure and habitation of local communities incorporated.

- The concept of classification of CRZ into four zones has continued in the 2011 notification with the following delineation:

    - CRZ I- ecologically sensitive areas such as mangroves, coral reefs, salt marshes, turtle nesting ground and the inter-tidal zone.
    - CRZ II- areas close to the shoreline, and which have been developed.
    - CRZ III- Coastal areas that are not substantially built up, including rural coastal areas.
    - CRZ IV- water area from LTL to the limit of territorial waters of India

- Preparation of Action Plans: The 1991 Notification does not lay down adequate measures for the control of the pollution. The State and Union Territory Government are directed to prepare an action plan to mitigate discharge of untreated waste, effluent, sewage including solid waste in a time bound manner. Necessary budget to deal with pollution related activities are to be provided by State/UT Government. The Central Pollution control Board shall monitor the implementation

- Classification of Erosion Prone Areas: The 1991 Notification does not provide for restriction on port development and other fore shore developmental activities along the coasts which are erosion prone. Majority of the erosion being caused is due to anthropogenic activities. Keeping in views this irreversible damage to the coast a provision is incorporated in the amended Notification.

[In the case where the proposed DFC line is passing through mangrove areas in Thane District and creek area in Raigad District as well as the new bridge is to be constructed near Vaitarna and Ulhas Rivers in further change of the project design, clearance under this

new CRZ Notification may be required. Although this Notification does not say specifically for Railway projects, however, in general, construction, operation or decommissioning of projects involving actions which could cause physical changes in the locality (topography, land use, changes in water bodies) have to undergo clearance requirement.]

3.3.4 MoEF Eco-sensitive Area Notifications

Ministry of Environment and Forests, Government of India from time to time has brought out various Notifications on Eco-sensitive area across the country. These Notifications clearly mentions the prohibitive/ restricted activities and the minimum distance to be maintained for any sort of activities. These include non-establishment of any industrial unit adjacent to the eco-sensitive zone, no construction activities to be entertained in the vicinity and quarrying and mining to be strictly prohibited. In addition to the above activities tree felling, ground water extraction, increased noise levels, discharge of effluent and solid waste disposal are also strictly restricted activities in the eco-sensitive areas. The relevant notifications applicable to the DFC Phase 2 Project are listed below:

(1) Aravalli ESA Notification, 1992 and its Amendments

Under Section 3(1) and 3(2)(v) of the Environment (Protection) Act, 1986 and the rule 5(3)(d) of the Environment (Protection) Rules, 1986, this Notification has restricted certain activities in specified area of the Aravalli Range which are causing environmental degradation in the region. This Notification prohibits carrying in on certain processes and operations without prior permission, in the areas specified in the Notification. This includes location of any new industry including expansion/modernisation, mining operations, cutting of trees, construction of any cluster of dwelling units, farm houses, sheds, community centres, and any other activity connected with such construction including the roads, and electrification.

[Since the responsibility of implementation of this Notification lies with the respective States, the applicability of legal procedures to the DFC Project, if any, needs to be confirmed with the District level revenue officials such as Collector, Tehsildar to avoid unforeseen risk at the later stages.]

(2) Dahanu ESA Notification, 1991 and its Amendments

Dahanu area which comes under the Thane district in the State of Maharashtra has mangrove forests, which is considered to be eco-sensitive area and several legislations are supporting to safeguard of the mangrove areas in the district. Through this Notification, the Central Government in consultation with the Government of Maharashtra declared entire Dahanu Taluka as an ecologically fragile area and to impose restrictions on the setting up of industries which have detrimental effect on the environment. Further, an Authority known as Dahanu Taluka Environment Protection Authority (DTEPA) was constituted to exclusively monitor the activities in the area and implement all provisions as mentioned in the Notification.

To verify the provisions of this Notification as applicable to DFC Phase 2 Project, clarification was sought from DTEPA. DTEPA has informed that it has introduced the concept of Pre-afforestation i.e. ten trees are required to be planted and survived for each tree cut. The Deputy Conservator of Forests, Dahanu will prepare Pre-afforestation Scheme for plantation of trees and will give Plans and Estimates for implementation of the Pre-afforestation scheme. DFCCIL will be required to deposit necessary funds/social costs with the Deputy Conservator of Forests, Dahanu for implementation of Pre-afforestation

Scheme. Besides this, no other sort of permission has been indicated by DTEPA to DFCCIL in order to comply with the statutory requirement of this Notification.

3.4 APPLICABLE STATE LEVEL LEGISLATIONS

3.4.1 Important Tree Felling Acts

(1) Maharashtra Felling of Trees (Regulation) Act, 1964 and its Amendments

This Act makes better provision for regulating the felling of certain trees in the State of Maharashtra, for the purpose of the preservation thereof, and for the protection of the soil against erosion. There are restrictions on felling of 16 species of trees which are specified in the Schedule of the said Act (*called as "Scheduled Trees*") in urban areas without the previous permission of the 'tree officer'. An application made to a Tree Officer for felling a tree should contain the name of the owner of land on which the tree stands; number of trees to be felled; and the purpose for felling the trees. The application should be accompanied by a site plan, indicating the position of the trees required to be felled.

Besides this Act, there are tree felling and transit regulations in the State which has put restrictions on felling of some other varieties of trees (*called as "Non-Scheduled Trees"*) in non-urban areas without written permission of the Tehsildar (Revenue official).

Therefore, during the construction of DFC Project in Maharashtra, tree felling permission will be required from the Maharashtra State Forest Department.

(2) Saurashtra Felling of Trees (Infliction of Punishment) Act, 1951

In Gujarat, felling and removal of Limbo, Desi baval, Khijdo, Kanji, Amli and Ambo trees (*called as "Scheduled Trees"*) have been governed by this Act. It is desirable that an equal number of trees need to be planted and cared for a year or more in advance before felling of trees. Such trees planted are normally recorded in revenue records.

Besides this, there are restrictions on felling of twenty six tree species (*called as "Non Scheduled Trees"*) under the tree felling and transit regulations. These trees are divided as reserved and unreserved. For felling a reserved tree or unreserved tree, prior permission of the Deputy Conservator of Forest in writing is mandatory. Similarly, if any tree is felled from wasteland vested in Panchayat, half of the sale value has to be paid to the State. Permission is generally not given for fruit bearing trees while for non-fruit bearing trees, it is given only if the tree measures more than 60 cm in girth.

Therefore, during the construction of DFC Project in Gujarat, tree felling permission will be required from the Gujarat State Forest Department.

(3) Uttar Pradesh Protection of Trees in Rural and Hill Areas Act, 1976

There are certain varieties of trees (called as "Restricted Trees" or "Scheduled Trees") covered under this tree protection Act which is completely protected in all Districts of the State. This Act describes the competent authority that has to authorize felling of trees wherever permission for felling is necessary.

Since the DFC Project alignment is passing through Gautam Buddh Nagar in Uttar Pradesh, tree felling permission has to be obtained from the respective competent authority as described in the Act.

(4) Delhi Preservation of Trees Act, 1994

It provides power to the Tree Authority and responsibility for the preservation of all trees within its jurisdiction. For felling/ removing or dispose of a tree, one shall make an application to the concerned Tree Officer for permission and such application shall be accompanied by attested copies of such documents as may be prescribed in support of ownership over the land, the number and kind of trees to be cut with their girth measure at a height of 1.85 m from ground level and the reasons therefore, copy of *sajra* showing clearly the site and *khasra* numbers of the property. Tree means any woody plant whose branches spring from and are supported upon a trunk or body is not less than 5 cm in diameter at a height of 30 cm from the ground level and is not less than one metre in height from the ground level.

Since, some portion of the Faridabad-Tugalakabad DFC line is falling in the territory of Delhi, the necessary permission has to be obtained before felling of trees.

(5) Tree Felling Procedures in Haryana

Tree felling procedures for restriction and permission in Haryana are mostly governed by internal circulars and guidelines of the State Forest Department. Besides this, the Punjab Land Preservation Act, 1900 is also followed. Recently, seven trees are allowed for cutting without permission to promote agro-forestry in the State. These species are - ailanthus (ulloo neem), bakain, amrood (guava), bamboo, tut (mulberry), eucalyptus (safeda) and poplar.

(6) Rajasthan Tenancy Act, 1955

This Act makes provisions for cutting of trees. According to this Act, a tree can be cut when it is provided for every tree to be felled, two trees are planted. However, permission for felling of trees can be obtained by making an application to the Forest Department mentioning the details of the land plot, number and location of trees to be felled, nature of the tenure and the purpose for which it is being felled.

3.4.2 List of Scheduled and Non-Scheduled Trees

(1) Maharashtra

Scheduled trees: The scheduled trees which require felling permission from the tree officer of the forest department are given in Table 3.4.1.

Table 3.4.1 List of Scheduled Trees in Maharashtra

S. No.	Scientific Name	Vernacular Name	Common Name
1.	*Terminalia chebula*	Hirde	Harad
2.	*Tectona grandis*	Sag	Teak, anjan
3.	*Madhuca latifolia*	Mohua	Mahua
4.	*Tamarindus indica*	Chinch	Imli
5.	*Mangifera indica*	Amba	Aam/keri
6.	*Artocarpus integrifolia*	Fanas	Jack fruit
7.	*Acacia catechu*	Khair	Khair
8.	*Santalam alba*	Chandan	chandan
9.	*Pterocarpous marsupium*	bija	Biyo
10.	*Adina Cardifolia*	hed	haldu
11.	*Ougenis dalbergioidies*	Tiwas	Tiwas
12.	*Terminalia tomentosa*	Ain	Sadad

S. No.	Scientific Name	Vernacular Name	Common Name
13.	*Hardwickia binata*	Anjan	Anjan
14.	*Syzygium cuminii*	jambul	Jamun
15.	*Terminalia peniulata*	Kinjal	Kindal
16.	*Mangroves*		
	Rhizophora mucronata	Mangroves	
	Avicenia marina	Mangroves	
	Avicenia officinalis	Mangroves	
	Rhizophora apiculate	Mangroves	
	Ceriops candolleana	Mangroves	
	Sonneratia acida	Mangroves	
	Acanthus ilicifolius	Mangroves	
	Aegiceras majus	Mangroves	
	Salvadora persica	Mangroves	

Non-Scheduled trees:
Hirda, Sag, Mahua, Imli, Amba, Fanas, Khair, Chandan, Bija, Haldu, Tivas, Ain, Kinjal Anjan and Jampul

(2) Gujarat

Scheduled trees:
Limbo, Desi baval, Khijdo, Kanji, Amli and Ambo trees

Non-Scheduled trees:
Teak, Sandal, Blackwood, Mahua and Khair (Reserved Trees)

Limru, Semat, Sadar, Karanj, Kanji, Shivan, Biod, Rohan, Ebony, Haldu, Lakam, Hadoin, Hirda, Tauras, Ambo, Tar, Khajuri, Jambu, Desi awal, limbro and khijre (Un-reserved Trees)

(3) Uttar Pradesh

Scheduled trees: The scheduled trees which require felling permission from the forest department are given in Table 3.4.2.

Table 3.4.2 List of Scheduled Trees in Uttar Pradesh

S. No.	Scientific Name	Vernacular Name	Common Name
1	*Mangifera indica*	Mango	Aam
2	*Azadirachta indica*	Neem	Neem
3	*Ficus religiosa*	Peepal	Peepal
4	*Ficus bengalensis*	Bargad	Bad
5	*Shorea robusta*	Saal	Sal
6	*Juglans regia*	Akhrot	Akhrot
7	*Madhuca latifolia*	Mahua	Mahua
8	*Quercus spp*	Banj/Khar	Moru / Oak
9	*Cedrus deodara*	Deodar	Deodar
10	*Pterocarpus morsupium*	Beeja Sal	Beyo
11	*Euonymus lacerus*	Angu	Euonymus
12	*Carpinus viminea*	Chamakhdik	Carpinus
13	*Prunus cornuta*	Jamnoi	Himalayan bird cherry

Non-Scheduled trees:
August, Aru, Utis, Casuarina, Jangal Jalebi, Poplar, Parash, Bakain, Babul (Acacia nilotica), Villayati Babul (Prosopis Juliflora), Eucalyptus, Robinia, Wattle, Willow, Siris, Subabul, Avar, Kathber, Kharik, Jamun, Dhak, Palash, Paper Mulbery, Ber, Bhekula, Mehal, Sainjana and Shahtut

(4) Delhi

Since no particular species has been provided in the Act, all trees are covered whose trunk or body is not less than 5cm in diameter at a height of 30 cm from the ground & whose height is not less than 1 m from the ground.

(5) Haryana

Except seven varieties of trees, all other requires permission before felling. These species are - ailanthus (ulloo neem), bakain, amrood (guava), bamboo, tut (mulberry), eucalyptus (safeda) and poplar.

(6) Rajasthan

No specific category or name of tree is given. Therefore, restriction applies to all species of trees.

3.4.3 Mumbai High Court Order on Mangrove Areas

The Mumbai High Court has recently banned non-forest activities in the coastal areas of Maharashtra where mangroves are growing. A division bench of the Court ruled that "no non-forest activities shall be permitted throughout the state in mangrove areas" and such areas shall be treated as deemed 'reserved forests' and attract all provisions of the Forest Conservation Act, 1980.

[It has been revealed during ESIA survey that there are some locations falling within ROW of the proposed DFC alignment in Thane District such as Village Malodhi, Village Kasarali and Wadiv Saravali near Vaitarna Creek, Village Shirgaon and Ulhas River where existing mangrove vegetation might be disturbed. It means the proposals under FCA have to be submitted for necessary permission before cutting and removal of mangrove vegetation in these areas.]

3.4.4 Punjab Land Preservations Act, 1900 and its Amendments

It provides better preservation and protection of entire territory Haryana. This legislation was enacted to save the soil from erosion. It provides power to the State Government to provide for the conservation of subsoil water or the prevention of erosion in any area subject to erosion or likely to become liable to erosion through directives or Notifications.

CHAPTER 4
OVERVIEW OF THE EXISTING ENVIRONMENTAL CONDITIONS OF THE PROJECT AREA

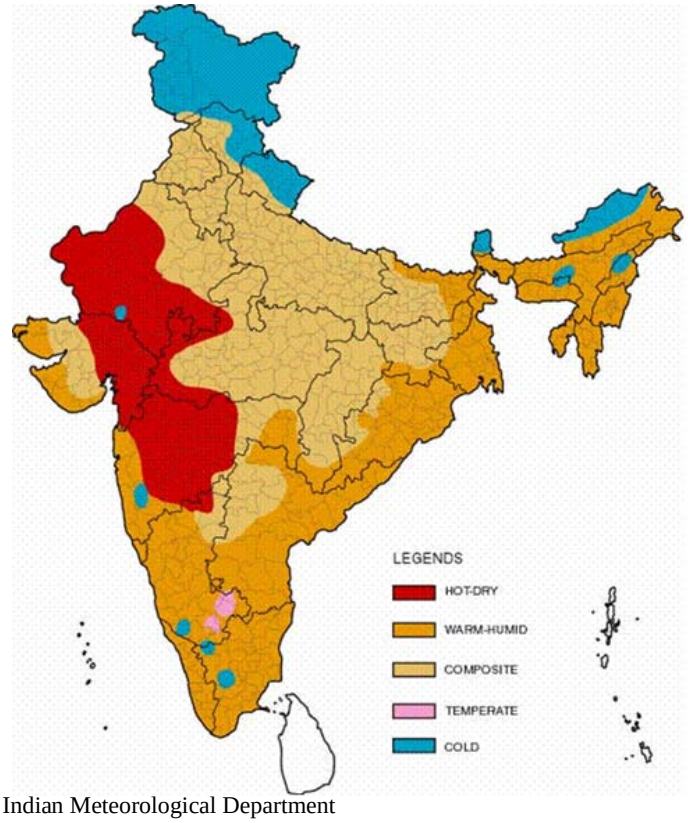
CHAPTER 4 OVERVIEW OF THE EXISTING ENVIRONMENTAL CONDITIONS OF THE PROJECT AREA

4.1 NATURAL ENVIRONMENT

4.1.1 Climate

In general, the climate of India may be broadly described as tropical monsoon type. There are four seasons - winter (January-February), hot weather summer (March-May), rainy south-western monsoon (June-September) and post-monsoon, also known as north-east monsoon in the southern Peninsula (October-December). India's climate is affected by two seasonal winds - the north-east monsoon and the south-west monsoon. The north-east monsoon, commonly known as the winter monsoon blows from land to sea, whereas the south-west monsoon, known as the summer monsoon blows from sea to land after crossing the Indian Ocean, the Arabian Sea, and the Bay of Bengal. The south-west monsoon brings most of the rainfall during a year in the country.

The different sections of the proposed DFC of Phase 2 from JNPT to Vadodara and Rewari to Dadri fall in three broad distinct climatic zones of the country as shown in Figure 4.1.1. The Rewari-Dadri section falls in semi-arid (composite) climatic zone, Gujarat section falls in hot and dry climatic zone and Maharshtra section falls in tropical wet and dry (warm and humid) climatic zone. The climate profile of the districts falling along the corridor including normal monthly rainfall and temperature collected from the Indian Meteorological Department (IMD) and FAO's Climwat data are provided in Table 4.1.1.



Source: Indian Meteorological Department

Figure 4.1.1 Climatic Zone Map of India

Table 4.1.1 Monthly Average of Climatic Parameters for Weather Stations Falling along the Proposed DFC (1980-2007)

Station: Thane*				**Station: Mumbai Alibag****				
	Normal Temperature (°C)		Normal Rainfall (mm)	Normal Temperature (°C)		Normal Rainfall, (mm)	Humidity	Wind
Month	Min	Max	Monthly	Min	Max	Monthly	%	km/day
Jan	17	27.6	1	17.7	28.2	0	60	95
Feb	17.9	28.1	0.4	18.4	28.6	0	62	112
Mar	20.9	30.7	0.3	21.2	30.1	0	67	138
Apr	24.1	32.7	2.3	24.2	31.1	1	75	164
May	27	34	14.3	26.4	31.8	4	77	199
Jun	26.7	32.8	436.9	26	30.8	563	84	311
Jul	25.6	30.7	991.1	25.3	29.2	752	89	518
Aug	25.1	30.1	646.6	24.9	28.8	533	87	432
Sep	24.5	30.6	336.2	24.4	29.2	317	84	207
Oct	23.6	32.7	76.9	23.6	31.2	64	75	112
Nov	20.9	32.1	17.8	20.9	31.3	16	64	95
Dec	18.3	27.6	1.4	18.7	29.7	3	59	86

Station: Mumbai Colaba**						**Station: Navasari****		
	Normal Temperature (°C)		Normal Rainfall (mm)	Humidity	Wind	Normal Temperature (°C)		Normal Rainfall, (mm)
Month	Min	Max	Monthly	%	km/day	Min	Max	Monthly
Jan	19.3	29.6	1	77	164	14.3	29.9	0.4
Feb	20	29.6	1	76	164	15.8	31.3	0.7
Mar	22.6	31.1	0	78	190	19.6	34.6	0.7
Apr	25	32.3	1	80	164	23.2	36.3	1.7
May	27	33.4	9	79	190	25.7	35.9	7.3
Jun	26.3	32	561	89	242	25.9	33.5	267.7
Jul	25.3	30.1	721	92	268	24.7	30.6	756.2
Aug	24.9	29.6	474	92	268	24.3	29.9	478.7
Sep	24.9	30.5	291	87	164	23.9	31.4	286.6
Oct	24.8	32.5	55	85	147	22.3	34.2	38.7
Nov	23	32.9	13	79	147	18.5	33.2	12.8
Dec	20.9	31.6	4	80	164	15.4	31.1	1.3

Station:Valsad*				**Station: Bharuch***		
	Normal Temperature (°C)		Normal Rainfall, (mm)	Normal Temperature (°C)		Normal Rainfall (mm)
Month	Min	Max	Monthly	Min	Max	Monthly
Jan	14.5	28.2	0.6	13.9	30.2	0.7
Feb	15.4	29.1	0.6	15.7	32.2	0.6
Mar	18.9	32	0.7	19.9	36.3	0.7
Apr	22.9	33.2	1.9	23.8	38.8	3
May	26	33.4	7.2	26.5	38.8	6.3
Jun	26.1	32.2	321.4	26.7	35.8	136.3
Jul	24.8	29.9	803.8	25.5	31.9	323.9
Aug	24.4	29.2	522.3	24.8	30.9	229.5
Sep	23.9	30.4	299	24.5	32.8	167.5
Oct	22.2	32.9	39.5	22.6	35.6	25.6
Nov	18.5	32.4	14.7	18.4	33.8	10.1
Dec	15.3	30.3	0.9	15.1	31.2	1.2

Station:Vadodara*						**Station:Surat ****				
	Normal Temperature (°C)		Normal Rainfall,mm	Humidity	Wind	Normal Temperature (°C)		Normal Rainfall,mm	Humidity	Wind
Month	Min	Max	Monthly	%	km/day	Min	Max	Monthly	%	km/day
Jan	12.7	29.6	2	48	170	14.4	30.5	0	56	86
Feb	14.2	32.7	0	41	156	15.6	31.7	0	58	86
Mar	18.5	36.5	0	35	161	19.4	35.5	1	44	104
Apr	22.9	39.7	0	36	175	23.3	37.2	0	52	112
May	26.8	40.6	5	46	290	26.1	36.1	4	72	173
Jun	27	36.7	121	63	374	26.7	33.9	249	83	190
Jul	25	32.1	305	80	312	25.5	30.5	446	90	181
Aug	24.9	31.1	283	81	257	25	30.5	298	88	173
Sep	24.4	32.7	171	76	189	24.4	31.7	174	83	112
Oct	21.4	34.9	45	62	153	22.2	34.4	34	58	95
Nov	16.4	33.3	3	56	156	18.3	33.3	14	54	104
Dec	13.5	31	0	52	146	15	31.1	2	58	95

Station: Rewari*				**Station: Alwar***		
	Normal Temperature °C		Normal Rainfall (mm)	Normal Temperature °C		Normal Rainfall (mm)
Month	Min	Max	Monthly	Min	Max	Monthly
Jan	5.9	21	11.4	7.8	22.3	8.8
Feb	8.2	24	9.9	10.3	25.6	9
Mar	13.1	29.9	7.7	15.6	32	5.8
Apr	19.4	36.9	4.9	21.7	38.3	4.7
May	24.4	40.3	13.6	26.2	41.5	16.7
Jun	26.7	40.1	37	27.7	40.4	43.1
Jul	26.2	35.8	164.8	26.1	34.8	199.3
Aug	25.3	34	204.8	25	33.1	207.9
Sep	23.5	34.5	82.2	23.7	34.4	103.1
Oct	17.8	33.5	16.7	19.4	34.3	18.4
Nov	11.5	28.9	3.9	13.5	29.6	3.3
Dec	23.3	23.3	4.8	8.8	24.5	5

Station: Faridabad*				**Station: Gurgaon***		
	Normal Temperature (°C)		Normal Rainfall, mm	Normal Temperature (°C)		Normal Rainfall, mm
Month	Min	Max	Monthly	Min	Max	Monthly
Jan	6.7	20.9	10.2	5.8	21.1	12.1
Feb	9.2	23.7	8.8	8.3	23.7	10.3
Mar	14.2	29.6	6	13.1	29.9	8.5
Apr	20.3	36.6	3.7	19.1	37	5.8
May	25	40	7.1	24.1	40.4	10.6
Jun	27.3	39.4	30.3	26.7	39.8	37.2
Jul	26.7	35.2	176.4	26.3	35.2	184.4
Aug	26	33.8	158.3	25.5	33.7	189
Sep	24.1	34.1	95.3	23.4	34.1	97.4
Oct	18.4	33.1	20.1	17.4	33.2	20.3
Nov	12	28.5	2.8	11.1	28.6	3.6
Dec	7.5	23	2.4	6.6	23	4

Source: * IMD, ** FAO-CLIMWAT

(1) JNPT-Vadodara Section

1) Raigad District

The climate of the district is typical of that on the west coast of India and characterized by plentiful and regular seasonal rainfall, oppressive weather in summer and high humidity throughout the year. The summer season from March to May is followed by the south-west monsoon season from June to September. October and November form the post-monsoon or the retreating monsoon season. The period from December to February is the cold season. The annual mean minimum temperatures are 17.7°C and mean maximum temperature is 31.8°C. The south-west monsoon commences by about the first week of June and the rains continue till about the beginning of October. The average annual rainfall for the district as a whole is 3,030 mm. Nearly 95% of the annual rainfall is received during the south-west monsoon months, and the rainfall in October forms the major portion of the rest. July is the month with the heaviest rainfall, the same being 38% of the annual rainfall. The year-to-year variations in the annual rainfall of the district are not large. On an average there are 94 rainy days in a year. The air is humid throughout the year. Relative humidity is on an average over 80% during the south-west monsoon season. In the rest of the year, the relative humidity is between 65% and 75%.

Winds are very strong and blow from west or south-west during monsoon season. During the period from October to December winds are generally moderate but sometimes strong in October and blow from directions between north-east and south-east. In the three months from January to March the winds continue to be moderate and are predominantly from directions between north and east. In April while there is a slight strengthening of wind, the direction is variable. In May there is a further strengthening of winds and the directions are between south-west and north-west.

The rainfall in the area varies spatially as well as with time. The average monthly rainfall of Raigad District for the period 2006-2010 is given in Table 4.1.2.

Table 4.1.2 Monthly Rainfall Data of Raigad District (2006-2010)

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2006	0.0	0.0	1.1	0.0	73.2	568.3	1,427.0	1,184.2	365.1	210.6	2.4	0.0
2007	0.0	0.0	0.0	5.1	0.1	1,086.6	1,024.3	1,062.8	558.6	8.6	11.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	815.4	912.9	965.5	542.2	86.2	0.4	0.6
2009	0.0	0.0	0.0	0.0	0.1	205.4	1,185.3	287.5	349.3	228.9	203.3	0.0
2010	0.0	0.0	0.0	0.5	0.0	508.3	1,372.6	946.0	520.2	131.0	95.9	0.0

Source: Indian Meteorological Department (IMD)

2) Thane District

The climate of Thane District is characterised by high humidity nearly all the year round, an oppressive summer season, and well-distributed and heavy rainfall during the south-west monsoon season. The year may be divided into four seasons. The cold season from December to February is followed by the summer season from March to June. The south-west monsoon season is from June to September. October and November constitute the post-monsoon season. The average annual rainfall in the district is 2,300 mm. The rainfall in the district increases from the coast towards the interior. The rainfall varies from 1730 mm at Mahim on the coast to 2,600 mm at Shahapur in the interior. The rainfall during the south-west monsoon season, June to September, constitutes about 94% of the annual rainfall. July is the heaviest rainfall month with a rainfall of about 40% of the annual total. The variation in the annual rainfall from year to year in the district is not large.

Being a coastal district, the variation in temperature during the day and between the seasons is not large. After February, temperatures progressively increase till May which is the hottest month with the mean daily maximum temperature at 33°C. In the summer season and in June before the onset of the monsoon, day temperature may sometimes go above 37°C in the coastal parts while in the interior it may be a couple of degrees higher. The oppressive heat is on most days relieved by cool sea-breezes particularly in the coastal regions. Owing to the proximity of the sea, the district is on the whole very humid nearly all the year round.

The rainfall in the area varies spatially as well as with time. The average monthly rainfall of Thane district for the period 2006-2010 is given in Table 4.1.3.

Table 4.1.3 Monthly Rainfall Data of Thane District (2006-2010)

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2006	0.0	0.0	0.3	0.0	32.8	489.7	1153.7	1073.1	284.0	105.7	0.0	0.0
2007	0.0	0.0	0.0	0.0	0.0	512.5	723.7	957.4	401.0	0.0	0.1	0.0
2008	0.0	0.0	0.0	0.0	0.0	528.0	925.1	846.5	443.9	37.7	0.1	0.1
2009	0.0	0.0	0.0	0.0	0.0	131.1	1290.5	176.2	203.2	189.2	62.9	0.0
2010	0.0	0.0	1.4	0.0	0.0	380.4	1007.2	851.1	426.1	94.3	80.2	0.0

Source: Indian Meteorological Department (IMD)

3) Valsad District

The general climate of the district is characterized by three well defined seasons - summer from March to middle of June, monsoon from middle of June to middle of October and winter from middle of October to February. The annual average rainfall is about 1500 mm to 2,200 mm.

4) Navsari District

The general climate of the district is sub-tropical and is also characterized by three well defined seasons. Weather in the district is sunny from September to May, rainy from June to August. The average maximum and minimum temperatures are 40°C and 18°C, respectively. The annual average rainfall is about 2,000 mm.

5) Surat District

The general climate of the district is sub tropical and is characterized by three well defined seasons - summer from April to June, monsoon from July to September and winter from October to March. The monthly average minimum temperature is about 14.4°C in January and maximum of 26.7°C in the month of July. The rainy seasons confine to mainly June to September. The annual average rainfall is about 1,000 mm to 1,200 mm.

6) Vadodara District

There are three main seasons in Vadodara District - summer, monsoon and winter. The weather is hot through the months of March to July and the average summer maximum temperature is 36°C, and the average minimum is 23°C. From November to February, the average maximum temperature is 30°C, the average minimum is 15°C, and the climate is extremely dry. Cold northerly winds are responsible for a mild chill in January. The southwest monsoon brings a humid climate from mid-June to mid-September. The annual average rainfall is about 1,000 mm, but infrequent heavy torrential rains cause the rivers to flood in the area.

7) Bharuch District

The weather of Bharuch District is hot and dry starting from mid-March till mid-June. While from mid-June till end of September weather remains humid and can be considered pleasant. From October-November weather is bit hot. From December to February climate remains cool. The average minimum temperature at Bharuch is about 13.9°C in the month of January whereas the average maximum is about 38.8°C in the month of April-May. The rainy days mainly confine from June to September. The annual average rainfall is about 800 mm. The average maximum rainfall of 325 mm comes in July.

(2) Rewari-Dadri Section

1) Rewari District

The climate of Rewari District can be classified as tropical steppe, semiarid and hot which is mainly dry with very hot summer and cold winter except during monsoon when moist air of oceanic origin penetrates into the district. There are four seasons in a year. The hot weather season starts from mid March to last week of the June followed by the south west monsoon which lasts up to September. The transition period from September to October forms the post monsoon season. The winter season starts late in November and remains upto the first week of March.

The normal monsoon and annual rainfall of the district is 489 mm and 553 mm respectively, which is unevenly distributed over the area over 23 days. The south west monsoon sets in from last week of June and withdraws in the end of September, contributing about 88% of annual rainfall. July and August are the wettest months. The remaining 12% rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms. Generally rainfall in the district increases from southwest to northeast. The mean minimum and maximum temperature in the area ranges from 5.6°C to 41°C in January and May or June, respectively.

2) Alwar District

The climate of the district can be classified as semi-arid. Hot summer, cold winter and a fairly good monsoon season characterize it. The normal rainfall in the district is 610 mm. The cold season starts from middle of November and continues till the end of February. January is the coldest month of the year with mean daily maximum temperature at 21.8°C and mean daily minimum temperature at 7.7°C. Both day and night temperatures increase rapidly from March onwards. May and June are the hottest months of the year. There is appreciable fall in temperature with onset of south-west monsoon by the end of June. After the withdrawal of monsoon in mid-September, the day temperature increases for a brief period. The night temperature however, continues to fall gradually.

The air is generally dry except in the south-west monsoon season. In the summer months, the relative humidity is very low, often less than 20% in the afternoon. However, the relative humidity values are much higher during monsoon season. August is the most humid with mean daily relative humidity of 80% in the morning and 70% in the afternoon. Winds are strongest (13.1 km/hr) in June and lightest (5.6 km/hr) in November. The micrometeorological data of the district reveals that in most of the time, the calm conditions prevail. The predominant wind directions are NW, SW, SE and NE. During the cold weather periods, the winds are generally light. Violet and dust raising winds are experienced in the entire district during summer. Winds are generally stronger over the western part of the district than the eastern part.

3) Mewat District

The climate of the district can be classified as semi-arid and hot which is mainly characterized by the extreme dryness of the air except during monsoon months, intensely hot summers and cold winters. During three months of south west monsoon from last week of June to September, the moist air of oceanic origin penetrate into the district and causes high humidity, cloudiness and monsoon rainfall. The period from October to December constitutes post monsoon season. The cold weather season prevails from January to the beginning of March and followed by the hot weather or summer season which prevails up to the last week of June.

The normal annual rainfall in Mewat District is about 594 mm spread over 31 days. The temperature varies from mean maximum of 40°C (May and June) to mean minimum of 5.1°C (January). Humidity is considerably low during the greater part of the year. During the monsoon, the sky is heavily clouded, and winds are strong during this period. Winds are generally light during the post-monsoon and winter months. Mewat experiences a high incidence of thunderstorms and dust storms, often accompanied by violent squalls during the period from April to June. Sometimes the thunderstorms are accompanied by heavy rain and occasionally by hailstorms. In the winter months, fog sometimes appears in the district.

4) Gurgaon District

The climate of the district can be classified as tropical steppe, semi-arid and hot which is mainly characterized by the extreme dryness of the air except during monsoon months, intensely hot summers and cold winters. During three months of south west monsoon from last week of June to September, the moist air of oceanic origin penetrate into the district and causes high humidity, cloudiness and monsoon rainfall. The period from October to December constitutes post monsoon season. The cold weather season prevails from January to the beginning of March and followed by the hot weather or summer season which prevails up to the last week of June. The normal annual rainfall in Gurgaon District is about 596 mm spread over 28 days. The south west monsoon sets in the last week of June and withdraws towards the end of September and contributes about 85% of the annual rainfall. July and August are the wettest months. 15% of the annual rainfall occurs during the non-monsoon months in the wake of thunder storms and western disturbances. The temperature variation in the district is from mean maximum of 40°C (May and June) to mean minimum 5.1°C (January).

5) Faridabad and Palwal Districts

The climate of Faridabad and Palwal Districts can be classified as tropical steppe, semiarid and hot which is mainly characterized by the extreme dryness of the air except during monsoon months. During three months of south west monsoon from last week of June to September, the moist air of oceanic penetrate into the district and causes high humidity, cloudiness and monsoon rainfall. The period from October to December constitutes post monsoon season. The cold weather season prevails from January to the beginning of March and followed by the hot weather or summer season which prevails up to the last week of June. The normal annual rainfall in these two districts is about 542 mm spread over 27 days. The south west monsoon sets in the last week of June and withdraws towards the end of September and contributes about 85% of the annual rainfall. July and August are the wettest months 15% of the annual rainfall occurs during the non-monsoon months in the wake of thunder storms and western disturbances. The mean maximum temperature is 41°C (May and June) and minimum temperature is 8°C in January.

6) Gautam Buddha Nagar District

The district is endowed with typical climate with extremes in summer as in winters. The mercury shoots up to 40°C or even more during peak summer and dips to less than 5°C. The rainfall in the area is mainly due to southwest monsoon and nearly 80% to 85% of the annual rains occur between July and September. Remaining 15% to 20% rain is distributed unevenly, some time rain also occurs between January and March. The normal annual rainfall of the district has been reported to be 731 mm. There is a large variation in rainfall in space and time.

4.1.2 Ambient Air

The ambient air quality status of criteria pollutants for major cities falling within the DFC Phase 2 Project area is given in Table 4.1.4. The pollution level classification based on the concentration of pollutants is given in Table 4.1.5. Relatively higher to critical levels of respirable fraction of total Suspended Particulate Matter (SPM) in the form of PM_{10} are observed in the ambient air of most of the cities. These values for some of the cities are well above the permissible values prescribed in the Revised National Ambient Air Quality Standards, 2009.

The levels of sulphur dioxide are even below the prescribed values for the notified ecologically sensitive areas in most of the cities. The levels of nitrogen dioxide are showing the trends of values closer towards or slightly above the prescribed standard for industrial, residential, rural and other areas.

Table 4.1.4 Ambient Air Quality in year 2010 based on Pollution Level Classification

City	SO_2 ($\mu g/m^3$)	Air Quality	NO_2 ($\mu g/m^3$)	Air Quality	PM_{10} ($\mu g/m^3$)	Air Quality
JNPT-Vadodara Section						
1) Maharashtra						
Navi Mumbai, Raigad (R)	15	Low	42	Morerate	111	Critical
Thane (R)	13	Low	19	Low	58	Morerate
2)Gujarat						
Surat, (R)	19	Low	26	Morerate	93	Critical
Vadodara, (R)	16	Low	30	Morerate	86	High
Ankaleshwar, Bharuch, (I)	19	Low	41	Morerate	118	Critical
Rewari-Dadri Section						
Noida (R)	11	Low	22	Low	155	Critical
Faridabad (R)	14	Low	31	Morerate	115	Critical
Alwar (S)	8	Low	23	Morerate	153	Critical
Delhi (R)	9	Low	49	Morerate	243	Critical

Note: Abbreviations are defined as follows:

1. Area Type: R-Residential, I-Industrial, S-Sensitive Receptors including religious places, hospitals, schools, etc.
2. Air Quality Categories:

The air quality is categorized into 4 broad categories based on an Exceeding Factor EF (the ratio of annual mean concentration of a pollutant with that of a respective standard) The EF is defined as below:

EF=Observed annual mean concentration of criteria pollutant/annual standard for the respective pollutant and area class. Four air quality categories are as follow:

- Critical pollution (C): when EF is more than 1.5;
- High pollution (H): when the EF is between 1.0-1.5;
- Moderate pollution (M): when the EF between 0.5-1.0; and
- Low pollution (L): when the EF is less than 0.5.

Source: National Ambient Air Quality Status 2010, Central Pollution Control Board

Table 4.1.5 Ambient Air Quality Pollution Level Classification Based on Concentration of Pollutants

Pollution Level	Annual Mean Concentration Range (µg/m^3)			
	Industrial, Residential, Rural & Other Area			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Low (L)	0-30	0-20	0-30	0-20
Moderate (M)	30-50	20-40	30-60	20-40
High (H)	50-80	40-80	60-100	40-60
Critical (C)	>80	>80	>100	>60

Source: Central Pollution Control Board, 2010

The Central Pollution Control Board has recently done a nation wide environmental assessment of different areas in the country based on Comprehensive Environmental Pollution Index (CEPI) and 43 such areas having CEPI greater than 70, on a scale of 0 to 100, has been identified as critically polluted. The Government has imposed a temporary moratorium on any new activities related to the developmental projects in critically polluted areas. Some of these areas which fall within DFC Phase 2 project area include – Faridabad in Haryana, Noida in Gautum Buddh Nagar, Dombivali in Thane, Navi Mumbai in Raigad, and Ankaleshwar in Bharuch. Although the temoprary ban is primarily on industrial related activities, but because of worsening conditions of ambient air quality levels in these areas, the local pollution control authories may from time to time can also put restriction or stringent control even on construction related activities for infrastructure projects.

4.1.3 Physiography

(1) JNPT-Vadodara Section

1) Maharashtra section

The dominant physical trait of the Maharshtra State is its plateau character. The Sahyadri Range is the physical backbone of Maharashtra, rising on an average to an elevation of 1000 m, it falls in steep cliffs to the Konkan on the west. Eastwards, the hill falls in steps through a transitional area known as Mawal to the plateau level. The series of crowning plateau on the crest forms a distinctive feature of the Sahyadri Range.

The Konkan, lying between the Arabian Sea and the Sahyadri Range is narrow coastal lowland, barely 50 km wide. Though mostly below 200 m, it is far from being a plain area. Highly dissected and broken, the Konkan alternates between narrow, steep-sided valleys and low laterite plateau.

Forests comprise about 17% of the state area and are mainly in the eastern region and the Sahyadri Range. The open scrub is in the plateau. The soils of Maharashtra are residual, derived from the underlying basalts. In the semi-dry plateau, the regur (black-cotton soil) is clayey, rich in iron, but poor in nitrogen and organic matter; it is moisture-retentive.

Thane and Raigad Districts are part of the north Konkan Region that lies towards the west of the Sahyadri Ranges. In this region the Sahyadri re-curves inwards and recedes further eastwards.

2) Gujarat section

The state of Gujarat is situated on the west coast. It is bounded by the Arabian Sea on the west, the states of Rajasthan on the north and Madhya Pradesh on the north-east and on the

east and Maharashtra on the south and south-east of the state. The main rivers of the state are Banas, Sabarmati, Mahi, Tapi and Narmada.

Surat, Valsad, Vadodara and Navsari Districts come under the 'main land Gujarat' regions. Based on the categories of physiographic units as relief, slopes and land forms, the state is divided into three parts - the coastal areas, the plains, the eastern highlands. The coastal areas from the Damanganga River upwards north is a narrow coastal belt which is mainly a barren strip of silt and salt marshes which broadens north towards Bharuch District and becomes fertile. The Plains are also small strips in these two districts as they merge with the eastern highlands in Bharuch and Surat Districts and nearly disappear in the south of Surat. The eastern highlands consist of the Vindhya, Saputara and Sahyadris mountain ranges.

(2) Rewari-Dadri Section

1) Rewari District

Rewari District can be divided into four terrain classes' viz. barren rocky/stony waste/sheet rocky, sandy plain with sand dunes, old flood plains and occasional hillocks and undulating uplands with or without scrub. Generally physical condition of terrain and its evolution is the result of poly-cyclic activities and also affected by the change of climate. The Aravalli consist of organic and volcanic action and presently it is undergoing weathering and denudation. The hills traverse through western part of district roughly in south west to north east direction.

2) Alwar District

The district is a fairly regular quadrilateral in shape. The Aravalli range forms ridges of rocky hills for the most part and are parallel. It makes its appearance in the district from the northeast in Tijara subdivision and runs southwards forming the boundary of the district in the northeast for about 24 km, almost parallel to Alwar-Delhi road, terminating near Nowgaon. Another range, a continuation of the Aravallis, comes into prominence at Mandawar and passes through Jindoli and Alwar towards the extreme southwestern corner of the district to the Jaipur boundary. This uninterrupted chain of hills runs for about 81 km from south to north and intersects the district into two parts.

These hills are low in the north and east of the district but become more prominent and more precipitons from the eastern border towards Alwar town and from north to south and congregate in the south. They cover nearly the whole of Thanagazi and Rajgarh Tehsils and about one-third of Alwar Tehsil and form important features in Bansur, Kishangarh and Tijara Tehsils. They enclose between them fertile valleys and high land, which are reserved forests, thickly wooded with spontaneous growth.

3) Mewat District

Mewat District largely comprises of planes. Inconsistency in Mewat topography is evident from its patches of land with hills and hillock of the Aravalli on the one hand and plains on the other. Thus, physiographically the area is divided into two tracts- upland and low land.

4) Gurgaon District

The area is conspicuously flat topography however, in the north-eastern part small isolated hillocks of Precambrian rocks are exposed. The alluvial plain is formed by the Sahibi River which is tributary of Yamuna River.

5) Palwal District

Palwal District has monotonous physiography and has alluvium deposits. The alluvial plains have been divided into two units. Khadar that is low lying flood plain of newer alluvium and Banger, an upland plain made of older alluvial and is spread towards west. The general slope in the district is towards east. The levelled surface, fertile alluvial soil and facilities for irrigation make the district beast suited for intensive cultivation.

6) Gautam Buddha Nagar District

Gautam Buddha Nagar District falls under northern plains category of physiographic zones. It belongs to area of highly fertile alluvial soils, flat topography with average slope of 2 m/km. The Hindon and Yamuna Rivers flows through this district. Surajpur Lake is also a prominent feature of the area.

4.1.4 Land Use

Land use distribution of the proposed DFC corridor project area have been mapped through satellite imageries and confirmed through site survey along the entire corridor route within 100-150 m on both sides of the alignment. Agricultural land with varying degree of fertility, and crop pattern is forming the major land use category in both JNPT-Vadodara and Rewari-Dadri sections. Most of these agricultural lands are under the influence of rapid urbanization as the project area lies closer to the major cities. The other land use categories are recorded forest areas, hilly areas, wastelands, water bodies comprising important, major and minor rivers, low lying areas, barren and salt affected areas.

Land use classification survey reveals that in JNPT-Vadodara section, the agricultural area is nearly 30.4% as compared to 72% in Rewari-Dadri section. This is mainly due to the fact that the entire Rewari-Dadri mainline as well as the major part of TKD line is a detour route whereas in JNPT-Vadodara section, the detour part is about 29%. The wasteland and low land area together constitute about 30.3% area in JNPT-Vadodara section and 19.4% in Rewari-Dadri section.

Table 4.1.6 Land Use Distribution in Study Area

Category of Land Use	JNPT-Vadodara Section (%)	Rewari-Dadri Section (%)
Agriculture	30.4	72.0
Recorded Forest	8.9	1.5
Barren Land	11.3	1.1
Waste Land	16.2	19.4
Water Body	1.65	0.5
Hill	3.25	-
Low Land	14.1	-
Human Settlement	14.2	5.5

Note:

a) The above distribution is based on the land use category falling within 100-150 meters on both sides of the DFC alignment.
b) Agriculture - It refers to both irrigated and unirrigated cultivable lands on which atleast one crop is taken every year
c) Recorded Forest Area – The area recorded as a forest in the Government records.
d) Barren Land – It refers to the rocky, swampy, salty or uncultivable land
e) Wasteland – It refers to the land under non-agricultural use for a longer time and has become barren or overgrown
f) Water Body – It refers to rivers, ponds, canals, lakes or any other area where water remains most of the time in a year
g) Hill – It refers to the elevated rocky hills
h) Low Land – It refers to the area having lower level than the general elevation in the vicinity
i) Settlement – It refers to the habitation, school or any other building complex

Source: JICA survey team

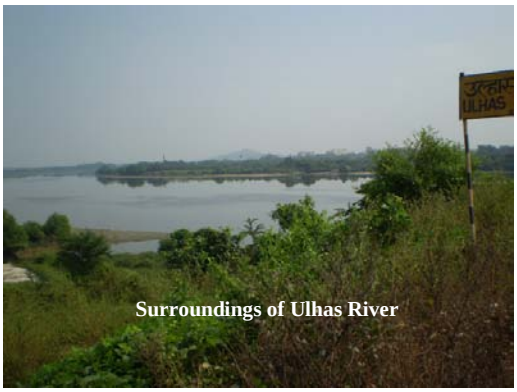
4.1.5 Water Resources

(1) JNPT-Vadodara Section

1) Maharashutra section

The proposed project crosses over Ulhas River and Vaitarna River in Thane District of Maharashtra.

a) Ulhas River

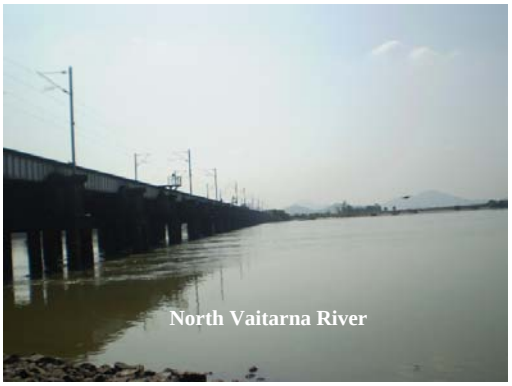


Surroundings of Ulhas River


DFC alignment will be parallel to the existing rial bridge over Ulhas River

The Ulhas River enters Thane District through neighbouring Raigad District. This river has its source in the Borghat and meets the Arabian Sea at the Vasai Creek. The total length of the Ulhas from its origin to its outfall in to the Arabian Sea is 122 km.The important tributaries of Ulhas River are Bharvi, Bhatsa and Kalu Rivers. The Kalu and Bhasta are the major right bank tributaries which together accounts for 56% of the total catchment area of Ulhas. The Ulhas River branches out in two directions near Thane. The western distributary of this river flows into the Thane creek. The Datiware creek in Palghar taluka is near the mouth of the Vaitarna River.

b) Vaitarna River


North Vaitarna River


South Vaitarna River

The Vaitarna River rises in the hills near Trimbak in the Nashik District and enters Thane District at Vihigaon in Shahapur Tehsil. After running for 120 km in Maharashtra towards west, it falls in the Arabian Sea. The catchment area of the river basin is 3,637 km^2. It further passes across northern boundary of Shahapur Tehsil to enter Wada Tehsil near Nishet Village and then taking east-west course through the middle of Wada Tehsil. It enters Palghar Tehsil and runs in north-west direction up to Manor, from where it turns south-west and southwards up to Navghar Village forming Vaitarna creek at the south of Palghar Tehsil. The important tributaries of Vaitarna are Pinjal, Daherja, Surya and Tansa.

2) Gujarat section

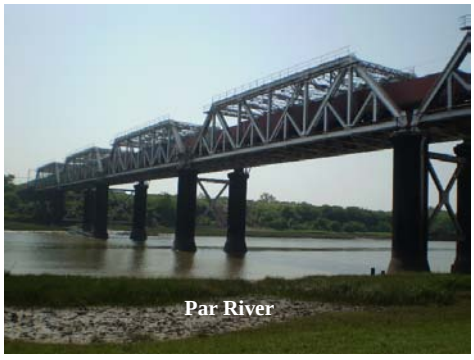
The proposed project crosses over number of rivers in Gujarat. These rivers are – Damanganga, Par, Auranga in Valsad District; Kaveri (South and North), Ambika, North Poorna, Mindhola in Navsari District; Tapi in Surat District; and Narmada in Bharuch District.

a) Damanganga River


Damanganga River

The Damanganga River travels a distance of about 130 km before it drains to the Arabian Sea at Daman. The major tributaries of the Damanganga River are Dawan, Shrimant, Val, Rayate, Lendi, Wagh, Sakartond, Roshni, Dudhni, and Piperiya. The total drainage area of the basin is 2,318 km^2, out of which 495 km^2 area falls in Valsad District of Gujarat.

b) Par River


Par River

The Par River is one of the important west flowing rivers in the region, north of Mumbai and south of the Tapi River. The river rises in the Sahyadri Hill ranges at an elevation of about 1,100 m above mean sea level in Nasik District of Maharashtra State and traverses a distance of 131 km before draining into the Arabian Sea. The Par basin lies in the states of Maharashtra and Gujarat and has a total catchment area of 1,664 km^2. The percentages of the area of the basin in the states of Maharashtra and Gujarat are 47% and 53%, respectively. The effective drainage area of the river in Gujarat is 875 km^2 since 16 km^2-area near the mouth is low-lying and cannot be beneficially utilised.

c) Auranga River


Auranga River

Like the Par River, the Auranga River is also one of the important west flowing rivers in the region north of Mumbai City and south of Tapi River. The river is known as Auranga after the confluence of its two tributaries such as the Man and the Tan. The river traverses a distance of about 30 km from confluence of the tributaries before draining into the Arabian Sea. The Auranga basin extends over an area of 787 km^2, out of which 150 km^2 is in Maharashtra State and 637 km^2 is in Gujarat State. The effective drainage area of the basin in Gujarat State is 598 km^2 since 39 km^2 area near the mouth is low-lying, marshy and cannot be beneficially utilised.

d) Ambika River


Ambika River

After flowing for a length of about 135 km, the Ambika River drains into the Arabian Sea. The important tributaries of the Ambika River are

Kapri, Wallan, Kaveri and Kharera, with a total drainage area of 2,715 km^2, out of which 2,613 km^2 lies in Gujarat.

e) North Poorna River

The Poorna River is an important west flowing river with its catchment in Gujarat and Maharashtra. The length of the river from its source to outflow in the Arabian Sea is about 180 km. The important tributaries of the river are Dhodar nala, Bardanala, Nagihpar nala, Girna River, Zankari River and Dumas khadi. The catchment area of the Poorna basin is 2,431 km^2, out of which nearly 98% lies in the Gujarat State.


N. Poorna River

f) Mindhola River

The Mindhola River is a small west flowing river with its catchment lying entirely in the Gujarat state. The basin has a drainage area of 1,180 km^2. The effective drainage area of the river is 1,056 km^2 since 124 km^2 near the mouth is low-lying, marshy and affected by tides. The important tributaries of the river are Khalikhadi, Vijarakhadi, Ghabai Nadi and Chickkhadi Rivers.


Mindhola River

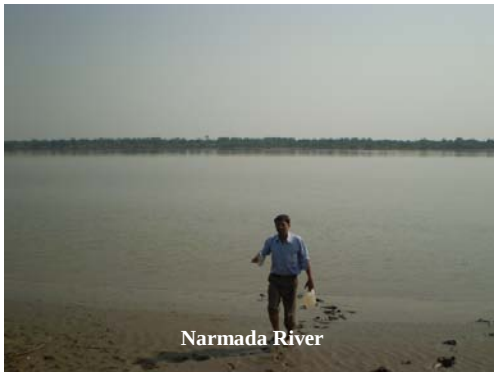
g) Tapi River

The Tapi River is the second largest westward draining interstate river basin. The Tapi River drains an area of 65,145 km^2, out of which nearly 79% lies in Maharashtra, 15% in Madhya Pradesh and 6% in Guajarat. The total length of this west flowing river from its origin to its out fall into the sea is 725 km. Traversing a length of 214 km in Gujarat, the Tapi River joins Arabian Sea in the Gulf of Cambay after flowing past the Surat city. The river receives tidal influence for a length of about 25 km upstream from the mouth. There are several major tributaries namely the Vaki, Gomai, Arunavati and Aner joining the Tapi River. Nesu, Amaravati, Buray, Panjhra, Bori, Girna, Waghur, Purna, Mona and Sipna drain into the main channel.


Tapi River

h) Narmada River

The Narmada River is the largest west flowing and seventh largest river of India. It drains an area of 98,796 km^2, out of which nearly 87% lies in Madhya Pradesh besides some areas in the states of Maharashtra and Gujarat. It flows into the Gulf of Cambay in the Arabian Sea about 10 km north of Bharuch District of Gujarat. In Gujarat State, it stretches for


Narmada River

nearly 160 km. There are several important tributaries to the Narmada River. They are Burhner, Banjar, Hiran, Tawa, Chhota Tawa, Orsang and Kundi which are the major tributaries having catchment area of more than 3,500 km^2 each. The remaining tributaries are having catchment areas ranging from 500 to 2,500 km^2.

(2) Rewari-Dadri Section

The proposed corridor is crossing over Yamuna River at the border between Faridabad District and Gautam Buddh Nagar District and Hindon River in Gautam Buddh Nagar District. Both are perennial rivers in the area. The Yamuna River forming a boundary between Haryana and Uttar Pradesh flows in a southerly direction and almost bisects the area. The Hindon River also flows in southerly direction.

a) Yamuna River


Yamuna River

The Yamuna River is the largest tributary of the Ganges in northern India. Originating from the Yamunotri Glacier at a height of 6,387 m on the south western slopes of Banderpooch peaks, in the lower Himalayas, it travels a total length of 1,376 km and has a drainage system of 366,223 km^2. It crosses several states in the northern India and meets several of its tributaries on the way. Most parts of catchment in Haryana and U.P. lie in the Gangetic alluvial plains. There are three main sources of pollution in the river, namely households and municipal disposal sites, soil erosion resulting from deforestation occurring to make way for agriculture along with resulting chemical wash-off from fertilizers, herbicides, and pesticides and run-off from commercial activity and industrial sites. Major stretch of river in Faridabad District and Delhi is highly polluted.

b) Hindon River


Hindon River

The Hindon River, a tributary of the Yamuna River, originates from upper Shivalik in lower Himalayan Range. The river is entirely rainfed and has a catchment area of 7,083 km^2. It flows between the Ganges and Yamuna Rivers, for 400 km through Muzaffarnagar District, Meerut District, Baghpat District, Ghaziabad, Noida, Greater Noida in the state of Uttar Pradesh before it joins the Yamuna River just outside Delhi. The Hindon River is a highly polluted river and dissolved oxygen levels are nearly zero throughout the length of this river.

4.1.6 Soil

(1) JNPT-Vadodara Section

1) Maharashtra-section

Mainly three types of soil are found in Thane District – regur soil, red soil and brownish black soil. Regur soil, which is found in Dahanu, Palghar, Vasai and Thane Tehsils, is fertile and useful for horticulture, paddy cultivation and vegetables. Red soil which is found in Mokhada, Talasari, and some parts of other tehsils on the eastern slopes is used for growing coarse millets. Third type of soil found in Bhiwandi, Kalyan and Shahpur Tehsils is useful particularly for paddy cultivation.

Laterite and lateritic soils cover most of the part of Panvel and Uran tehsils of Raigad District. The soils are sandy clay loam to clay in texture. The soils are susceptible to erosion.

2) Gujarat section

Deep black and coastal alluvium soils are predominant in south Gujarat, medium black is prevalent in middle Gujarat, grey brown and coastal alluvial soils are in north and north-west while the Saurashtra peninsula has calcareous medium black and to some extent coastal alluvial soils. Only about 28% of the total geographical area of the state has soil of over 150 cm depth, while about 15% have soil of 100-150 cm depth. In terms of its texture, loamy soils cover about 37% of the state while 40% is clayey and 7% is sandy.

The deep black soils are found in major part of Bharuch, Surat, Valsad, and the southern part of Vadodara Districts. The depth varies from 60 cm to as high as few meters. The deep black soils in general are clay in texture, poor in drainage and neutral to alkaline in reaction. The specific information on soil quality of different districts falling along the proposed alignment route is mentioned below:

a) Valsad District

The soil in Valsad District in general has neutral pH. Electricity conductivity, too, is medium. Organic carbon and nitrogen is low, phosphorus is medium and potash content of the soil is high. Therefore, overall, the soil fertility indices are good from the point of view of agriculture.

b) Navsari District

The soil in Navsari District in general has neutral pH. Electricity conductivity, too, is medium. Organic carbon, nitrogen and phosphorus content of the soil is low. Potash is medium. Therefore, overall, the soil fertility indices are not so good from the point of view of agriculture.

c) Surat District

The soil in Surat District in general has neutral pH. Electricity conductivity, too, is low. Organic carbon, nitrogen and phosphorus content of the soil is medium. Potash is high. Therefore, overall, the soil fertility indices are good from the point of view of agriculture.

d) Bharuch District

The soil in Bharuch District in general has neutral pH. Electricity conductivity is medium. Organic carbon is low, nitrogen and phosphorus content of the soil is low and medium.

Potash is high. Therefore, overall, the soil fertility indices are poor from the point of view of agriculture.

e) Vadodara District

The soil in Vadodara District in general has neutral pH. Electricity conductivity is medium. Organic carbon and nitrogen content of the soil, too, is low. Phosphorus content is medium and potash is high. Therefore, overall, the soil fertility indices are average from the point of view of agriculture.

(2) Rewari-Dadri Section

a) Rewari District

Soils in this district are sandy to loamy sand alluvial soil (Bhanger) with low water table and undulating topography. The district has 2.4% of the soils under rocky land subjected to high runoff and highly susceptible to erosion. 29% of the land is under soils of Aravalli pediment, which are severely eroded and highly saline, confined to Bawal and Rewari Tehsil/Taluka. 2.6% of the soils are under soils of old alluvial plain with sand dunes. Some stretches covered by sand dunes are found in the northern portion of the district. Soils are light in texture with low availability of moisture and poor retention capacity. The major part of the soils of the district falls under soils of fluvioaeolian plain, which accounts for 65% of the total area. Mostly these soils are confined to Sahibi flood plain area, which are sandy soils with loamy surface.

b) Alwar District

The Alwar District is covered by the soils of Aravalli Hills and Aravalli pediments, which account for 16.3% and 15.5% of the total area respectively. These are moderately deep, undifferentiated and rocky land of Aravallis, subjected to high run off and severe erosion. Soils of Aravalli pediment are very deep, well drained, with gentle slopes, coarse loamy soils with loamy surfaces, severely eroded and slightly saline. Soils of old alluvial plains accounts for 5.9% of the area of the district.

Major parts of soils of Alwar District is covered by soils of recent flood plain which accounts for 52% of the total area, mostly found in the area along the riverine tract of Sahibi, characterised by highly stratified river deposits. The soils are sandy to coarse loamy in texture, moderately drained and has a good capacity to retain plant nutrients. The soil of Fluvioaeolian plain accounts for 12.6% of the total area of the district. This type of soil is calcareous to sandy with loamy surfaces and has a slight erosion problem.

The soils of the district according to the local classification fall into three broad natural categories - Chiknot, Mattiyar and Bhoor. Chiknot is stiff clay found throughout the district except in the tehsils of Tijara and Behror. Mattiyar is a loamy soil and found everywhere except in Tijara and Behror Tehsils. The Bhoor is most common in Tijara Tehsils.

c) Mewat District

The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The soils are light and derived from the older and new alluvial layers; the older alluvium is dark-coloured and is generally rich in concretions and nodules of impure calcium carbonate known as “Kankar”. The new alluvium is light coloured and poor in calcareous matter. The soils are generally shallow and low in organic matter.

d) Gurgaon District

The soils in this district are mostly rocky surfaces of Aravalli Hills except some areas which are sandy loam to coarse loamy in texture. In the northwestern, extreme northern and southern parts of the district, the soils are tropical arid brown soils, water logged, salt affected and medium in texture. About 68% of the total area is under the soils of Aravalli pediment. These soils are very deep, coarse loamy, severely eroded and slightly saline.

e) Faridabad District and Palwal District

Both districts comprise of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam (surface), clay loam/silty clay (sub-surface) in low lying plains/depressions.

f) Gautam Buddh Nagar District

The district is covered by soils of Fluvioaeolian plain, which are calcareous to sandy, with loamy surfaces in nature. Soil erosion problem is moderate to slight, with excellent fertility status. More than 25% of the area are covered by soils of active flood plains, which are sandy to coarse loamy in texture. Some depressions are found along Ganges and cause water logging.

4.1.7 Geology and Hydrogeology

The geology, hydrogeology and drainage characteristics of the project area has been described especially for Aravalli Hills in Rewari-Dadri Section where DFC Phase 2 Project will result in deep rock cutting and Vasai Detour in Thane District of Maharashtra where the project has proposed to build tunnel.

(1) Vasai Detour in Maharashtra Section

1) Geology and Hydrogeology

Geologically the Vasai detour area is underlain by alluvium and Deccan basalt inter-bedded with pyroclastic material. The area is represented by flat alluvium terrain undulated with flat topped hills of basalts forming chain of plateaus. The area is also structurally disturbed and seismically active. The Geological succession is as follows at the Tunnel site at Vasai Detour:

Table 4.1.7 Geo-chronological Order at Tunnel Site

Layer	Type	Thickness	Property
I Top layer	Weathered Limonite Formation	150 – 200 mm	Mixed with Dust
II Layer	Weathered Laterites with Nodular formation	1000 – 1500 mm	Lateritic Iron
III Layer	Andesites Basalt as bottom Layer	1500 mm onward	Ferromagsium + Silica

Basalts and alluvium constitutes the two major aquifers in the area. Each basaltic flow consists of two distinct units i.e. lower massive unit and an upper vesicular unit. The lower massive layer is generally devoid of primary porosity and interconnected pores and hence the water bearing and transmitting properties of these formations are limited to negligible. However, the fractured and jointed portions in the massive zone and presence of vesicles

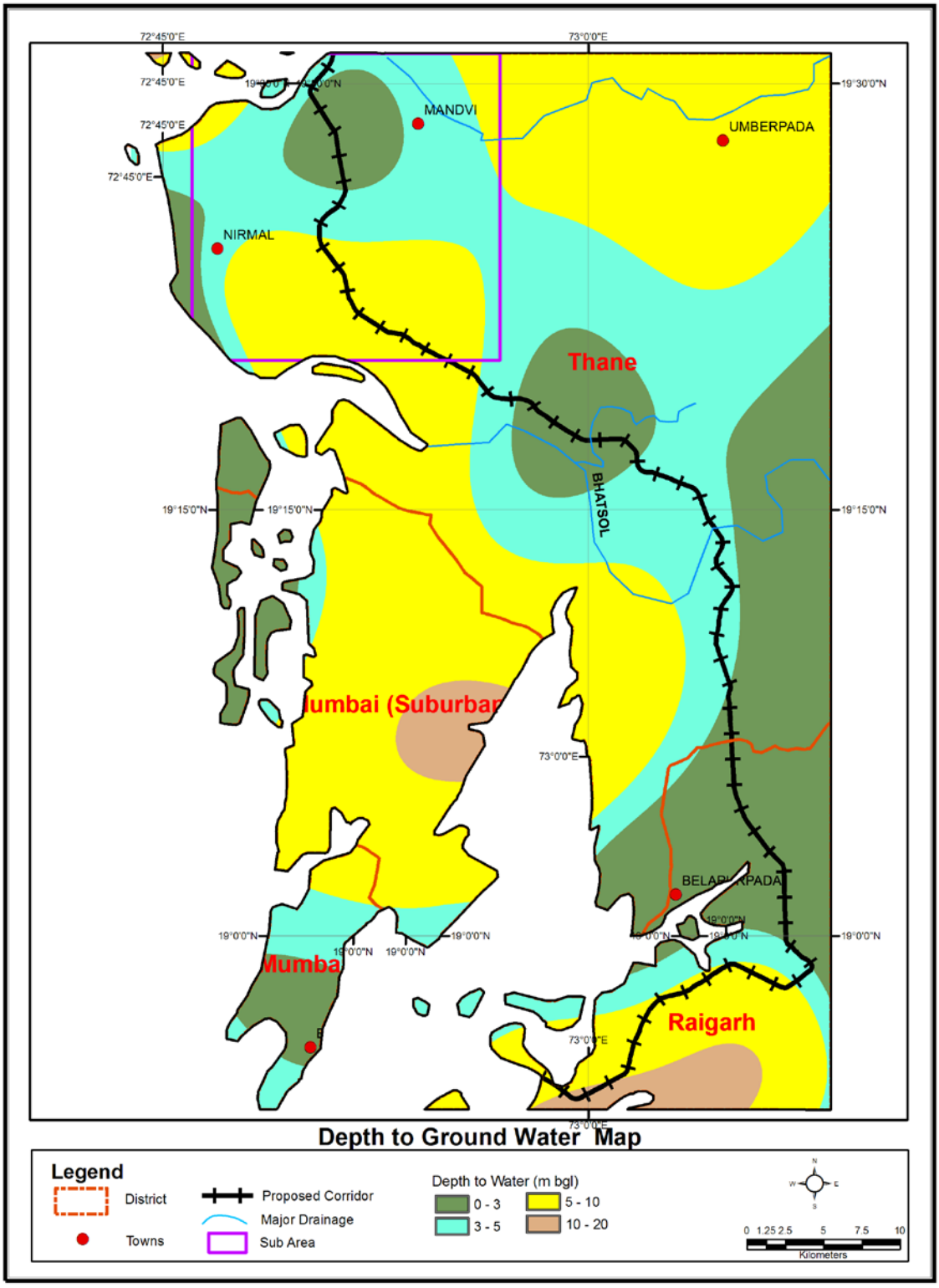
act as moderate to good aquifer. Degree of weathering and topographic setting plays important role for occurrence and distribution of ground water. The top weathered zone however, acts as fairly good aquifer. The alluvium comprises detritus material, sand, gravel and clay and its admixtures form the major aquifer system in the area.

The ground water regime condition in the project area has been studied through compilation of water level data collected from various organizations including CGWB. The water level data collected from the observation wells in the area has been used to generate a depth to water level map of the project area as shown in Figure 4.1.2. From the depth to water map for the pre-monsoon period, it may be observed that, in general the ground water level in the area remains within 10 m bgl. Major area falls within the water level of 5 m bgl. The area around Vasai in which the tunnel has been proposed lies within the range of 5 to 10 m bgl.

The ground water quality has been studied through compilation of data related to various chemical constituents. Electrical conductivity is the basic parameter which indicates the overall quality of ground water for various uses. Electrical conductivity in the project area is within the permissible limit of 1,500 micro mhos/cm. In the tunnel area, the EC values lies in the range of 750 to 1,500 micro mhos/cm.

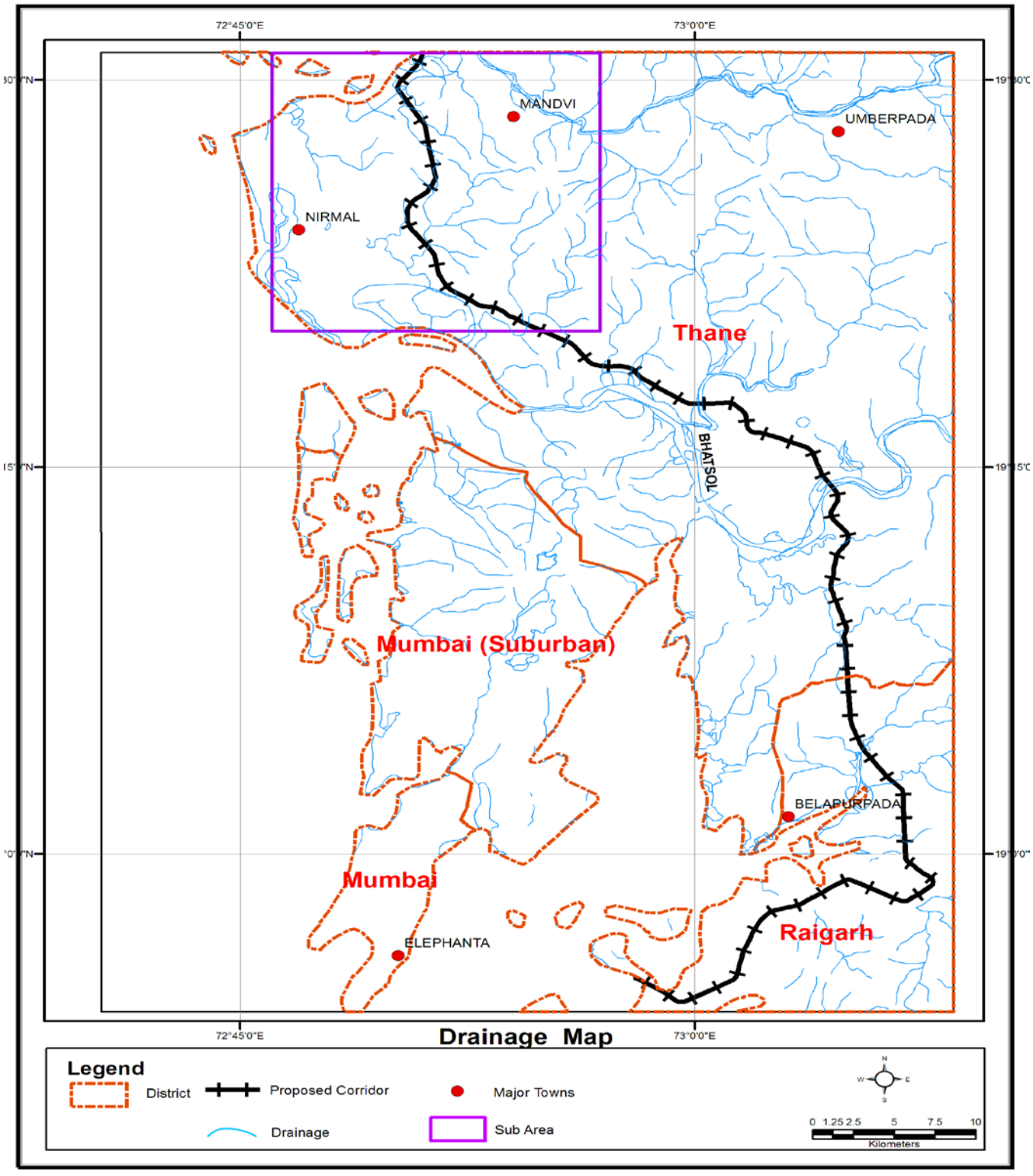
2) Hydrology and Drainage

The project area is represented by a plain land occasionally traversed with dissected plateaus. Due to slope variations the drainage in the area is well developed. The drainage map of the stretch of the corridor in Maharashtra Region is shown in Figure 4.1.3. From the drainage map of the project area it may be observed that at several places the corridor crosses the drainage and hence adequate measure need to be taken to preserve the natural drainage.



Source: CGWB

Figure 4.1.2 Depth to Ground Water level map of the Project Area (Vasai Detour in Maharashtra Section)



Source: Geological Survey of India

Figure 4.1.3 Drainage Map of the Project Area (Vasai Detour in Maharashtra Section)

(2) Aravalli Hills in Rewari-Dadri Section

1) Geology

The rock formations in the Aravalli area are represented by quartzites, mica schist and pegmatite intrusive. Structurally the area represents an active tectonic zone. The area is dissected by number of faults, fractures and shears, the trend of which varies from NNE-SSW to ENE-WSW. Locally the Delhi region forms northern part of the southerly plunging fold known as Harchandpur anticline. Since the Aravalli rocky hill ridges b/w Banban Village to Keherani Village in Tijara block, Alwar District and from Dhulawat Village to Rojka Village in Mewat District is made up of quartzites which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure profile showing major as well as minor faults passing through the area.

The hill outcrops near Taoru Block (Mewat District), near Sohna and Tijara Blocks (Alwar District) were examined. The area is traversed by two parallel ridges bordering N-S trending Sohna Valley named as Sohna and Harchandpur Ridges. Geologically, the hill outcrops comprise Alwar and Ajabgarh series of Delhi super group rock formations that run in N-S and NNE-SSW direction. Three to four sets of joints in rocky exposures are conspicuous by their presence.

The DFC also passes through the Sohna area of the Gurgaon District. The Gurgaon District as such indicates various geomorphological units such as fluvial origin, alluvial plain, alluvial plain with sand cover, paleao channel/abandoned channel, denudational origin pediment, pediplians, intermontane valley/basin, valley fill, residual hills, structural origin structural hills and, linear ridges. The area is characterized by the quartzites which are geo-morphologically identified denudational hills meeting with the older alluvial deposits abruptly or many a times narrow strip of pediplain can also be observed. The older alluvial plain extends further south and westward.

2) Hydrogeology

The hydrogeological conditions are fast changing because of the continuous development of ground water resources irrespective of its annual replenishment and aquifer sustainability. The water table is continuously declining and the ingress of brackish/saline aquifers towards fresh aquifers is increasing disturbing the total hydrodynamics of ground water in the study area as well as in the surrounding areas under NCR. Ground water occurs in alluvium and weathered / fractured hard rocks. Sand, gravel and silt-kankar constitute potential aquifer zones in alluvium. Shallow aquifer systems in alluvium are generally under unconfined conditions and deeper aquifer systems are under semi-confined/confined conditions. Highly potential ground water structures can be installed in these aquifer systems. Weathered/ fractured hard rocks having secondary porosity constitute poor to moderately potential aquifer zones which can sustain low capacity ground water structures, locally. The hydrogeological map of the project area is given in Figure 4.1.4.

In the major part of the project area, the depth of water table lies between 10 m and 20 m. The part of the area falling in Alwar District, water table rests between 10 m and 20 m and in some areas, it is deeper than 20 m and westwards, the water level is further below and goes up to 40 m bgl. Similar conditions prevail in Rewari adjoining the Alwar. The depth to water level map prepared from existing observation wells in the project area depicting the depth to water zones is given in Figure 4.1.5.

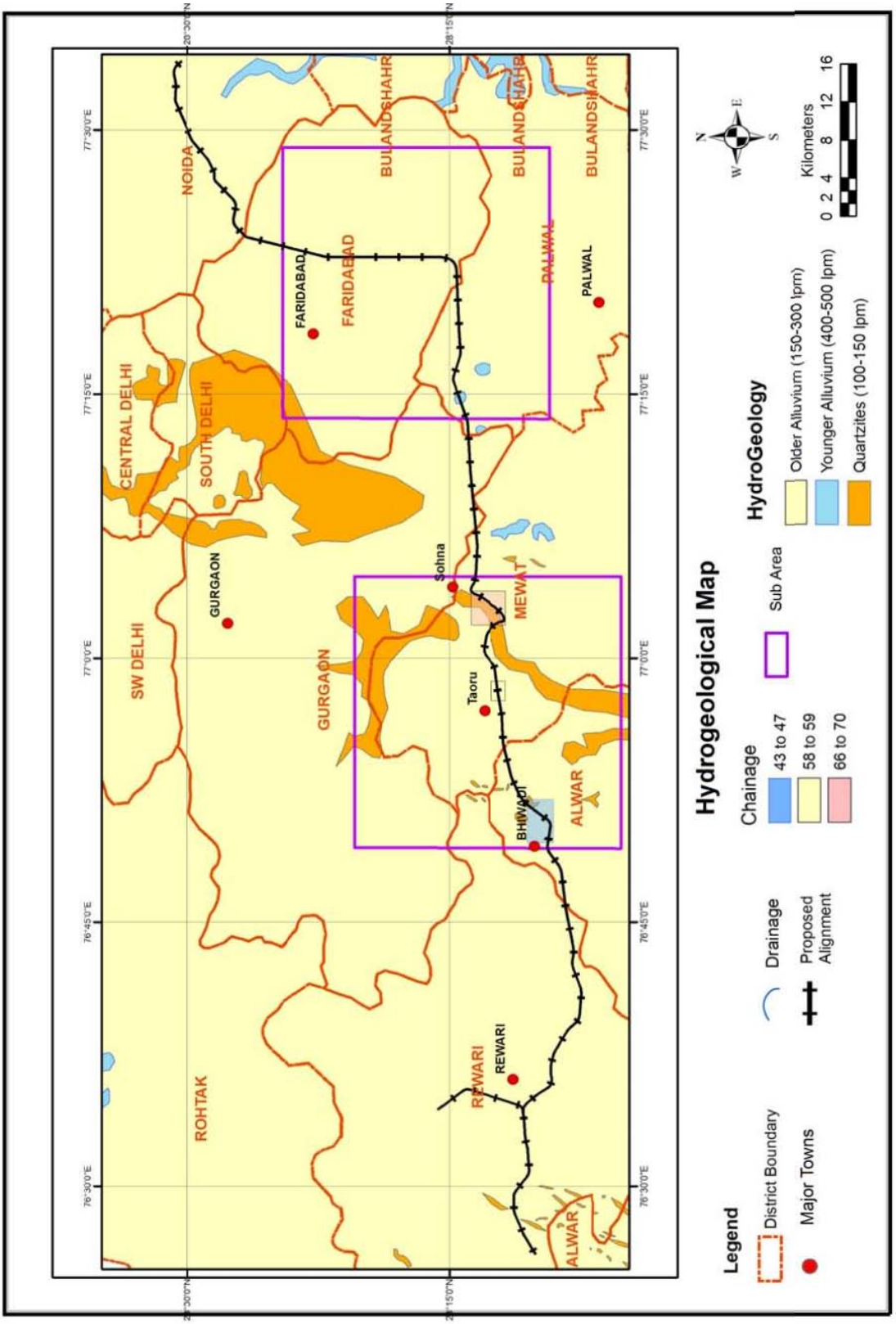
In a major part of the area, the shallow ground water is fresh (EC up to 3000 micro siemens/cm at 25^{o}C). Areas with brackish quality of water (EC between 3000-6000 micro siemens/cm at 25^{o}C) occur in north western parts of Sonepat District, northern and north western parts of Rohtak District, north-western and south western parts of NCT of Delhi, north-west and northern parts of Gurgaon District, western parts of Rewari District, southwest parts of Faridabad District. The water quality map of the project area showing the electrical conductivity zones is given in Figure 4.1.6.

From the perusal of map it may be observed that in the entire stretch of the corridor the electrical conductivity is below 3000 micro siemens, in pockets it is even less than 1500. However, the higher values of conductivity approaching 3000 micro siemens are very vulnerable, since the underlying aquifers in the major part of the study area contains brackish to saline water and hence any overexploitation of uncontrolled withdrawal may lead to up-coning of underlying saline water.

3) Drainage

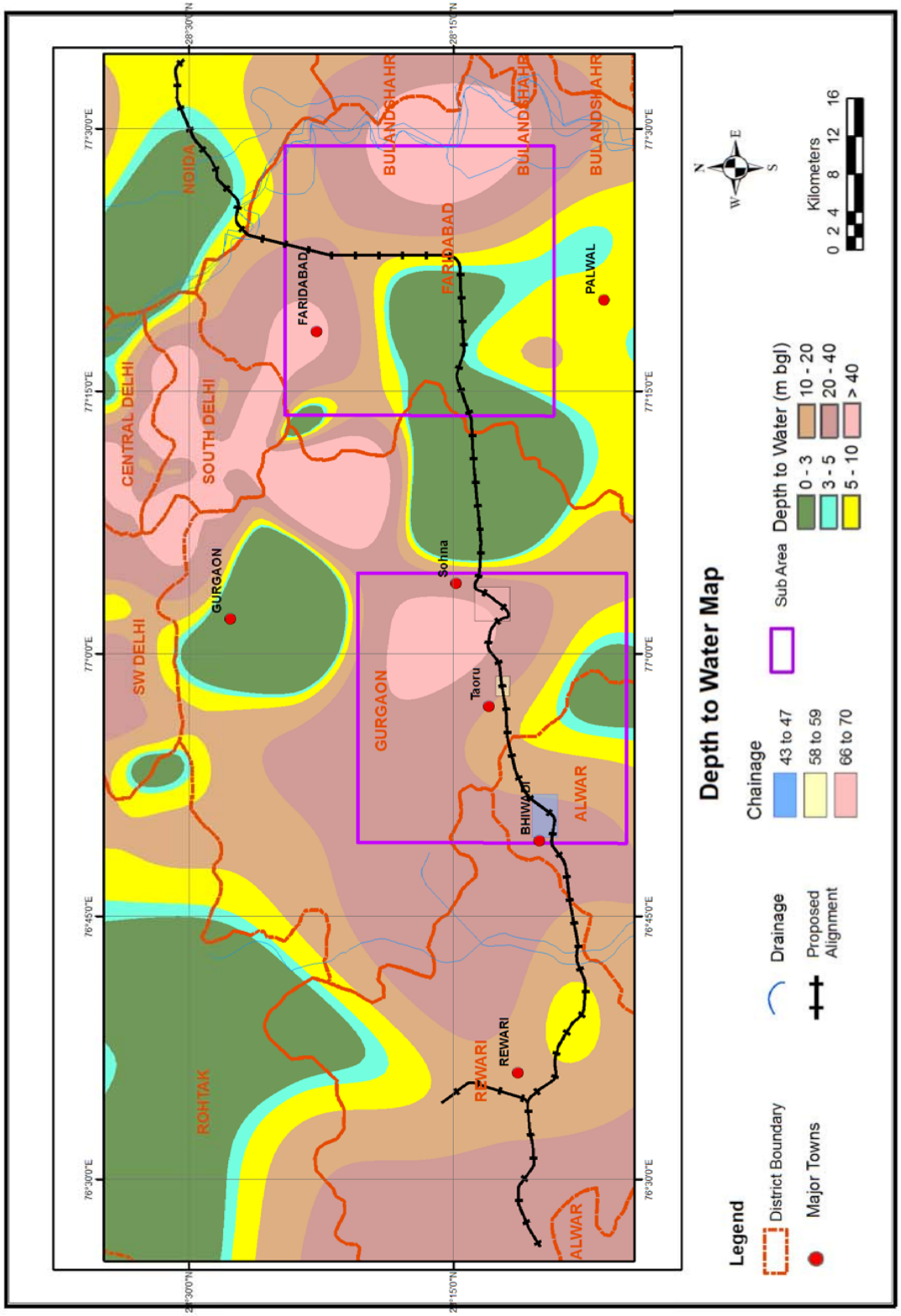
It has been observed that in the middle of Gurgaon stretch there is a surface water divide owing to the presence of nearly N-S trending Aravalli ridges. The stream originating from the western flank of ridge flows westerly and joins Sahibi River and the east flowing streams finally join the Yamuna River flowing in the eastern boundary of project area.

There are two perennial rivers in the project area - the Yamuna and Hindon Rivers. The Sahibi River represents ephemeral nature of flow. It flows in a north-east direction towards Rewari. It carries away the water of the western slope of the central range of Aravalli hills. The Yamuna forms the boundary between Haryana and Uttar Pradesh and flows southerly. The Hindon River also flows in southerly direction. The drainage map of the project area is given in Figure 4.1.7.



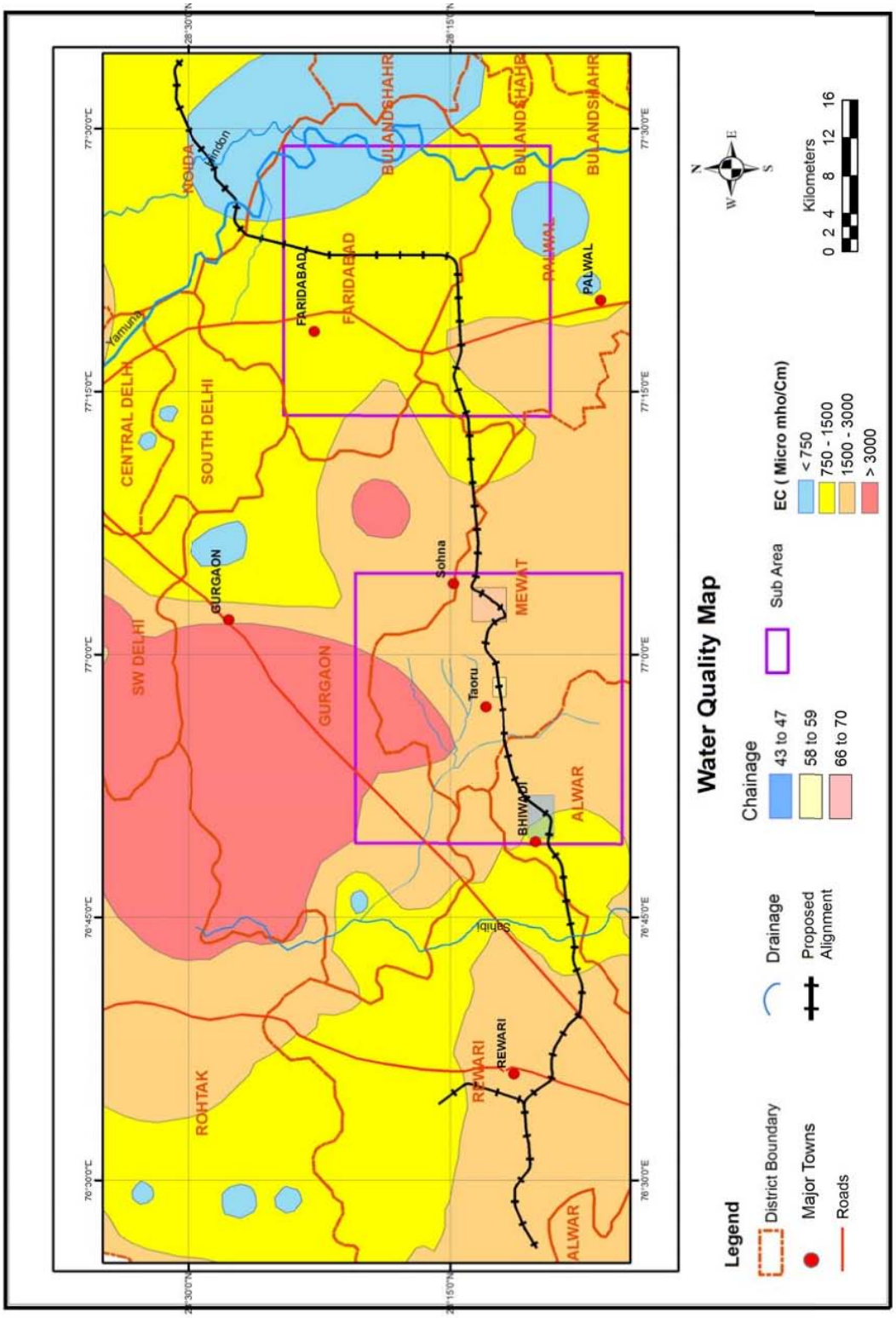
Source: CGWB

Figure 4.1.4 Hydrogeological Map of the Project Area (Aravalli Hills in Rewari-Dadri Section)



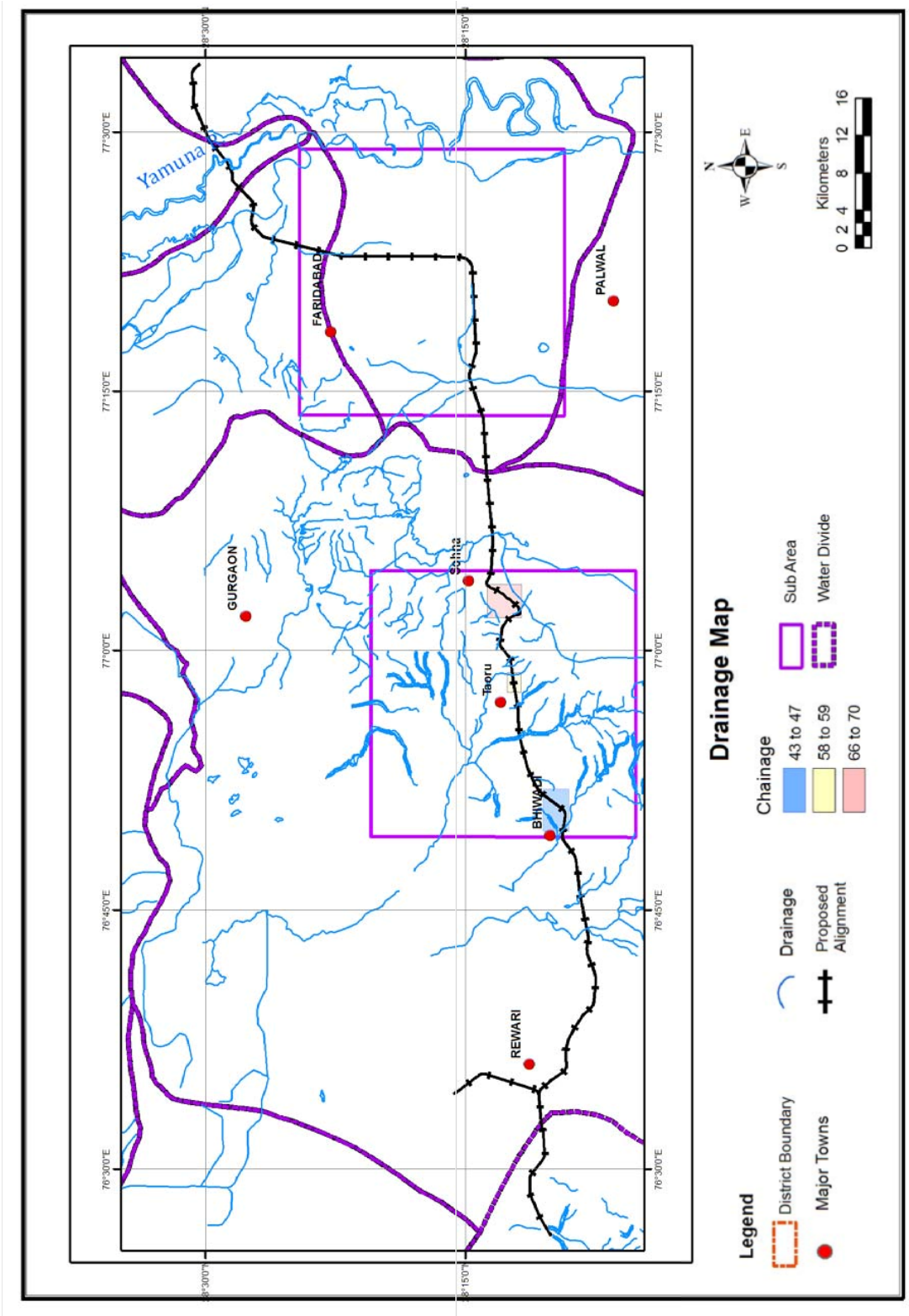
Source: CGWB

Figure 4.1.5 Depth to Water Level Map of the Project Area (Aravalli Hills in Rewari-Dadri Section)



Source: CGWB

Figure 4.1.6 Drainage Map of the Project Area (Aravalli Hills in Rewari-Dadri Section)



Source: CGWB

Figure 4.1.7 Water Quality Map of the Project Area (Aravalli Hills in Rewari-Dadri Section)

4.1.8 Habitat along the Alignment

Natural environment conditions vary along the DFC alignment route due to different ecological and ago-climatic variation. Nearly 45% of the alignment route passes through the cultivated agricultural area, barren land and wasteland in DFC Phase 2. Besides this, the alignment crosses over number of important, major, and minor rivers and streams and also traverses through many recorded forest area. The length of alignment in these forest areas comprises approximately 1.6 km length in Gulistanpur reserved forest in G. B. Nagar District of Uttar Pradesh and approximately 9.2 km in Thane District of Maharashtra. The forest areas in Thane District are mostly dry and degraded land and supports very little habitat pattern. Most of these forest areas are under the influence of encroachment and increased human activities. The proposed alignment also passes near the edge of the range boundary of the Sanjay Gandhi National Park in Thane District. The proposed corridor passes through the buffer area but away from the range boundary of the Tungareshwar Wildlife Sanctuary.

(1) JNPT-Vadodara Section

1) Maharashtra section

Thane and Raigad Districts come under the Western Ghats. The region between the Arabian Sea and the Sahyadri Range is called the Konkan. It is narrow coastal lowland. The area is a splendid combination of plant and animal life. The forest of this area is the southern tropical semi evergreen forest and occupies a wide range of plant life, magical herbs, and shrubs. Dominant species are Mango, Jamun, Hirda, Behda, Bamboo, various shrubs, herbs, climber, grass, and fern. The area is rich in fauna since there are a variety of forest types. The wildlife found here includes leopards, barking deer, sambar, wild boar, langur, and hyena. Among the birds, Malabar grey hornbill, Quaker babbler, Malabar whistling thrush, green pigeon, black eagle, and grey jungle fowl are common. The largest tree squirrels are also found here.

2) Gujarat section

The state of Gujarat boasts of a rich flora and fauna. It has varied landforms, ranging from dry deciduous forests to majestic grasslands, wetlands, marine ecosystems and rich moist deciduous forests. This has made the state suitable as the habitat of rare wildlife species. Asiatic lion, wild ass, black buck, four-horned antelope and great Indian bustard are some of the rare species preserved by the various wildlife sanctuaries in Gujarat. These rare animals constitute the wildlife heritage of India. Therefore, the National Parks in Gujarat are trying their best to save these creatures from the threat of extinction. This is arid region and the coastal region gives way to a low area of wooded hilly region in the central part. Gujarat is home to some rare species. The Asiatic lion is found only in the Gir forest, while the wild ass is found in the Rann of Kutcch. Besides these, the great Indian bustard, the world's only four-horned antelope, the black buck, the dugong and the boralia are all found in different habitats across the state.

Valsad District falls under the Sahyadri Region. This is the northern part of Western Ghats, which is very rich in biodiversity.

(2) Rewari-Dadri Section

The forests in Haryana District are classified under reserved forests, protected forests, unclassed forests, closed u/s 38 of Indian Forest Act and areas closed u/s 4 & 5 of Land Preservation Act. Alwar has rich forest area. Reserved forests in Gurgaon District have

214.9 ha, in Mewat District 16.2 ha, in Faridabad District 314.2 ha and in Rewari has 514.0 ha area. However, the proposed DFC alignment route is not affecting any forest area in these districts.

Corresponding to its variegated topography and climate, the project districts have a wealth of wildlife. Their avifauna is among the richest in the country. Widespread in the forest areas of Haryana, Gautam Buddha Nagar, and Alwar, is found the leopard, wild bear, sloth bear, chital, sambhar, jackal, porcupine, jungle cat, hare, squirrel, monitor, lizard and fox. The most common birds include the crow, pigeon, dove, jungle fowl, black partridge, house sparrow, peafowl, parakeet, kite, myna, quail, bulbul, kingfisher and woodpecker. The chinkara and the sand grouse prefer a dry climate and have their habitat in the Aravalli area. Among the game birds resident in the section are the snipe, comb duck, grey duck, cotton teal and whistling teal.

4.1.9 Flora

(1) JNPT-Vadodara Section

Flora along the proposed alignment belongs to arid, semi arid, coastal climatic system. Forest type comprising of mainly tropical dry deciduous, the Western Ghats, and monsoon forests occur both on the western (coastal) margins of the ghats and on the eastern side where there is less rainfall. These forests contain several tree species of great commercial significance like Indian rosewood, *Dalbergia latifolia*, *Malabar kino, Pterocarpus marsupium, teak* and *Terminalia crenulata*. Clumps of bamboo occur along streams throughout the evergreen and semi-evergreen forests of south-west Gujarat and Maharashtra.

The Thane forests are one of the valuable and well-preserved forests in Maharashtra. The forest areas occurring in the district do not consist of single block, but are scattered all over the district. The forest area in Thane District is 3,822.6 km^2 or 42% of the total geographical area. Of this, the area under reserved forests is 2,838.5 km^2 or 74% while protected forests covers 983.9 km^2 or 26% of the total forest area. The area under unclassed forests is only 0.13 km^2. More than 90% of the forests of Thane District fall under the type 'Tropical moist (mixed) deciduous forests'. The occurrence of teak is only 25% to 30%. On better sites it is associated with other species like ain, khair, hed, bibla, shisham, sawar, etc.

(2) Rewari-Dadri Section

The Gulistanpur reserved forest area in Gautam Buddh Nagar District is a plantation work of the Forest Department. The area has semi-arid climatic plantation of thorny plants such as *Prosopis juliflora* and *Acacia nilotica*.

Forests in the state of Haryana are comprised of dry deciduous forest, pine and thorny shrubs. Main trees are *babul (Acacia nilotica), khair (Acacia catechu), neem (Azadirachta indica), shisham (Dalbergia sissoo), pipal (Ficus religiosa), aam (Mangifera indica), jamun (Syzygium cumini), imli (Tamarindus indica), barh (Ficus indicus), sagwan or teak (Tectona grandis), ber (Zizyphus mauritiana), mitha jal or pillu (Salvadora indica), khara jal or pillu (Salvador persica), semul, khejri (Prosopis cineraria), lasura or lehswa (Cordia dichotoma), amla, dhak (Butea frondosa), shahtoot (Morus alba), eucalyptus, amrood (Psidium guajava),* pine and poplar.

4.1.10 Fauna

(1) JNPT-Vadodara Section

1) Maharashutra section

The varied climate and topography have resulted in rich vegetation and a good animal population in Maharashtra. The forests found here are mainly evergreen deciduous types. Majority of the forests are in the eastern and Sahyadri regions of the state. Here many different kinds of animals are found like tiger, panther, bison, deer and antelope, wild boar, bear and blue bull.

2) Gujarat section

The fauna of Gujarat is quite diverse. The thick forests of Dangs in Gujarat, receiving maximum rains and having abundant greenery, are the home of beautiful birds such as trogon, hornbills, barbets, babblers, racket-tailed drongos and minivets. The saras, pea-fowls, red-wattled lapwings, parakeets, babblers and mynas are mostly found in the plains. The extensive coastal regions of the state give shelter to a number of birds such as plovers, stints, sandi pipers, curlews, lesser flamingoes, terns and gulls.

(2) Rewari-Dadri Section

In Gautam Buddha Nagar District, back-naped hare (Lepus nigricollis) and neelgai (Boselaphus tragocamelus) droppings in the areas of the Gulistanpur forest were observed during investigation for biodiversity. The presence of such animals is usually associated with wild or semi-wild scrub areas. It is indeed rare to be found in such close vicinity of a bustling township. This indicates the habitat is not encroached by industrial development in the nearby area, and the credit can be given to the Forest Department for its safety and conservation. Wildlife constitutes an integral part of the forests. Development of wildlife to a greater extent relies on the type of forests, their density and climate of the region.

In Haryana State, there are 9 wildlife sanctuaries and 2 national parks out of which there are 3 wildlife sanctuaries and 1 national park in the Haryana sub-region covering an area of 1,742.6 acres and 359.5 acres respectively consisting of the rare species of birds, black bucks, chital, barking dears, red jungle fowls and leopards etc. The proposed corridor is not falling in any of these protected areas in Haryana.

4.1.11 Legally Protected Areas

The proposed DFC alignment between JNPT and Vadodara and Rewari and Dadri passes through some of the recorded forest areas, eco-sensitive areas and close to one of the protected areas.

The two notified eco-sensitive areas which fall along the alignment include Aravalli Hills in Mewat and Alwar Districts and Dahanu in Thane District. The recorded forest area villages which are getting affected by the proposed alignment route falls in Bhivandi, Vasai, and Palghar Talukas/Tehsils and Dahanu of Thane District and in Sadar Taluka in Gautam Buddha Nagar District. These recorded forests are either reserved forest or protected forest or private forest or un-classed forest. There are some locations falling within ROW of the proposed DFC alignment in Thane District such as Village Malodhi, Village Kasarali and Wadiv Saravali near Vaitarna Creek, Village Shirgaon and Ulhas River where existing mangrove vegetation might be disturbed. Most of these recorded forests areas in Thane District are dry and degraded lands and do not support any

significant diversity of species. Only 1-2% of the total forest area land under various categories of recorded forest will be acquired for the project in Thane District.

The Gulistanpur Reserved Forest in Gautam Buddha Nagar District is located close to the industrial area of Surajpur. It is not a natural forest but a result of plantation work done by the local forest department for greenery development in the area. Nearly 4-5% of the total forest area land will be acquired for the project.

The Sanjay Gandhi National Park is the only protected area falling along the DFC alignment route whose outer boundary is in proximity to the proposed DFC (Figure 4.1.8). The forest patches adjoining proposed alignment within the National Park is in degraded condition.

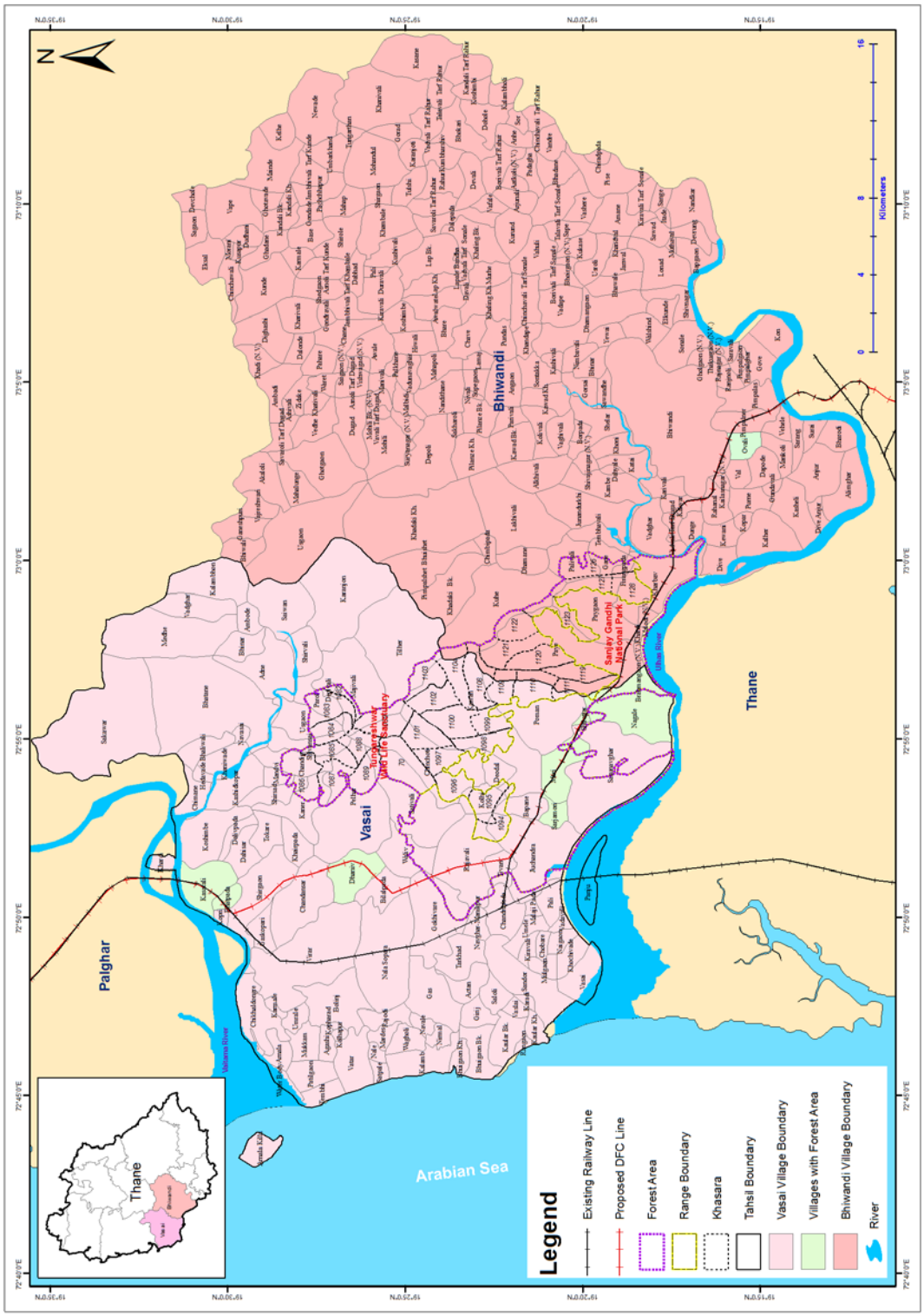


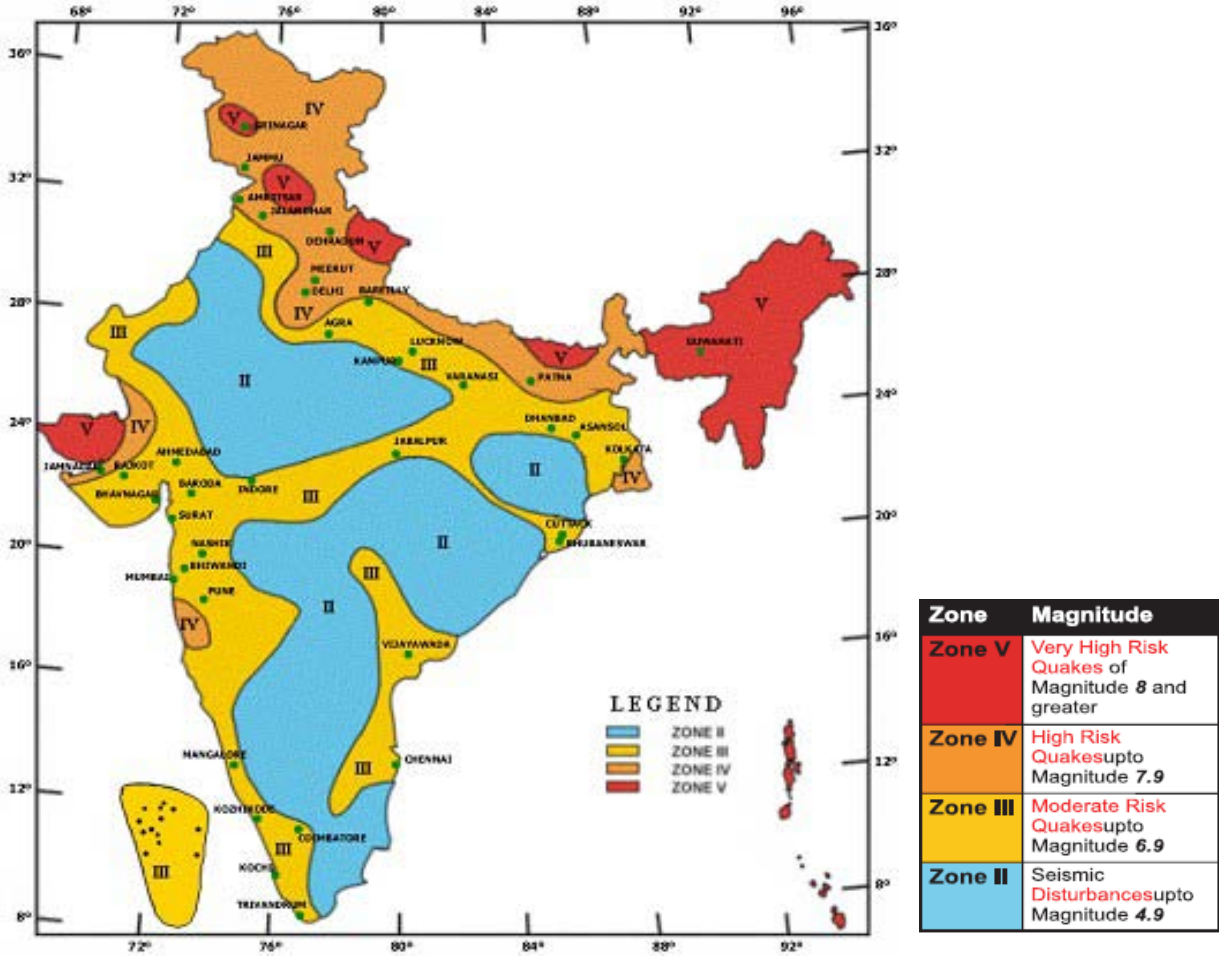
Figure 4.1.8 DFC Alignment near Sanjay Gandhi National Park

Source: CGWB

4.1.12 Seismicity

Geographical statistics of India show that almost 54% of the land is vulnerable to earthquakes. The seismic zoning map of India (Figure 4.1.9) has assigned four levels of seismicity for the entire country in terms of zone factors. According to the present zoning map, zone V expects the highest level of seismicity whereas zone II is associated with the lowest level of seismicity. The MSK (Medvedev-Sponheuer-Karnik) intensity broadly associated with the various seismic zones is VI (or less), VII, VIII and IX (and above) for zones II, III, IV and V, respectively, corresponding to Maximum Considered Earthquake (MCE).

Each zone indicates the effects of an earthquake at a particular place based on the observations of the affected areas. The Bureau of India Standards (BIS) has assigned zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for zone II and 0.24 for zone IV. The Rewari-Dadri section of the corridor falls in zone IV where as the JNPT-Vadodara section falls in zone III. Zone IV is called the high damage risk zone.



Source: IS 1893 (Part 1): 2002 (BIS)

Figure 4.1.9 Seismic Zoning Map of India

4.2 SOCIO-ECONOMIC ENVIRONMENT

The existing status on socio-economic environment has been described for the overall project area as well as the immediate project affected area. The status for the overall project area pertains to the information at the district level whereas the immediate project affected area pertains to the information at the taluka/tehsil and village level. The source of information is based on the census survey of India, statistical abstract of the district, district census handbook, Planning Commission reports, and Baseline Survey and Census for RRP.

4.2.1 Socio-economic Conditions of the Overall Project Area

(1) Demographic profile

Demographic profile of the project affected districts is given in Table 4.2.1. Uttar Pradesh is the most populous state followed by Maharashtra, Rajasthan, Gujarat and Haryana. Population density is the highest in Delhi and among cities it is the highest in Faridabad.

Table 4.2.1 Demographic Profile of Overall Project Area

India/ State/ /District	Population 2011*			Decadal growth rate		Sex ratio		Density	
	Persons	Males	Females	1991-2001	2001-2011	2001	2011	2001	2011
India 2001	1,027,015,247	531,277,078	495,738,169	21.34		933		324	
India 2011	1,210,193,422	623,724,248	586,469,174	17.64		940		382	
Maharashtra									
Maharashtra 2001	96,752,247	50,334,270	46,417,977	22.73		922		315	
Maharashtra 2011	112,372,972	58,361,397	54,011,575	15.99		925		365	
Raigad	2,635,394 (2205972)	1,348,089 (1116821)	1,287,305 (1089151)	20.99	19.36	976	955	309	368
Thane	11,054,131 (8,128,833)	5,879,387 (4,377,806)	5,174,744 (3,751,027)	54.92	35.94	858	880	851	1157
Gujarat									
Gujarat 2001	**50,596,992**	**26,344,053**	**24,252,939**	**22.66**		**920**		**258**	
Gujarat 2011	60,383,628	31482282	28,901,346	19.17		918		308	
Vadodara	4,157,568 (3,639,775)	2,150,229 (1,896,859)	2,007,339 (1,742,916)	19.87	14.16	919	934	482	551
Bharuch	1,550,822 (1,370,104)	805,945 (713,475)	744,877 (656,629)	19.37	13.14	921	924	210	238
Surat	6,079,231 (4,996,391)	3,399,742 (2,722,675)	2,679,489 (2,273,716)	54.30	42.19	810	788	968	1376
Navsari	1,330,711 (1,229,250)	678,423 (628,814)	652,288 (600,436)	13.24	8.24	955	961	557	602
Valsad	1703068 (1,410,680)	884064 (734,945)	819004 (675,735)	29.65	20.74	920	926	465	561
Haryana									
Haryana 2001	21,082,989	11327658	9755331	28.01		861		477	
Haryana 2011	25353081	13505130	11847951	19.9		877		573	
Rewari	896,129 (764,727)	472,254 (402,381)	423,875 (362,346)	25.24	17.1	901	898	483	562
Gurgaon	1,514,085 (1,657,669)	817,274 (884,456)	696,811 (773,213)	44.64	73.9	874	853	599	1241
Faridabad	1,798,954 (2,193,276)	961,532 (1,192,537)	837,422 (1,000,739)	48.47	31.7	839	871	1020	2298

India/ State/ /District	Population 2011*			Decadal growth rate		Sex ratio		Density	
	Persons	Males	Females	1991-2001	2001-2011	2001	2011	2001	2011
Mewat	1,089,406 (993,617)	571,480 (524,872)	517,926 (468,745)	-	37.9	893	906	-	729
Palwal	1,040,493 (404,136)	553,704 (217,233)	486,789 (186,903)	-	25.5	862	879	-	761
Delhi									
Delhi 2001	13,782,976	7,570,890	6,212,086	46.31		821		9294	
Delhi 2011	16,753,235	8,976,410	7,776,825	20.96		866		11297	
Rajasthan									
Rajasthan 2001	56,473,122	29,381,657	27,091,465	28.33		922		165	
Rajasthan 2011	68,621,012	35,620,086	33,000,926	21.44		926		201	
Alwar	3,671,999 (2,990,862)	1,938,929 (1,585,046)	1,733,070 (1,405,816)	30.23	22.75	887	894	357	438
Uttar Pradesh									
Uttar Pradesh 2001	166,052,859	87,466,301	78,586,558	25.80		898		689	
Uttar Pradesh 2011	199,581,477	104,596,415	94,985,062	20.09		908		828	
Gautam Buddha Nagar	1,674,714 (1,191,263)	904505 (646,554)	770,209 (544,709)	35.70	51.52	842	852	939	1306

Source: *Data in bracket is as per Census of India, 2001

1) Raigad District

As per the 2011 census, Raigad has a total population of 2,635,394 of which 1,348,089 are males and 1,287,305 are females. As against the state average of 925, the district has 955 females per 1,000 males. The overall density of population is close to the state average. Scheduled caste form 2.4% of the total population and scheduled tribe form 12.2% of the total population.

2) Thane District

The district has 15 tehsils, namely Thane, Kalyan, Murbad, Bhiwandi, Shahpur, Vasai, Ulhasnagar, Ambarnath, Dahanu, Palghar, Talasari, Jawhar, Mokhada, Wada and Vikramgad. It has 37 towns and 1,748 villages. Its total geographical area is 9,558 km^2. As per the 2011 census, it has a total population of 11,054,131 of which 5,879,387 are males and 5,174,744 are females. As against the state average of 925, the district has 880 females per 1000 males. In the age bracket 0-6 years, the sex ratio is 918. The overall density of population comes to 1,157 persons/km^2 which is very much higher than the state average of 365 persons/km^2. The population in the age bracket 0-6 years is 1,257,080 of which 655,354 are males and 601,726 are females.

The scheduled caste population of Thane District is 339,720 (4.2% of the total population) of which 177,990 are males and 161,730 are females. The scheduled tribe population of the district is pegged at 1,199,290 (14.7% of the total population of the district) out of which 600,809 are males and 598,481 are females.

3) Valsad District

The district of Valsad has 5 talukas, of which the major ones are Valsad (district headquarter), Pardi and Umargam. The total geographical area is 2,939 km^2. As per the 2011 census, it has a total population of 1,703,068 of which 884,064 are males and 819,004 are females. The district has 926 females per 1,000 males. In the age group of 0-6

years, the sex ratio is also 926. The overall density of population comes to 561 persons/km^2 which is much higher than the state average of 308 persons/km^2. The population in the age bracket of 0-6 years is 206,309 of which 107,110 are males and 99,199 are females.

The scheduled caste population of Valsad District is 37,304 (2.7% of the total population) of which 18,928 are males and 18,376 are females. The scheduled tribe population of the district is pegged at 772,405 (54.8% of the total population of the district) out of which 386,395 are males and 386,010 are females.

4) Navsari District

The district of Navsari has 5 talukas of which Navsari, Gandevi, and Chikhli are the major talukas. Its total geographical area is 2,196 km^2. As per the 2011 census, it has a total population of 1,330,711 of which 678,423 are males and 652,288 are females. As against the state average of 918, the district has 961 females per 1,000 males. In the age bracket of 0-6 years, the sex ratio is 921. The overall density of population comes to 602 persons/km^2 which is much higher than the state average of 308 persons/km^2. The population in the age bracket of 0-6 years is 129,530 of which 67,427 are males and 62,103 are females.

The scheduled caste population of Navsari District is 39,574 (3.4% of the total population) of which 19,937 are males and 19,637 are females. The scheduled tribe population of the district is pegged at 591,164 (28.2% of the total population of the district) out of which 297,103 are males and 294,061 are females.

5) Surat District

The district of Surat is divided into ten revenue talukas namely Choryasi, Palsana, Kamrez, Bardoli, Olpad, Mangrol, Mandvi and Surat City. Its total geographical area is 7,761 km^2. As per the 2011 census, it has a total population of 6,079,231 of which 3,399,742 are males and 2,679,489 are females. As against the state average of 918, the district has 788 females per 1,000 males. In the age bracket of 0-6 years, the sex ratio is 836. The overall density of population comes to 1,376 persons/km^2 which is very much higher than the state average of 308 persons/km^2. The population in the age bracket of 0-6 years is 710,805 of which 387,131 are males and 323,674 are females.

The scheduled caste population of Surat District is 169,324 (3.4% of the total population) of which 87,030 are males and 82,294 are females. The scheduled tribe population of the district is pegged at 1,408,270 (28.2% of the total population of the district) out of which 708,022 are males and 700248 are females.

6) Bharuch District

The district of Bharuch has 8 talukas, of which the major ones are Bharuch (district headquarter), Ankleshwar, Valia, Jhagadia and Jambusar. Its total geographical area is 5,253 km^2. As per the 2011 census, it has a total population of 1,550,822 of which 805,945 are males and 744,877 are females. The district has sex ratio of 924 females per 1,000 males. In the age bracket of 0-6 years, the sex ratio is 914. The overall density of population comes to 238 persons per km^2 which is lower than the state average of 308 persons/km^2. The population in the age bracket of 0-6 years is 170,565 of which 89,119 are males and 81,446 are females.

The scheduled caste population of Bharuch District is 61,491 (4.5% of the total population) of which 31,708 are males and 29783 are females. The scheduled tribe population of the district is pegged at 444,043 (32.4% of the total population of the

district) out of which 228,017 are males and 216,026 are females.

7) Vadodara District

The district has 12 talukas, 15 towns and 1548 villages, of which the major towns are Vadodara (district headquarter), Savli, Waghodia, Padra, Dabhoi, Karjan and Sankheda. Its total geographical area is 7,555 km^2. As per 2011 census, it has a total population of 4,157,568 of which 2,150,229 are males and 2,007,339 are females. As against the state average of 918, the district has 934 females per 1,000 males. In the age bracket of 0-6 years, the sex ratio is 894. The overall density of population comes to 551 persons/km^2 which is much higher than the state average of 308 persons/km^2. The population in the age bracket of 0-6 years is 474,479 of which 250,513 are males and 223,966 are females.

The scheduled caste population of Vadodara District is 204,285 (5.6% of the total population) of which 106,497 are males and 97,788 are females. The scheduled tribe population of the district is pegged at 967,393 (26.5% of the total population of the district) out of which 496,058 are males and 471,335 are females.

8) Rewari District

As per the 2011 census, Reawri has a total population of 896,129 of which 472,254 are males and 423,875 are females. As against the state average of 877, the district has 898 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 784. The overall density of population is slightly lower than the state average.

9) Alwar District

Alwar District has a total population of 3,671,999 with 1,938,929 males and 1,733,070 females. As against the state average of 926, the district has 894 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 825. The overall density of population is more than double than the state average.

10) Mewat District

As per the 2011 census, Mewat has a total population of 1,089,406 of which 571,480 are males and 517,926 are females. As against the state average of 877, the district has 906 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 903. The overall density of population is 729 against the state average of 573.

11) Gurgaon District

As per the 2011 census, Gurgaon has a total population of 1,514,085 of which 817,274 are males and 696,811 are females. As against the state average of 877, the district has 853 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 826. The overall density of population is 1,241 against the state average of 573.

12) Palwal District

As per the 2011 census, Palwal has a total population of 1,040,493 of which 553,704 are males and 486,789 are females. As against the state average of 877, the district has 879 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 862. The overall density of population is 761 against the state average of 573.

13) Faridabad District

As per the 2011 census, Faridabad has a total population of 1,798,954 of which 961,532 are males and 837,422 are females. As against the state average of 877, the district has

871 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 842. The overall density of population is 2,298 which is very much higher than the state average of 573.

14) Gautam Buddha Nagar District

As per the 2011 census, Gautam Buddha Nagar has a total population of 167,4714 of which 904,505 are males and 770,209 are females. As against the state average of 908, the district has 852 females per 1,000 males. In the age bracket 0-6 years, the sex ratio is 845. The overall density of population is 1,306 against the state average of 828.

(2) Economic Profile

1) Raigad District

Major business in the district is fish farming, food processing, coir, herbal and tourism. Agriculture farming provides gainful employment as an occupation for most of its population. Their dependency on land as a source of earning is complete and is directly related to the size of the farm holdings. Thus, development of rural Raigad has always attracted attention of the government, policy framers and social reformers. Most of the work force depends on agriculture and allied activities.

2) Thane District

Thane is the third most industrialised district in the Maharashtra State. There are nearly 1548 large and medium scale and 18,480 small scale industries in the district. The main products of these industries are drugs, textiles, adhesives, plastics, rubber, steel, pharmaceuticals, engineering, fertilizers, electronics, chemicals and iron and steel. The Thane-Belapur-Kalyan industrial belt is the centre of highly sophisticated modern industries. In Ambarnath, Bhiwandi, Badlapur, Tarapur and Murbad, there are nearly 4,000 industries which contribute towards the industrialization of the district.

Traditionally, Bhiwandi is famous for its handlooms. Fisheries constitute another important industry in Thane District. It is carried out in sea as well as in creeks and estuaries on the western coast. Marine fishery predominates over inland fishery in the district and provides employment to about 75% of the persons engaged in the fishing industry. Food processing industries like grain mill products, bakery products, cocoa, chocolate and sugar confectionery, salt, ice, slaughtering, preparation and preservation of meat, dairy products, canning and preservation of fruits and vegetables, canning, preserving and processing of fish are developed in the district.

The Tarapur Atomic Power Station which has ushered an era of utilisation of nuclear energy for electricity generation is also situated in the district.

The important kharif crops of the district are rice, vari and nachani (finger millet). The pulses like urad, moong and kulith are also grown in this season. Rice is the main crop of the district. Rice is grown in all the talukas of the district but mainly in Palghar, Bhiwandi, Murbad, Shahapur, Vada, Vikramgad and Dahanu. Dahanu taluka is famous for fruits. Chikoos (sapotas) are grown on a large scale at Gholwad. Chikoo orchards are also found in Palghar and Talasari Talukas. Other fruits grown in the district are guavas, mangoes, papayas, grapefruits and coconuts. Vasai and Palghar Talukas are famous for different varieties of bananas such as rajeli, tambeli, mutheli and velchi. Seasonal fruits grown in the district such as bor, wild berries and litchis have great demands in the markets of Mumbai. Vegetables are also grown in the district. Among the vegetables, eggplants are grown on a large scale. There are rose gardens at Dahanu.

Some of the potential growth engines in Thane District include the manufacturing sector, construction sector, ecotourism, the services sector (IT and BPO), the retail sector and inland navigation. It offers a tremendous opportunity for the ITES-BPO sector, due to its affordable pricing, fresh air and open, green spaces.

3) Valsad District

Valsad is an industrial base for sectors such as chemicals, textiles, and paper & pulp industries. Since 1980's, textile and chemicals have been the major sectors of investments and employment in the district. The district is emerging as a horticulture hub of the state, witnessing significant production in food grains and crops. With over 300 medium and large scale industries, Vapi is a major industrial center in Valsad witnessing tremendous business activities. Over 10,716 units of small and medium enterprises (SMEs), involved in different sectors, such as chemicals, textiles, engineering, and paper industry etc., are present in the district.

Major horticulture crops being produced in the district are mango, cucurbits, chiku, banana and sugarcane.

The proposed Delhi Mumbai Industrial Corridor (DMIC) and the proximity of the district with Mumbai and Surat have made it a key destination for industrial investments. The development of Maroli Port into a new Greenfield site, which is to be used as an industrial port with an infrastructure of handling 16 MMTPA of general and containerised cargo would help in attracting future investments. Industry sectors such as textiles, wooden boxes, dye stuffs and lathes & machine tools are the supporting pillars of the economy. They provide direct & indirect employment to over 7,000 people in the district. Tourism is another major economic activity observed in the district. Udawada City is an important tourist destination in Valsad District for the Parsi pilgrims, due to the presence of Fire Temple, a World Heritage Site.

4) Navsari District

Textiles, diamond business, sugar industry, agro & food processing, paper, engineering and chemicals are some of the key business sectors in Navsari. The district has well developed floriculture and horticulture activities owing to its suitable climate. The district is the largest producer of chikoo in the state and the largest exporter of the fruit in India. The district has huge sugarcane fields as a result of which sugar manufacturing industry is a major business in Maroli and Gandevi Talukas.

Navsari is the second largest producer of mango and sugercane. It is the largest producer of cucurbits among vegetable crops. Turmeric is the main spice crop of the district.

The development of Vansi-Borsi Port as direct berthing deep water port proposed by Gujarat Maritime Board will fuel the industrial growth in the district. It will improve business opportunities for industries such as mineral based industries, food and agro processing industries, salt industries and marine based industries. The climate of the district is well suited for floriculture activities. Surat- Navsari is proposed to be developed as an industrial area along the Delhi Mumbai Industrial Corridor (DMIC). This will augment development of textiles, chemicals, pharmaceuticals and food processing industries which are prominent sectors.

5) Surat District

Industrial development in Surat District could be attributed to the presence of a large number of diamond processing, textiles and chemical and petrochemical industries.

During 2006-2007, Surat contributed a maximum of 11.5% of Gross Domestic Product (GDP) to the state, as compared to any other district of India. The processes 10 out of 12 varieties of diamonds in the world are approximately 65% of total diamond exports from India. Surat is also the synthetic capital of India and contributes 18% to the total manmade fiber exports and 40% of manmade fabric production in India. The district has been very successful in attracting a sizeable amount of Foreign Direct Investment (FDI) in various sectors like energy, oil and petroleum.

The district is the largest producer of papaya and second largest producer of banana in the state. It is the largest producer of Okra (Lady Finger) in Gujarat. It is the largest producer of turmeric and second largest producer of ginger and chilly in the State.

The upgraded Surat airport is envisaged to offer direct air connectivity with important destinations in India and abroad. This is expected to boost commercial activities in the city as well as in the district, leading to an upsurge in the demand in hospitality sector, which is primarily driven by corporate tourism. Emergence of a petrochemical complex, a gem and Jewellery Park and the centrally promoted Surat SEZ are expected to further fuel the industrial and economic growth of the city. The expansion plan of Hazira Port is envisaged in two phases. The first phase envisions the development of port infrastructure to handle Liquefied Natural Gas (LNG) imports, and the second phase would offer port facilities for handling dry bulk and containerised cargo. The port facility would help in attracting sizeable investments in the times ahead.

6) Bharuch District

Bharuch is a formidable industrial base in sectors as diversified as chemicals & petrochemicals, textiles, drugs & pharmaceuticals and ports & ship building. Several private business conglomerates have their presence in Bharuch. Excellent port connectivity with the presence of Dahej Port makes it an investment destination in port & ship building activities. Over 11,500 units of small and medium enterprises, involved in different sectors, such as chemicals and petrochemicals, textiles etc. are present in the district. With over 70 medium and large scale industries, Ankleshwar is the major industrial center in Bharuch witnessing a large number of business activities

Major horticulture crops being produced in the district are banana, mango, cucurbits, papaya and Brinjal.

Emergence of the Petroleum, Chemicals and Petrochemicals Investment Region, Dahej SEZ and passing of DMIC are expected to further fuel the industrial and economic growth of the district. Centrally located within the industrial belt, Dahej is an ideal location in Asia to serve north, west and central India and international destinations such as, Middle East, Africa, Europe and North America. Bharuch is the exclusive producer of silica sand and presence of a large number of lignite has made the district a thriving industrial base for several industries. The district witnesses a large number of industrial estates and Special Economic Zones (SEZ).

7) Vadodara District

The industrial clusters include chemicals and fertilizers, pharmaceuticals, biotechnology, cotton textiles, machine tools, glass, engineering, tobacco, fisheries and dairy. Major crops cultivated are rice, wheat, sorghum (jowar), yellow peas, grams, oilseeds, groundnut, tobacco, cotton and sugarcane. The district has huge reserves of dolomite and fluorspar. Retail sector is also booming in the district in recent times.

The district is the largest producer of pulses in Gujarat, contributing 14.7% to the total production. Vadodara is among major fruit producing districts in the state, contributing 11.3% to the total fruit production. The district is a major cultivator of flowers in the state, contributing 16% to the total production, of them mogra (33.8%), marigold (18.3%) and rose (14.2%) contribute a substantial share.

The Delhi-Mumbai Industrial Corridor passes through Vadodara, making it a key destination for attracting industrial investments. Vadodara is the exclusive producer of dolomite and fluorspar in Gujarat, offering scope for tremendous growth in the processing industries. Proximity of Vadodara to key industrial centers of Gujarat such as Ahmedabad (via India's first expressway), Bharuch and Surat, along NH8 could be considered a major driver for growth of the economy.

8) Rewari District

The agriculture constitutes the main source of economy in the district. It is also famous for its metal work, particularly brass work and is called as the "brass hub of India". It is also famous for its cottage industries, small-scale industries and medium & large integrated units. Non-Ferrous Industries are producing India's best quality of cold rolled copper and brasses sheets, plates, colis & foils.

9) Alwar District

At present there are fifteen industrial areas developed in Alwar District. There are nearly 300 large and medium scale industrial units in the district. Alwar is fairly rich in mineral wealth. It produces marble, granite, felspar, dolomite, quartz, lime stone, and soap stone.

Alwar has an important place in agriculture production in Rajasthan. In kharif season, bajra, maize, jowar, karif pulses, arhar, sesamum, cotton, guar etc. are sown and in rabi season, wheat, barley, gram, mustard, taramira, rabi pulses etc. are sown. The main source of irrigation is wells and tube wells.

10) Mewat District

The main occupation of the people of Mewat District is agriculture and allied and agro-based activities. The agriculture in Mewat is mostly rain fed except in small pockets where canal irrigation is available. Animal husbandry is the secondary source of income.

11) Gurgaon District

With the passage of time, Gurgaon District has witnessed a phenomenal growth in all spheres of development particularly in urbanization and creating industrial climate. Therefore it is considered as one of the major towns of Haryana State which has been identified for all around development. Its ideal location on the National Highway of Delhi-Jaipur road, in close proximity to the Indira Gandhi International Airport and its well developed infrastructure base like existing roads and communications net work all through the district, total electrification environment has made Gurgaon the choicest location for the industry as such high tech and high value projects involving foreign collaboration with huge investment have come up in this area.

12) Palwal District

Palwal will have a big cargo for road, rail and air transport. The setting up of a transport hub in Palwal will put the district in an advantageous position for its economic growth.

13) Faridabad District

All the villages in the district have been electrified and are connected with pucca road. The major industrial production in the district is of tractors, steel re-rolling, scientific instruments, power looms, agriculture implements, JCB crane etc.

14) Gautam Buddha Nagar District

The importance of Gautam Buddha Nagar and its major industrial areas increases all the more because of its inclusion in the proposed Delhi Mumbai Industrial Corridor. The growth of industries in this district has been such that it is not restricting to the earlier designated industrial area of Noida. Further industrial lands / areas are being developed in the district in the form of Greater Noida, Dadri, Yamuna Express Highway from Greater Noida to Agra.

(3) Health Status

1) Raigad District

Under NRHM, Uran and Roha hospitals in Raigad District were selected for IPHS. Three hospitals, namely, Revdanda, Nagothane and Ambewadi were operationalised in 2006-07. The district has 17 rural family welfare centres and 277 sub-centres. It has 9 rural hospitals and 2 family hospitals. It also has 66 leprosy education and sub centre. There is a district hospital at Alibag in Raigad District.

2) Thane District

Thane District has one dental college. It has 28 hospitals, 43 dispensaries and 122 primary health centres. A number of state of the art hospitals in the private sector are coming up in the Thane District.

3) Valsad District

There are 43 primary healthcare centres, 10 community healthcare centres, 10 governmental and 1 municipal hospitals present in the district. Valsad has several private specialised hospitals to provide a comprehensive range of tertiary and secondary care services backed by state-of-the-art technology and trained medicos. A multi-speciality hospital is present in Vapi giving services in general and laparoscopic surgery, trauma, orthopaedic and urology etc. Beside this, several private hospitals such as, Kasturba Hospital, Bhatia General Hospital, and Adarsh Hospital are also present in Valsad.

4) Navsari District

There are 36 primary healthcare centers, 10 community healthcare centers and 281 sub centers in the district. The district has ‘Navsari Cancer Care Foundation’, a charitable trust which provides services to cancer patients. Navsari has 1 government general hospital which provides basic health facilities.

5) Surat District

Surat has a presence of specialised hospitals to provide a comprehensive range of tertiary and secondary care services backed by state-of-the-art technology and trained clinicians. There are 11 community and 50 primary health centers present in the district. 89 private hospitals are operational in Surat City. The city has some specialised hospitals for the treatment of life threatening diseases such as cancer and tuberculosis.

6) Bharuch District

There are 32 primary health centres, 8 community health centres and 1 civil hospital present in Bharuch. The district has a presence of over 20 private specialised hospitals to provide a comprehensive range of tertiary and secondary care services backed by state-of-the-art technology and trained medicos.

7) Vadodara District

Vadodara has 15 key specialised hospitals for systematic healthcare. Major super specialty cardiac hospitals include Bankers Heart Institute and Baroda Heart Institute & Research Centre. The district has - 76 primary health centers, 16 community health centers, 21 government general hospitals, and 1 mobile comprehensive unit.

8) Rewari District

Rewari District has a civil hospital run by the civil administation. It has fifty beds and the capacity has been planned to increase to one hundred beds. It also has a trauma centre for attending to accidents on highways. Indian Railways has a hospital near Rewari Railway Station. Rewari also has a number of private hospitals and nursing homes. Patients from villages come to Rewari for treatment. It has an active branch of Indian Medical Association.

9) Alwar District

Most health outcomes in Alwar District are above the state average. It has one district hospital and 2 community health centers. It has about 83 primary health centers, 9 maternity and child welfare centers and 460 sub centers.

District hospital in Alwar is a specialized hospital with 413 beds strength having all the specialists including medicine, surgery, pediatrics, ENT, ortho and blood bank. After the launch of NRHM and the implementation of the Janani Suraksha Yojana the number of institutional deliveries at various hospitals in the district has increased tremendously. This is mainly because of the incentive under the JSY. Since the institutional deliveries has increased people starts using the government facilities which increase health seeking behavior of the patients. Health facilities in the private sector are virtually non-existent at the sub-district level in Alwar.

10) Mewat District

Mewat has agovernment general hospital, public health centres and 110 sub-centres in villages. It has 28 homeopathic hospitals.

11) Gurgaon District

Gurgaon has excellent healthcare facilities as the most modern facilities are now available in large corporate hospitals. These hospitals have made Gurgaon the hub of medical tourism in India. In addition, Gurgaon also has several private nursing homes, the district-level civil hospital and several dispensaries run in partnership with various NGOs. Several independent private practitioners, as well as chains of family practice clinics provide outpatient care to the populace.

12) Palwal District

Palwal has a civil hospital and 15 other nursing home and hospitals. Villages of Palwal have primary health centres.

13) Faridabad District

Medical service continued to be provided by a multiplicity of agencies like state government, local bodies and voluntary organisation. In all 6 civil hospitals, 23 ayurvedic and 3 unani, 2 homeopathic, 39 dispensaries, 22 primary health centres, 117 sub-centres and 13 family welfare centres provide medical care facility in the district.

14) Gautam Buddha Nagar District

The district has 4 allopathic, 13 ayurvedic, and 17 homeopathic hospitals. It has 3 CHCs and 18 PHCs. There are 38 family and mother-infant centre and 321 sub centre. The district also has special hospital for tuberculosis and leprosy.

(4) Education Status

Literacy rate of the project affected districts is given in Table 4.2.2. Surat has the highest literacy rate amongst all districts of the overall project area.

Table 4.2.2 Literacy Rate of Overall Project Area

Sl. No.	State/District	Literacy Rate* (%)					
		Persons		Males		Females	
		2001	2011	2001	2011	2001	2011
Maharashtra		76.9	82.9	86.0	89.8	67.0	75.5
1	Raigad	77.0	83.9	86.2	90.7	67.8	76.8
2	Thane	80.7	86.2	87.1	90.9	73.1	80.8
Gujarat		69.1	79.3	79.7	87.2	57.8	70.7
3	Valsad	69.2	80.9	77.9	86.5	59.6	75.0
4	Navsari	75.8	84.8	82.8	90.1	68.6	79.3
5	Surat	77.6	86.7	83.8	91.1	69.9	81.0
6	Bharuch	74.4	83.0	83.0	88.8	65.1	76.8
7	Vadodara	70.8	81.2	80.0	87.6	60.7	74.4
Rajasthan		60.4	67.1	75.7	80.5	43.9	52.7
8	Alwar	61.7	71.7	78.1	85.1	43.3	56.8
Haryana		67.9	76.6	78.5	85.4	55.7	66.8
9	Rewari	75.2	82.2	88.4	92.9	60.8	70.5
10	Mewat	43.5	56.1	61.2	73.0	23.9	37.6
11	Gurgaon	78.5	84.4	88.0	90.3	67.5	77.6
12	Palwal	59.2	70.3	75.1	82.6	40.8	56.4
13	Faridabad	76.3	83.0	85.1	89.9	65.5	75.2
Uttar Pradesh		56.3	69.7	68.8	79.2	42.2	59.3
14	Gautam Buddha Naga	69.3	82.2	81.5	90.2	54.7	72.8

Note-* Literacy rate is the percentage of literates to population aged 7 years and above
Source: Census of India, 2011

1) Raigad District

Raigas has a literacy rate of 83.9% which is higher than the state average of 82.9%, as per 2011 census. Dr. Babasaheb Ambedkar Technological University is a unitary, autonomous university located in Raigad District.

2) Thane District

Thane has a literacy rate of 86.2% which is higher than the state average of 82.9%, as per 2011 census. There are 2,699 primary, 804 secondary and 152 higher secondary schools in the district. There are 26 industrial training institutes which offer several industrial training

programs in cutting and sewing, fitting, diesel engine mechanic, information technology and electronic system management.

3) Valsad District

Valsad has a literacy rate of 80.9% which is slightly higher than the state average of 79.3%, as per 2011 census. There are 990 primary and 161 secondary and higher secondary schools in the district. There are 6 industrial training institutes offering several industrial training programs which includes, fitting, armature and motor rewinding, electrician, information technology and electronic system maintenance etc. One Government polytechnic college is present in the district offering courses in civil, chemical, electrical, mechanical and plastic engineering. There is one Degree Engineering College present in Valsad offering engineering courses in mechanical and chemical branches.

4) Navsari District

Navsari has a literacy rate of 84.8% which is higher than the state average of 79.3%, as per 2011 census. Navsari Agriculture University in the district provides education in the fields of agriculture, forestry, horticulture, and fisheries. Sugarcane Research Station at Navsari Agriculture University is mainly engaged in the research of crop improvement, crop production, and crop protection. Mahatma Gandhi Institute of Technical Education and Research in the district offers courses in computer science, electrical, electronics, communication and mechanical engineering. Industrial Training Institutes in the Navsari provide training in areas like cutting and sewing, welding, fitting, dress making, chemical plant operating, computer operating, stenography, armature and motor rewinding etc.

5) Surat District

Surat has a literacy rate of 86.7% which is much higher than the state average of 79.3%, as per 2011 census. Surat has many medical, nursing, ayurvedic and physiotherapy colleges. Technical colleges offering courses in chemical, civil, electrical, electronics and communication, information technology, production and mechanical engineering are also present in the district. Institutes providing specialised courses in gems and jewellery and textile sector are also widely available to provide trained manpower for the industry. Indian Diamond Institute provides different courses in diamonds, coloured gemstones and machine cast jewellery. Besides imparting training, it is also undertaking research and development and consultancy services. Man Made Textile Research Association has been established to carry out research and development, testing and technical service activities to the man-made fiber textiles industry.

6) Bharuch District

Bharuch has a literacy rate of 83.0% which is higher than the state average of 79.3%, as per 2011 census. There are 850 primary, 118 secondary and 55 higher secondary schools in the district. There are 17 industrial training institutes which offer several industrial training programs in cutting and sewing, fitting, diesel engine mechanic, information technology and electronic system management. K.J. Polytechnic College in the district offers diploma courses to about 400 students every year in electronics, mechanical, computers, cosmetic design, chemical, civil and electrical engineering. Shri Sadvidya Mandal Institute of Technology and a Government engineering college are present in the district.

7) Vadodara District

Vadodara has a literacy rate of 81.2% which is higher than the state average of 79.3%, as per 2011 census. It has only one university, well known for its quality of education and renowned for several departments such as fine arts, medicine, arts and commerce,

journalism and communication, among several others. Other well renowned institutions include Indian Institute of Materials Management and National Fire Academy. The district also has institutes providing courses in physiotherapy, ayurvedic and homeopathic medicines. 33 industrial training institutes in Vadodara offer facilities to train the workforce at shop-floor level, which is a major requirement for all industries. 3 engineering colleges offer courses in all branches of engineering, 9 polytechnic college offers diploma courses in electrical, mechanical and plastic engineering

8) Rewari District

Rewari has a literacy rate of 82.2% which is higher than the state average of 76.6%, as per 2011 census. Rewari has 3 degree colleges, 2 teachers training colleges, 13 secondary / higher secondary schools, one industrial training institute and one footwear training institute. Several private colleges have been set up in Rewari District in the last decade to teach engineering, nursing, management, law, etc. though the quality of education in some of them is low.

9) Alwar District

Alwar has a literacy rate of 71.7% which is higher than the state average of 67.1%, as per 2011 census. There are 3,885 primary and middle schools, 356 secondary and senior secondary schools, 33 colleges in Alwar District.

10) Mewat District

Mewat has a literacy rate of 56.1% which is lower than the state average of 76.6%, as per 2011 census. There are 531 primary schools, 272 middle schools, 44 secondary schools, and 24 senior secondary schools and 6 new model schools. Mewat also has 4 industrial training institues and 6 colleges. The literacy rate in Mewat is appallingly low, particularly in case of females.

11) Gurgaon District

Gurgaon has a literacy rate of 84.4% which is higher than the state average of 76.6%, as per 2011 census. Gurgaon is home to India's top business schools.

12) Palwal District

Palwal has a literacy rate of 70.3% which is lower than the state average of 76.6%, as per 2011 census.

13) Faridabad District

Faridabad has a literacy rate of 83.0% which is higher than the state average of 76.6%, as per 2011 census. Higher and Senior Secondary schools continue to provide educational facilities to a large number of students. In addition, there are 20 degree colleges available in the district. Faridabad has several private deemed universities including several engineering colleges. However, most students aim to study in better-reputed government institutes outside of the city.

14) Gautam Buddha Nagar District

Gautam Buddha Nagar has a literacy rate of 82.2% which is higher than the state average of 69.7%, as per 2011 census. Gautam Buddha Nagar has 636 basic school and 127 senior basic schools, central school and Navodaya Vidyalaya. It also has degree colleges and state university. There are various engineering colleges and dental college.

(5) Heritage

1) World Heritage

There are 28 World Heritage Properties in India, out of which 23 are Cultural Properties and 5 are Natural Properties. All properties are out of the ESIA study area.

2) National Heritage

All the ancient and historical monuments and archaeological sites and remains are protected under the Ancient and Historical Monuments and Archaeological Sites and Remains (Declaration of National Importance) Act, 1951 (No LXXI of 1951). There are 104 properties of national importance in districted covered by the ESIA. Out of these, 14 are located within project affected Taluk/Tahsil (See Table 4.2.3). For properties whose exact location is identifiable, it is confirmed that they are at least several km away from the railway alignment.

Table 4.2.3 List of Ancient/Historical Monuments and Archaeological Sites in the Project-affected Taluk/Tahsil

Sl/No	Ancient/Historical Monuments and Archaeological Sites	Location (Taluk/Tahsil)	District	State
1	Dargah known as Khawaja Dana Saheb's Rouza	Surat	Surat	Gujarat
2	Old Armenian Tombs	Surat	Surat	Gujarat
3	Tomb of Khawaja Safar Sulemani	Surat	Surat	Gujarat
4	Old English and Dutch Tombs	Surat	Surat	Gujarat
5	Ancient site comprising S.Plot No.535	Kamrej	Surat	Gujarat
6	Fateh Burj	Vyara	Surat	Gujarat
7	Frescos on the walls of Tambekar's Wada	Vadodara	Vadodara	Gujarat
8	Historic site	Vadodara	Vadodara	Gujarat
9	Ancient site (Excavated)	Karvan (Kayavarohan)	Vadodara	Gujarat
10	Gateway of Torana	Karvan (Kayavarohan)	Vadodara	Gujarat
11	Jami Masjid	Bharuch	Bharuch	Gujarat
12	Lal Masjid	Tijara	Alwar	Rajastan
13	Kos Minar No. 11	Mawai (Faridabad Sector - 29)	Faridabad	Haryana
14	Kos Minar No. 19	Palwal	Faridabad	Haryana

Source: Archaeological Survey of India (ASI), Ministry of Culture, 2011

4.2.2 Socio-economic Conditions of the Immediate Project Affected Area

Socio-economic conditions with respect to demography of the immediate project affected area are provided below:

(1) Demographic profile

1) Raigad District

Jasai, Vadaghar, Kalundre are the bigger villages with population more than 5,000 persons. Literacy rate is good. Work participation rate is as high as 61% in some villages.

2) Thane District

Vangaon, Saravali, Shirgaon, Juchandra and Rahanal are the bigger villages with population more than 5,000 persons. Literacy rate is average. Work participation rate is as high as 57% in some villages.

3) Valsad District

Pardi Parnera, Pardi Sondhpur, Umarsadi, Vapi are the bigger villages with population of more than 5,000 persons. Literacy rate is average. Work participation rate is as high as 56% in some villages.

4) Navsari District

Sari bujrang, Amalsad, Mahuvar, and Bilimora are the bigger villages with population more than 5,000 persons. Literacy rate is average. Work participation rate is as high as 59% in some villages.

5) Surat District

Sayan, Kosamba, Kosad, and Variayav are the bigger villages with population of more than 10,000 persons. Work participation rate is as high as 54% in some villages.

6) Bharuch District

Bhadkodra, Diva, Kanthariya, Tankariya, Ikhar, Manubar and Ankleshwar are the bigger villages with population of more than 5,000 persons. Literacy rate is above national average for rural areas. Work participation rate is as high as 62% in some villages.

7) Vadodara District

Pingalwada, Kurai, Bodaka, Kambola, Mangrol and Mesrad are the villages with population of more than 1,000 persons. Literacy rate is higher than the average rural national level status of 58.7%. Work is defined as participation in any economically productive activity. All persons engaged in 'work' are workers. Work participation rate is as high as 67% in some villages. State wise work participation for Delhi is 32.8%, Haryana 39.9%, Uttar Pradesh 33.3% and Rajasthan as 42.8% (Census 2001).

8) Rewari District

Nandrampur Bas, Bharawas are the bigger villages with population more than 4,000 persons. Work participation rate is as high as 56% in some villages.

9) Alwar District

Only Jhiwana village has population more than 3,000 persons. Literacy rate is average and varying among villages. Work participation rate is as high as 66% in some villages.

10) Mewat District

Only Sehsaula village has the population more than 5,000 persons. Literacy rate is average. Work participation rate is as high as 49% in some villages.

11) Palwal District

Only Pirthala village has population more than 6,000 persons. Work participation rate is as high as 49% in some villages.

12) Gurgaon District

Only Udaka village has population more than 3,000 persons. Literacy rate is average. Work participation rate is as high as 52% in some villages.

13) Faridabad District

Pithala, Kheri Kalan are the bigger villages with population more than 5,000 persons. Literacy rate is average. Work participation rate is as high as 67% in some villages.

14) Gautam Buddha Nagar District

Sakipur is the bigger village with population more than 4,000 persons. Literacy rate is average. Work participation rate is as high as 43% in some villages.

CHAPTER 5
RESULTS OF SCOPING

CHAPTER 5 RESULTS OF SCOPING

As per the current regulations of Government of India, railway and bridge projects do not require conducting Environmental Impact Assessment studies and obtaining Environmental Clearance from the MoEF. Clause 11 of Railways Act 1989 empowered the Railways to carry out any kind of construction anywhere without any restriction. As per the notification of the MoEF dated 27th January 1994, amendment dated 4th May 1994 and new notification dated 14th September 2006, expansion or modernization of any activity shall not be undertaken in any part of India, unless it has been accorded environmental clearance for the projects enlisted under schedule of the Act. Under this schedule, railway and bridge projects are not included. However, considering the magnitude of activities envisaged as part of proposed corridor, the ESIA study has been exercised to mitigate potential negative environmental and social impacts by the project.

The process of ESIA shall constitute a systematic approach to the evaluation of a project in the context of the natural, regulatory and environment of the area in which development is proposed. Soon after the commencement of planning and design process, based on desk study, reconnaissance survey and experience of earlier projects, detailed methodology and schedule shall be prepared for the effective and timely execution of the environment and social impact assessment. The next step in the ESIA will be to define the proposed project activities and the natural, regulatory (i.e. legal) and environment of the area in which development will occur. This can be achieved through Scoping. The scoping identifies which of the activities has a potential to interact with the environment and shall be conducted early in the ESIA process to focus on the priority issues (i.e. those that have the greatest potential to affect the natural and/or environment) can be established for the rest of the ESIA process.

5.1 ENVIRONMENTAL SCOPING FOR THE ESIA STUDY

Environmental scoping for the proposed corridor, which clarifies conceivable environmental and social impacts due to proposed projects activities, was conducted. The major environment and social impact assessment studies are presented in the following scoping matrix and checklist. Details on the scoping were examined for its finalization through the public consultation meeting (PCM). It is noted that the evaluation in the matrix is made by considering a degree of conceivable impacts in the case any adequate mitigation measure is not conducted and also common to all of the proposed railway sections. The evaluation was utilized for preparation of specifications of detailed study as ESIA study.

5.1.1 Environmental Scoping for the ESIA Study

Environmental scoping for the Phase 2 of the Western Corridor is described in Table 5.1.1.

Table 5.1.1 Environmental Scoping Matrix for the Proposed Projects

	No.	Likely Impacts	Overall Rating	Project-related Activities								
				Planning / Design Phase		Construction Phase					Operation Phase**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of track, station,, viaduct/bridges and other related facilities	Traffic restriction in construction area	Operation of trains	Appearance / occupancy of track and related facilities
Pollution	1	Air pollution	B-/ B+	-	-	-	-	B-	B-	-	B+	-
	2	Water pollution	B-	-	-	-	B-	-	B-	-	-	-
	3	Soil contamination	B-	-	-	-	-	B-	-	-	-	-
	4	Waste	B-	-	-	-	B-	-	B-	-	-	-
	5	Noise and vibration	A-	-	-	B-	B-	B-	B-	-	A-	-
	6	Ground subsidence	-	-	-	-	-	-	-	-	-	-
	7	Offensive odor	B-	-	-	-	B-	-	B-	-	-	-
	8	Bottom sediment	B-	-	-	-	B-	-	B-	-	-	-
	9	Electromagnetic / radio wave interference	C-	-	-	-	-	-	-	-	-	C-
	10	Obstruction of sunshine	C-	-	-	-	-	-	-	-	-	C-
	11	Disaster	A-	-	-	-	-	-	A-	-	-	-
Natural Environment	12	Topography and geographical features	B-	-	-	-	B-	-	-	-	C	-
	13	Soil erosion	B-	-	-	-	B-	-	-	-	-	-
	14	Groundwater	B-	-	-	-	B-	-	-	-	-	-
	15	Hydrological situation	B-	-	-	-	B-	-	-	-	-	-
	16	Coastal zone	B-	-	-	-	B-	-	-	-	-	-
	17	Flora, fauna and biodiversity	B-	-	-	B-	B-	-	C-	-	-	-
	18	Meteorology	-	-	-	-	-	-	-	-	-	-
	19	Landscape	B-	-	-	-	B-	-	-	-	-	C-
	20	Global warming	C-/ B+	-	-	C-	-	-	-	-	B+	-
Social Environment*	21	Involuntary resettlement	A-	A-								
	22	Local economy such as employment and livelihood, etc.	A-/ A+	A-	-	B +	B-/ B+	-	B-/B +	B-	A+	-
	23	(Surrounding) Land use and utilization of local resources	B-	B-	B-	-	-	-	-	-	B-	-
	24	Social institutions (including regional severance)	B-	B-	B-	-	B-	-	B-	B-	B-	-
	25	Existing social infrastructures and services	B-/ C-	B-	-	-	B-	-	B-	B-	C-	-
	26	Socially vulnerable groups such as the poor, indigenous and ethnic people	C-	C-	-	C-	C-	-	C-	C-	C-	-
	27	Misdistribution of benefit and damage	C-	C-	-	-	-	-	-	-	C-	-
	28	Historical and cultural heritage (including religious matters)	B-/ C-	C-	-	-	-	B-	B-	B-	B-	-

	No.	Likely Impacts	Overall Rating	Project-related Activities								
				Planning / Design Phase		Construction Phase					Operation Phase**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of construction equipment and vehicles	Construction of track, station,, viaduct/bridges and other related facilities	Traffic restriction in construction area	Operation of trains	Appearance / occupancy of track and related facilities
Social Environment*	29	Water usage or water rights and rights of common	-	-	-	-	-	-	-	-	-	-
	30	Local conflict of interests	C-	C-	-	-	-	-	-	-	C-	-
	31	Sanitation	B-	-	-	-	-	-	B-	-	-	-
	32	Hazardous (risk) infectious diseases such as HIV/AIDS	B-	-	-	-	B-	-	B-	-	-	-
	33	Accident	B-/ B+	-	-	B-	B-	B-	B-	-	B-/ B+	-
	34	Occupational Safety	B-	-	-	B-	B-	B-	B-	B-	-	-

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.

** 'Operation and maintenance of depot' is excluded in the final scoping matrix and changed from the original scoping matrix, as it is not a part of DFC Phase 2

<Rating>

A-: Serious impact is expected, if any measure is not implemented to the impact.

B-: Some impact is expected, if any measure is not implemented to the impact.

C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)

-: No impact is expected. Therefore, EIA is not required.

A+: Remarkable effect is expected due to the project implementation itself and environmental improvement caused by the project.

B+: Some effect is expected due to the project implementation itself and environmental improvement caused by the project.

Overall rating: Highest rate will be the overall rating among the rating of relevant project-related activities for negative and positive ratings, respectively. (e.g. Even only one "A-" is included in an environmental item, overall rating of the environmental item becomes "A-".)

Reference: Japan Transport Cooperation Association (JTCA) and Japan Railway Technical Service (JARTS) (1996) "Manual for Environmental Considerations in International Cooperation for Transportation Technology (Railway Project) (provisional translation)", Tokyo, Japan.

Source: JICA survey team

5.1.2 Checklist of Environmental Scoping

Checklist of environmental scoping for the Phase 2 of the Western Corridor has been also prepared while scoping as described in Table 5.1.2. It was presented and discussed at the first round of PCM.

Table 5.1.2 Checklist of Environmental Scoping for the Proposed Projects

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
Pollution					
1	Air pollution	B-/ B+	B-	C	*<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Emission of exhaust gas from construction equipment and vehicles and dust pollution due to operation of the construction equipment and vehicles would cause air pollution in and around the construction sites during the construction.
			B+	O	*<Operation of trains>* Reduction of hazardous substances emitted from vehicles would be expected due to reduction of traffic congestion and traffic volume by changing freight transportation mode from truck to the proposed railway system.
2	Water pollution	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Muddy water from construction site and oil spill from construction equipment and vehicles would cause water pollution in the channel/river in and around the construction site.
3	Soil contamination	B-	B-	C	*< Leakage of oil and grease from construction equipment>* Soil contamination is likely to take place due to leakage of asphalt emulsifier at pavement of road. Soil contamination may also take place during filling of oil in vehicles or leakage from vehicles..
4	Waste	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Residue soil due to earth works would cause environmental impact in the disposal site.
			B-	C	*<Construction of track, station, , viaduct/bridges and other related facilities>* Construction waste including residue soil would cause environmental impact in the disposal site.
5	Noise and vibration	A-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges and other related facilities>* - Noise and vibration caused by such construction works and construction vehicle/equipment would annoy the residents and school/hospital nearby. - Vibration caused by such construction works would cause damage to the existing house and other kinds of building structures such as cracks in the wall.
			A-	O	*<Operation of trains>* Operation of the trains would cause noise along the railway track during operation time. Religious places near the freight railway and relevant facilities might be affected by the noise and vibration of the freight trains.
6	Ground subsidence	-	-	-	The project does not have any factor which may cause the ground subsidence in terms of project location and construction method.
7	Offensive odor	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges and other related facilities>* In some sections where pass along rivers and channels, offensive odor would occur around the construction site due to excavation and dredging of mad in the rivers/channels during the construction.
8	Bottom sediment	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, viaduct/bridges and other related facilities>* During the works in the construction phase, excavated soil would cause sedimentation, flushed into water course in case of rain.
9	Electromagnetic / radio wave interference	C-	C-	O	*<Appearance / occupancy of track and related facilities>* Embankment/bridge structure of the railway might interfere with the radio wave such as radio and television in the case where building structure is very close to the railway.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
Pollution					
10	Obstruction of sunshine	C-	C-	O	*<Appearance / occupancy of track and related facilities>* Due to embankment/bridge structure for elevated track, some railway tracks very close to the building might cause obstruction of sunshine to the building, especially residential house.
11	Disaster	A-	A-	O	*<Construction of track, station, , viaduct/bridges and other related facilities>* Embankment structure of the DFC, which is mainly applied in most of the section, would trap rain water and cause flood around the project area.
Natural Environment					
12	Topography and geographical features	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* In the most of sections, elevated bridge structure of the railway track will mainly be constructed in the center or along the existing road. However, earthworks would affect topographic condition in some sections along the river/channel.
13	Soil erosion	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works along the river/channel in some sections would cause soil erosion in some sections.
14	Groundwater	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Associated with the tunnel construction at the Vasai detour, a groundwater flow at the area would be affected. Associated with the deep cutting at the Aravalli range at the section of Rewari-Dadri, groundwater flow at the area would be affected.
15	Hydrological situation	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works along the river/channel in some sections would affect hydrological situation in such channel/river.
16	Coastal zone	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* DFC alignment passes the swamp area at river mouth in Dahanu, Thane District. Earth works associated with the construction works would affect the coastal environment through contamination by turbid water.
17	Flora, fauna and biodiversity	B-	B-	C	*<Land clearing / tree cutting>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Existing trees and plants on the ROW and work sites would be removed tentatively or permanently for the construction. DFC alignment is passing through the areas of National Park, Wildlife Sanctuary, Eco sensitive area in Raigad and Thane Districts, Maharashtra State in parallel to the existing railway. Animal movements on those areas are likely affected.
18	Meteorology	-	-	-	The project does not have any factor which may affect and/or be related to the meteorology.
19	Landscape	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* Construction works such as earthworks would affect the landscape in the project site.
			B-	O	*<Appearance / occupancy of track and related facilities>* Existing of elevated bridge structure of the railway track would affect the landscape from prior one in and around the project site.
20	Global warming	C- / B+	C-	C	*< Land clearing / tree cutting>* Cutting of existing trees and plants alongside the ROW due to construction of the railway will partly reduce amount of total resource of the CO_2 absorption in the area.
			B+	O	*<Operation of trains>* With change of transport mode from fossil fuel used automobile to electrified railway system, reduction of emission of greenhouse gas such as CO_2 will be expected as per unit transport distance per person.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
Social Environment*					
21	Involuntary Resettlement	A-	A-	P	<*Land acquisition*> It is expected that a large scale of involuntary resettlement (more than 200 persons to be displaced) will be caused by the Project, even though the railway alignment is planned to minimize the scale of the involuntary resettlement by applying the following policy: (1) Existing railway land is used for the DFC as much as possible to avoid land acquisition; (2) In the section where existing railway land is not available in built-up area, detour is planned to avoid/minimize the involuntary resettlement; and (3) Due to some limitations such as a feature of the railway alignment which makes design sharp curb unable, and topographic condition in the project area, involuntary resettlement will be caused by the project. Additionally, a larger impact is expected for land owners which land will be partially required due to a feature of the linear project. According to DFCCIL's "Section Wise Progress of Land Acquisition" as on 31 August 2010, it is expected that approximately 2,348 ha.
22	Local economy such as employment and livelihood, etc.	A-/ A+	A-	P	<*Land acquisition*> While detour route is applied to minimize the involuntary resettlement in the built-up area, the detour route passes through agricultural land in the most project area. Acquisition of the agricultural area for the Project would affect livelihood for a large number of farmers whose farmland will be acquired.
			B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, , viaduct/bridges & other related facilities*> <*Traffic restriction in construction area*> Overall construction activities and traffic restriction would affect local economy activities to some extent due to disturbance in smooth operation of commercial/public transportation during construction.
			B+	C	<*Deforestation / tree cutting*> <*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, , viaduct/bridges & other related facilities*> Overall, the construction of the Project will make more employment and business opportunities for local residents during construction.
			A+	O	<*Operation of trains*> After operation of the DFC, regional economy particularly industrial sector in major industrial locations along the DFC would have positive impact due to improved freight transportation.
23	(Surrounding) Land use and utilization of local resources	B-	B-	P	<*Land acquisition*> <*Change of land use plan, control of various activities by regulations for the construction*> Land use could be worsened due to the acceleration of unplanned development along the proposed route and around new stations unless the land use is property planned by the local government.
			B-	O	<*Operation of trains*> - ditto -
24	Social institutions (including regional severance)	B-	B-	P	<*Land acquisition*> <*Change of land use plan, control of various activities by regulations for the construction*> Regional severance is expected due to construction of a new freight tracks with mainly embankment structure as well as stations, viaduct/bridges and other related facilities.
			B-	C	<*Alteration to ground by cut land, filling, drilling, tunnel, etc.*> <*Construction of track, station, , viaduct/bridges & other related facilities*> <*Traffic restriction in construction area*> During construction, if access to the rest of the community is disturbed, social institution could be temporarily disturbed.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
			B-	O	*<Operation of trains>* Regional severance is expected due to construction of a new freight tracks, stations, viaduct/bridges and other related facilities.
25	Existing social infrastructures and services	B-/ C-	B-	P	*<Land acquisition>* Land acquisition for the project, involving relocation of public and/or community facilities, would affect local communities to some extent.
			B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction work and traffic restriction would disturb access to the existing social infrastructures and services.
			C-	O	*<Operation of trains>* Unless affected existing social infrastructure is replaced in a proper manner, nearby residents' access to existing social infrastructure will be negatively affected.
26	Socially vulnerable groups such as the poor, indigenous and ethnic people	C-	C-	P	*<Land acquisition>* Overall, it is expected that the poor, illegal occupants, small scale farmers, women headed households, and the disables would be affected by land acquisition and/or resettlement. The extent shall be studied through the RRP and public consultation meetings. As for the impact on the indigenous and ethnic people, the potential impacts on the Scheduled Caste and Scheduled Tribes needs to be studied in the RRP.
			C-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction activities and traffic restriction would cause inconvenience to the disables in construction area.
			C-	O	*<Operation of trains>* The project would cause inconvenience to the disables to during operation in the detour areas. Construction of RUBs in the detour areas should be considered as the Phase 1 project.
27	Misdistribution of benefit and damage	C-	C-	P	*<Land acquisition>* Inequality between beneficiaries of the Project (e.g. overall DFC owners/users) and the Project Affected Persons (PAPs) (e.g. affected land owners/users and nearby residents) would occur to some extent. The type and extent of the damage (negative impacts of the project) shall be studied and mitigated by under the ESIA and RRP.
			C-	C	*<Operation of trains>* - ditto -
28	Historical and cultural heritage (including religious matters)	B-/ C	C-	P	*<Land acquisition>* Some existing historical, cultural and religious assets along the planned alignment and in proposed relevant facilities will be affected by the Project; however the number is not known and should be studied in the RRP.
			B-	C	*<Operation of construction equipment and vehicles >* Religious places which usually require silence might be affected by the noise and vibration of the construction equipment and vehicles.
			B-	C	*<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Access to historical places, cultural, and religious places might be disturbed by construction activities and traffic restriction and during construction temporarily.
			B-	O	*<Operation of trains>* Religious places near the freight railway and relevant facilities might be affected by the noise and vibration of the freight trains.

No.	Likely Impacts	Rating		Project phase	Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"< >".)
		Overall	by project phase		
29	Water usage or water rights and rights of common	-	-	-	The impact on water usage is not directly relevant to the project except some limited amount of water will be used for during construction.
30	Local conflict of interests	C-	C-	P	*<Land acquisition>* Conflicts of interests related to the Project could occur among beneficiaries and the PAPs unless the adequate RRP and public consultation are not arranged.
			C-	O	*<Operation of trains>* - ditto -
31	Sanitation	B-	B-	C	*<Construction of track, station, , viaduct/bridges & other related facilities>* Sanitary issues would occur in labor camp and neighboring area in the case sanitary facility is not adequately installed such as toilet and septic tank.
32	Hazardous (risk) infectious diseases such as HIV/AIDS	B-	B-	C	*<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, , viaduct/bridges & other related facilities>* Risk of infectious diseases by labors would be expected during construction due to the inflow of the construction workers from outside.
33	Accident	B- B+	B-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges and other related facilities>* Some accidents are inevitable during construction.
			B+	O	*<Operation of trains>* In the long run, with a change of transport mode from freight trucks to railway system, a reduction of accidents would be expected due to a decrease of the number of freight trucks.
			B-	O	*<Operation of trains>* Some minor accidents are inevitable during operation.
34	Occupational safety	B-	B-	C	*<Deforestation / tree cutting>* *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, , viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Minor negative impacts on occupational safety are inevitable during construction; however, it will be secured in accordance with the domestic laws and regulations during construction.

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.

<Rating>

A-: Serious impact is expected, if any measure is not implemented to the impact.
B-: Some impact is expected, if any measure is not implemented to the impact.
C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)
-: No impact is expected. Therefore, EIA is not required.
A+: Remarkable effect is expected due to the project implementation itself and environmental improvement caused by the project.
B+: Some effect is expected due to the project implementation itself and environmental improvement caused by the project.
Overall rating: Highest rate will be the overall rating among the rating of relevant project-related activities for negative and positive ratings, respectively. (e.g. Even only one "A-" is included in an environmental item, overall rating of the environmental item becomes "A-".)

<Project phase> P: Planning and design phase, C: Construction phase, O: Operation phase

Reference: Japan Transport Cooperation Association (JTCA) and Japan Railway Technical Service (JARTS) (1996) "Manual for Environmental Considerations in International Cooperation for Transportation Technology (Railway Project) (provisional translation)", Tokyo, Japan.

Source: JICA survey team

5.2 PUBLIC CONSULTATION MEETINGS

The Public Consultation Meetings(PCMs) for ESIA were carried out at the time of environmental scoping in the initial stage of the ESIA study. Information on the Project and scope of the ESIA study was disseminated to the public, and comments and opinion was collected to incorporate in the ESIA study. The results of PCMs are described in Chapter 9.

CHAPTER 6
POLLUTION CONTROL STUDY

CHAPTER 6 POLLUTION CONTROL STUDY

6.1 NOISE

6.1.1 Study Methodologies

(1) Survey on Regulations of Railway Noise

The published literature, governmental documents, and existing regulations related to the noise pollution in India and those in Japan were reviewed to grasp potential impacts and to consider mitigation measures.

(2) Survey of Existing Circumstance

1) Railway and Background Noise Level Measurement along the Parallel Section

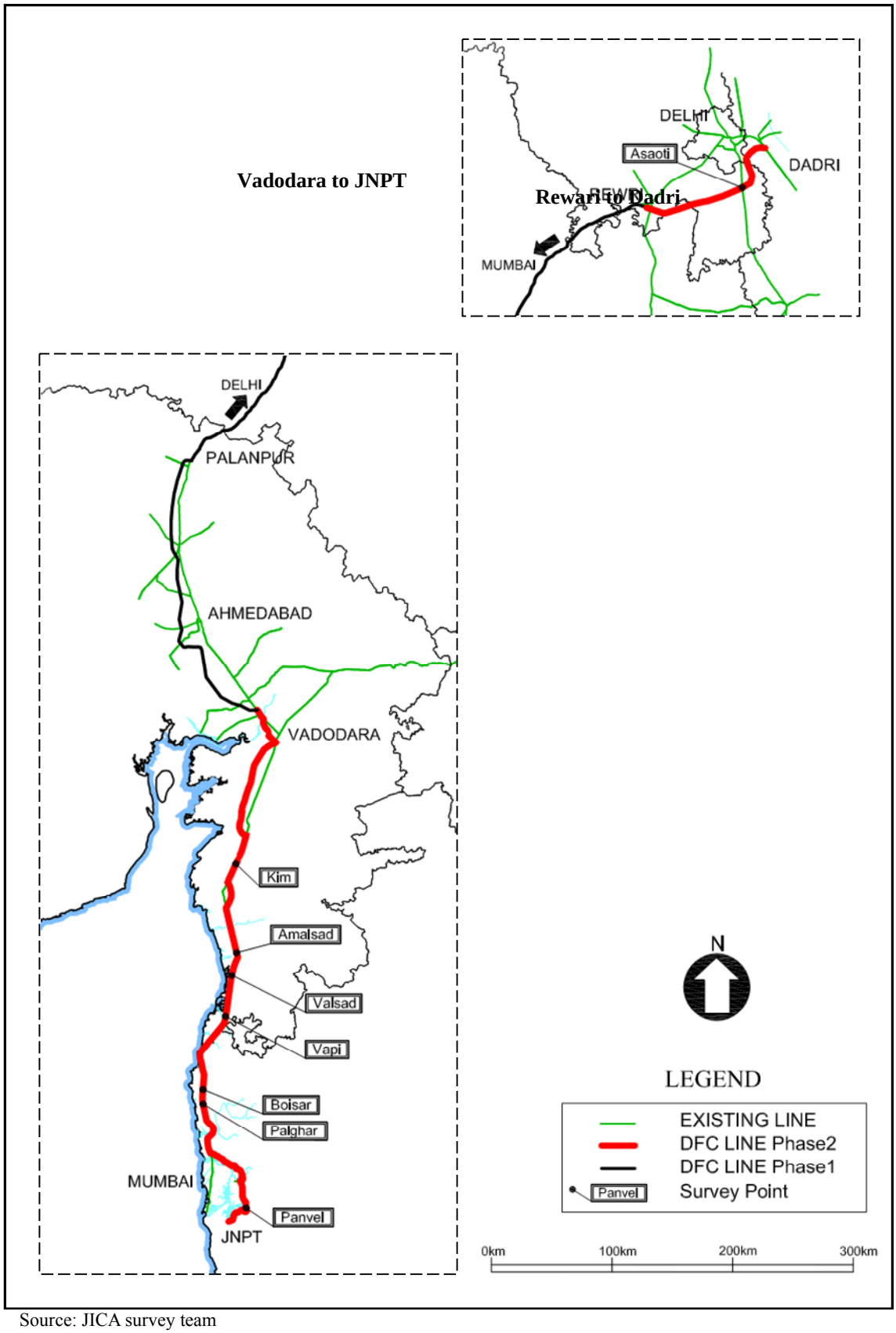
a) Measurement Sites

In parallel sections, in the case there are facilities which require silent circumstance such as school, hospital, temple and residence etc, noise generated by DFC operation in addition to existing railway might make the actual impact against them at the operation period. Therefore, in consideration of land use, relatively near and densely populated areas were selected as measurement locations. They are Panvel, Palgar, Boisar, Vapi, Valsad, Amalsad, Kim and Asaoti stations. The height of measurement is 1.2m above the ground. These places are shown in Table 6.1.1, Figure 6.1.1, and Figure 6.1.2(1)-(8).

Table 6.1.1 Details of Noise Measurement Sites

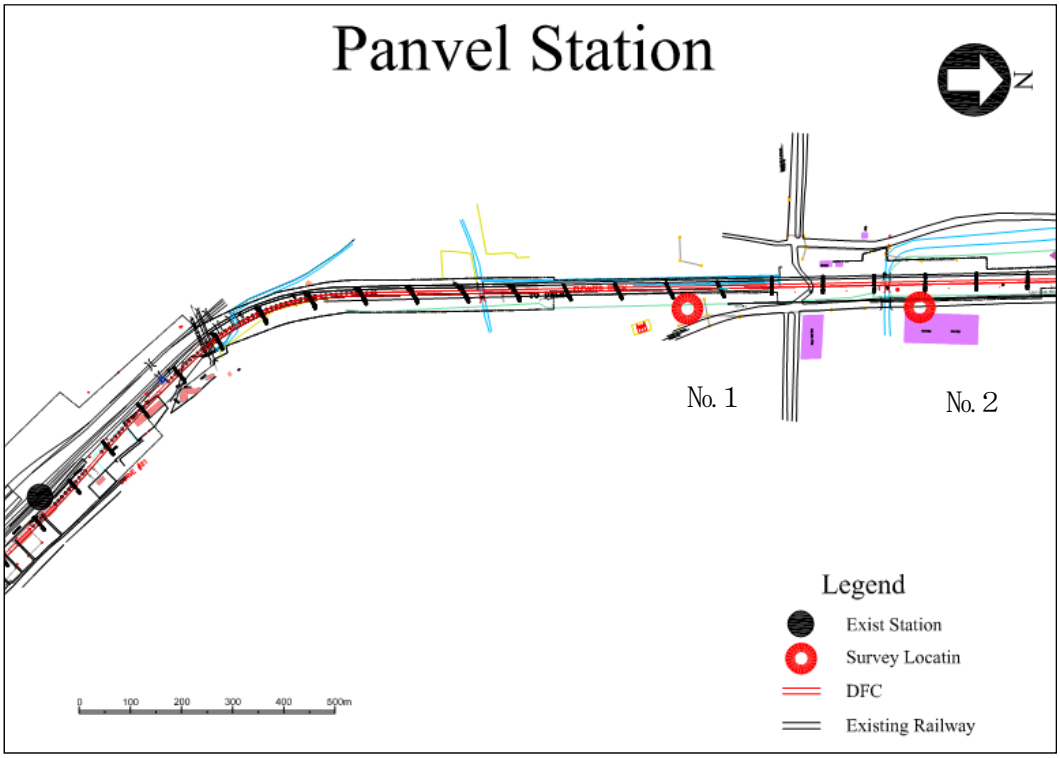
Survey Point	No.	Location		Numbers of measurement point	Reason of choose
		Latitude	Longitude		
Panvel	1	N19 00.455	E73 06.932	2(12.5m,25.0m)	Residential area
	2	N19 00.508	E73 03.566	2(14.5m,25.0m)	Residential area
Palgar	1	N19 42.224	E72 46.243	2(12.5m,25.0m)	Residential area
	2	N19 42.470	E72 46.173	2(10.0m,20.0m)	Residential area
Boisar	1	N19 48.333	E72 45.721	2(12.5m,23.0m)	Residential area
	2	N19 48.784	E72 45.744	2(15.0m,28.0m)	Residential area
Vapi	1	N20 21.025	E72 54.334	2(12.5m,25.0m)	Industrial area
	2	N20 21.653	E72 54.420	2(12.5m,25.0m)	Industrial area , near temple
Valsad	1	N20 35.242	E72 55.915	2(15.0m,25.0m)	Residential area
	2	N20 35.819	E72 55.962	2(12.5m,25.0m)	Residential area
Amalsad	1	N20 48.903	E72 57.279	2(12.5m,25.0m)	Residential area
	2	N20 49.005	E72 57.259	2(12.5m,24.0m)	Residential area , near temple
Kim	1	N21 23.539	E72 55.441	2(12.5m,25.0m)	near school
	2	N21 23.679	E72 55.466	2(12.5m,25.0m)	Residential area
Asaoti	1	N28 14.746	E77 19.523	2(12.5m,25.0m)	Residential area
	2	N28 15.457	E77 19.392	2(12.5m,25.0m)	Industrial area

Note: ( ) indicates the distance from centre of existing railway line.
Source: JICA survey team



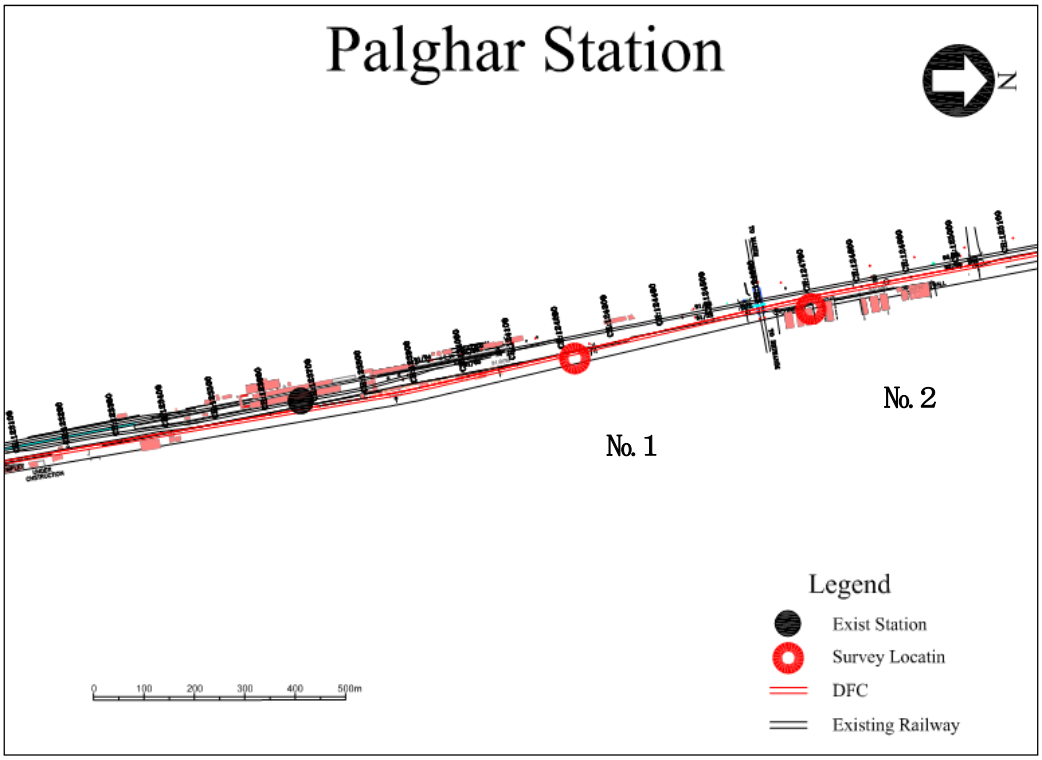
Source: JICA survey team

Figure 6.1.1 Target Areas for Noise Measurement



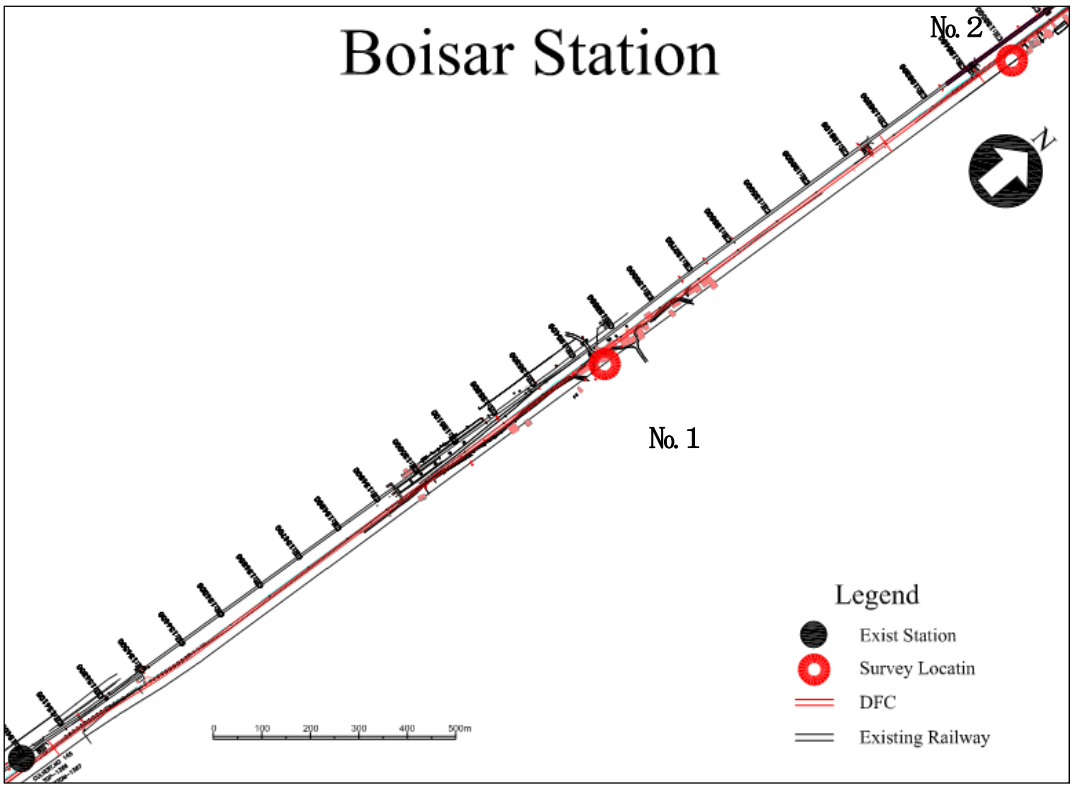
Source: DFCCIL

Figure 6.1.2(1) Location of Noise Measurement Sites in Panvel



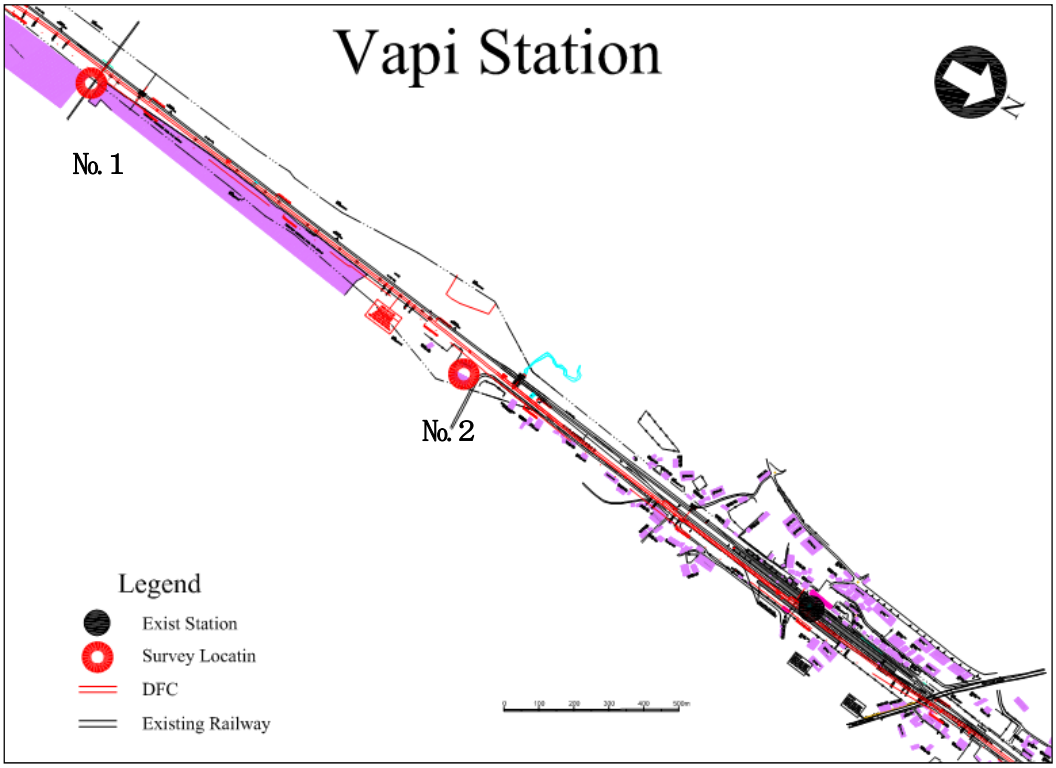
Source: DFCCIL

Figure 6.1.2(2) Location of Noise Measurement Sites in Palgar



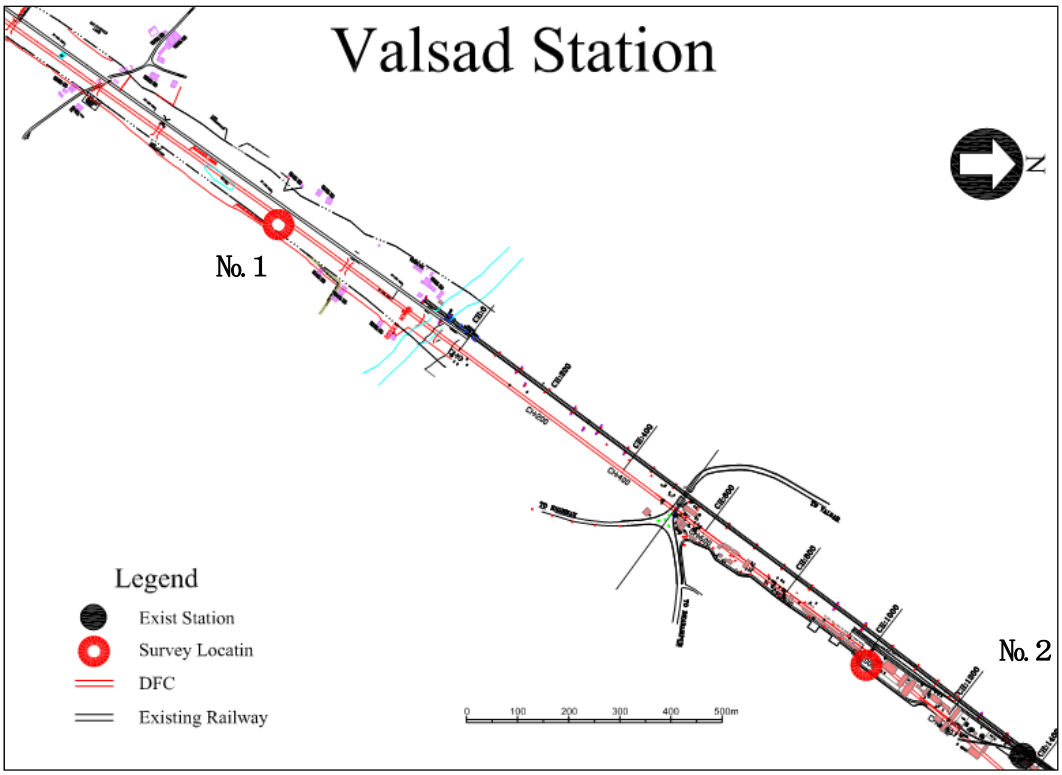
Source: DFCCIL

Figure 6.1.2(3) Location of Noise Measurement Sites in Boisar



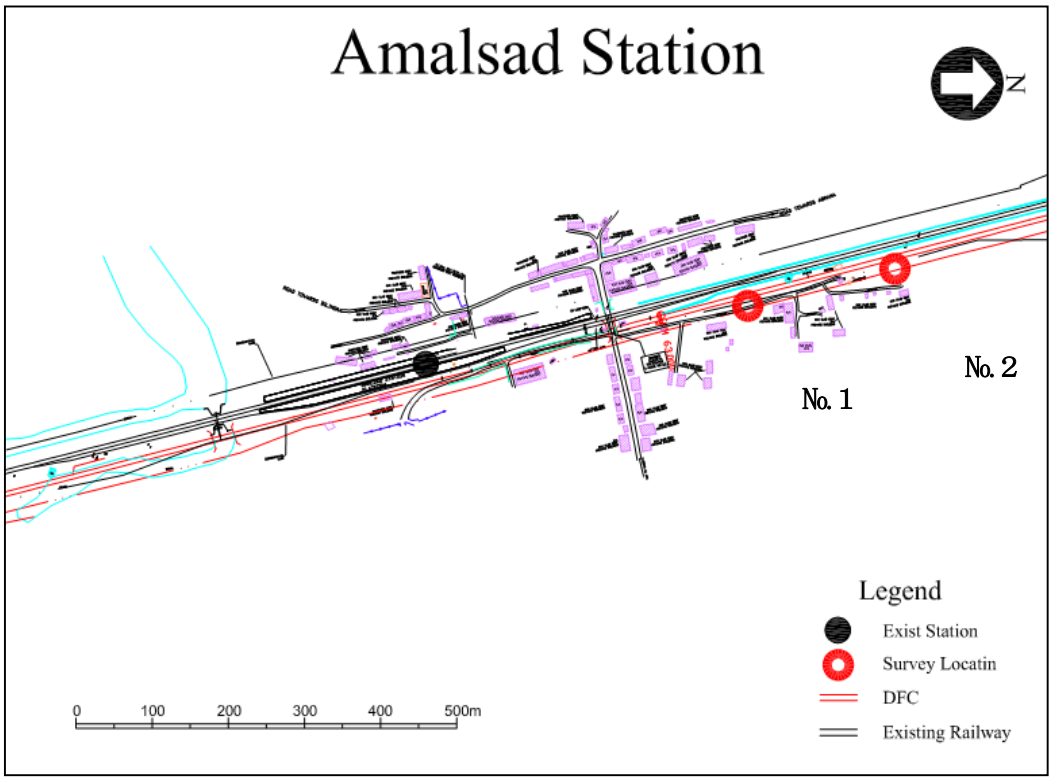
Source: DFCCIL

Figure 6.1.2(4) Locations of Noise Measurement Sites in Vapi



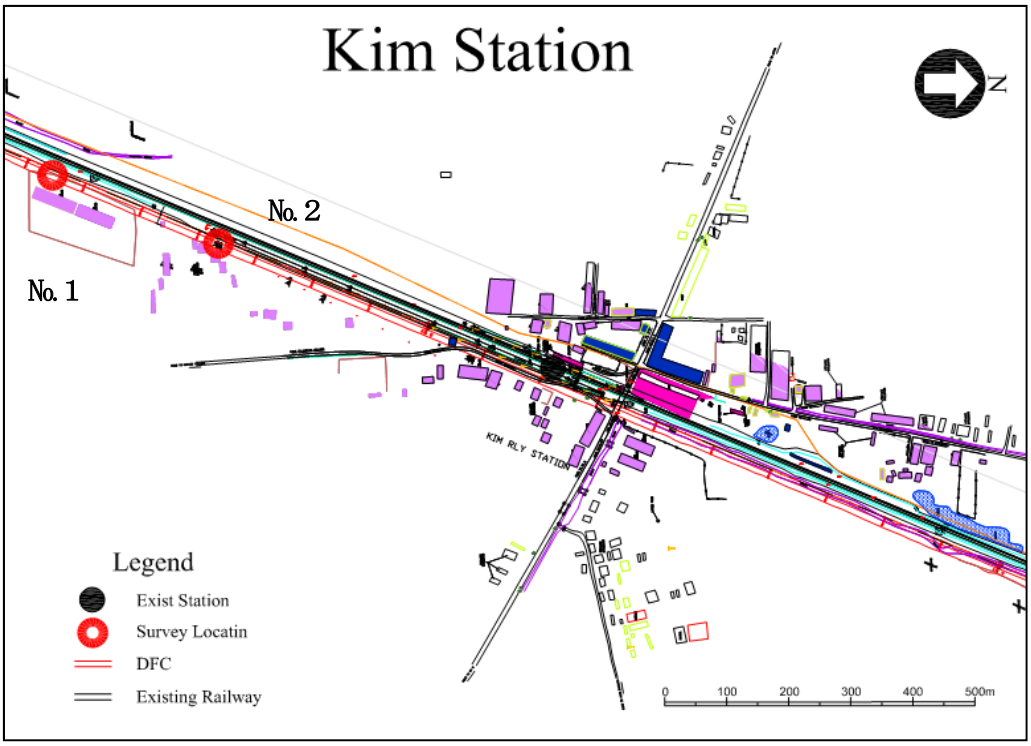
Source: DFCCIL

Figure 6.1.2(5) Location of Noise Measurement Sites in Valsad



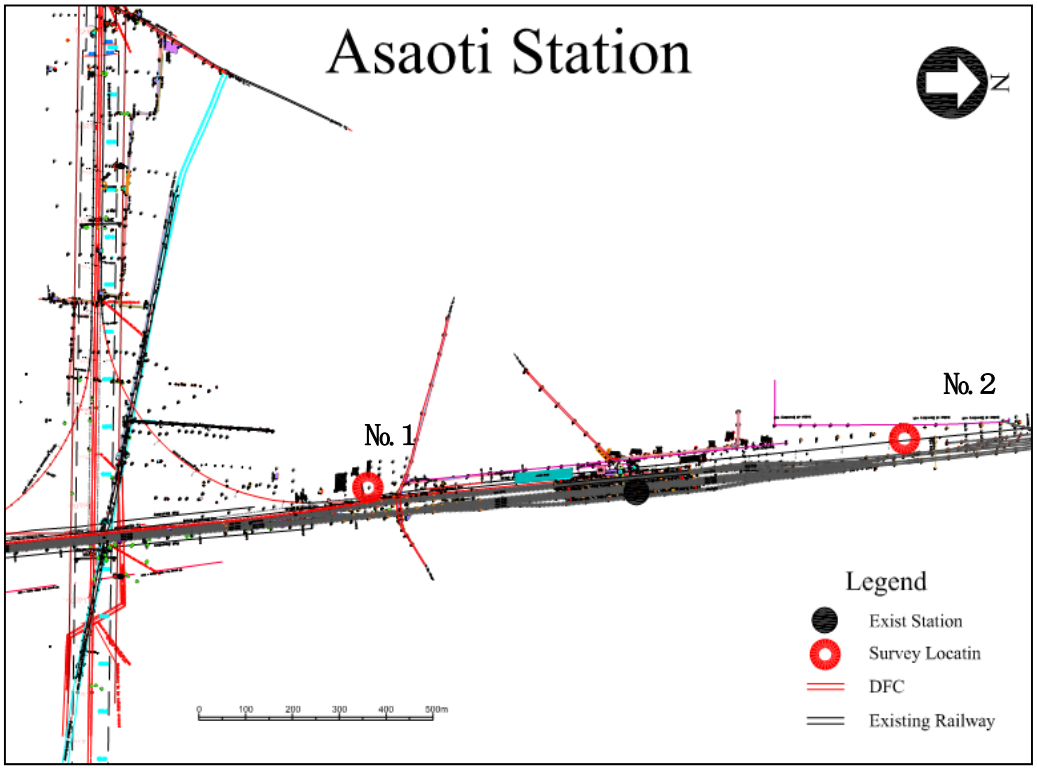
Source: DFCCIL

Figure 6.1.2(6) Location of Noise Measurement Sites in Amalsad



Source: DFCCIL

Figure 6.1.2(7) Location of Noise Measurement Sites in Kim



Source: DFCCIL

Figure 6.1.2(8) Location of Noise Measurement Sites in Asaoti

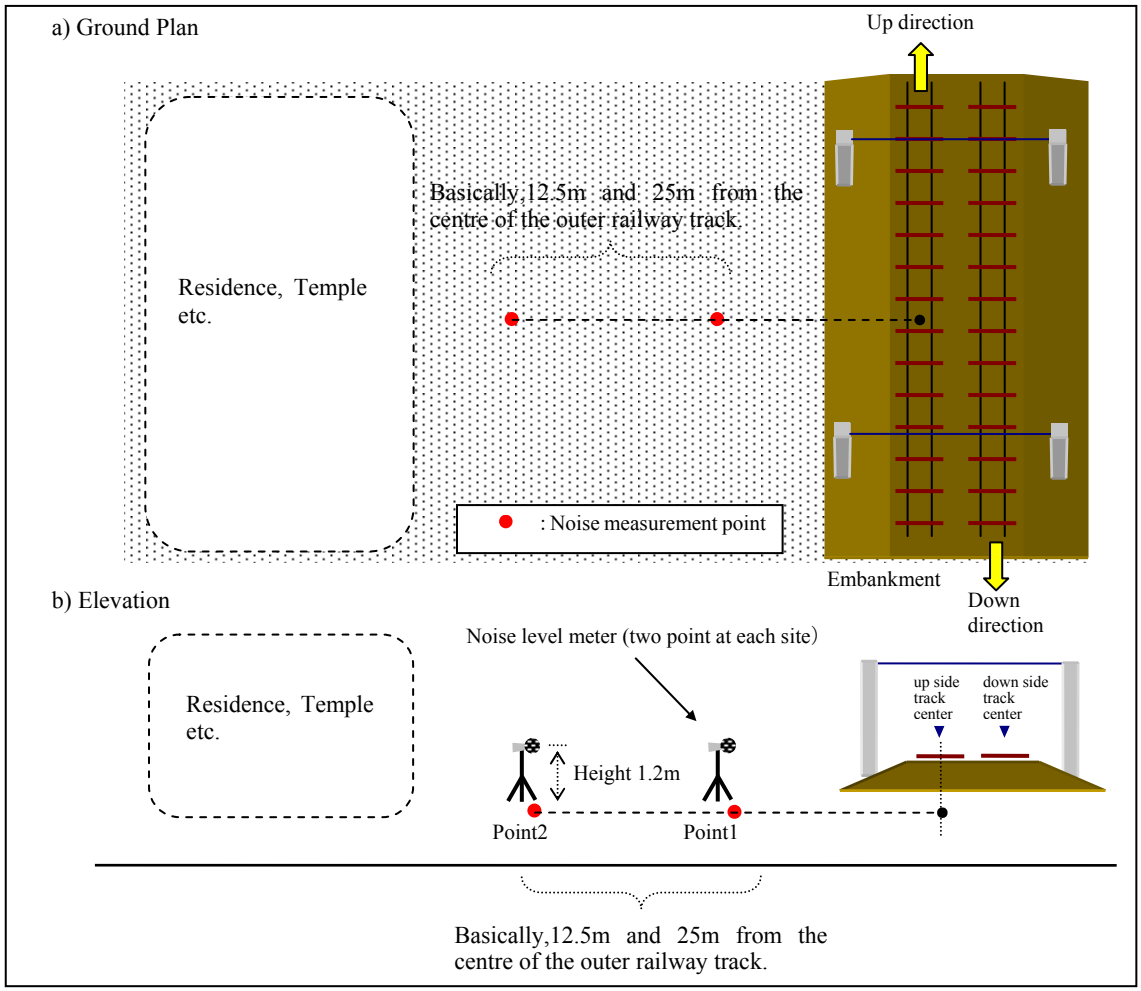
b) Method of Railway Noise and Background Noise Measurement

The measuring method of the railway noise is not set in India. Japanese standard of noise measurement, JIS Z 8731 (Method of Measurement of Noise Level) was used for noise measurement which is accepted by the International Organization for Standardization (ISO). Since there is no relevant standard method for measuring railway noise in India, noise measurements are generally conducted following the International Standards. Therefore, in the similar way to have been carried out in the ESIA study, the noise measurement based on JIS Z 8731 was conducted. The measurement machinery used generally in Japan was utilized. Based upon distribution of facilities that needed consideration of noise impact such as school, hospital, temple and residence etc, two measurement sites are selected in each locations. Background noise was also measured at the same sites during the time when trains did not pass through. The measuring method is shown in Table 6.1.2.

Table 6.1.2 Measurement Method of Railway and Background Noise Levels

Item	Specifications
Noise Level Meter	Noise Level Meter which complies with "JIS C 1509-1: 2005 Electro acoustics-Sound Level Meters- Part1: Specifications" (LION NL-22)
Measurement Points	Select two points at each site. Basically, 12.5 m and 25 m from the centre of the outer railway track. The height is 1.2 m above the ground.
Measurement Items	**Railway noise** L_{AE} (sound exposure level), L_{Amax} (maximum sound level), 1/3octave frequency analysis (1/3octave band center frequency : 20～8000Hz) **Background noise** L_{Aeq} （equivalent continuous A-weighted sound pressure level）
Frequency Weighting Characteristics	A
Time Weighting Characteristics	Slow
Measurement Period	2010.9.28 - 2010.10.13
Measurement Time	Railway noise : 10:00-17:00 Background noise : 10 minutes within each term (10:00-12:00, 12:00-14:00, 14:00-16:00, 16:00-18:00)
Other Data	Date and time, location, train types (freight/passenger) & load (container/bulk), number of train cars, train length, passage time, train speed, pictures, information on surrounding environment, etc.

Measurement instruments were installed as shown in Figure 6.1.3.



Source: JICA survey team

Figure 6.1.3 Schematic Plan of Railway and Background Noise Levels Measurement in Parallel Section

3) Survey of Sensitive Receptor and Landuse

a) Definition of Sensitive Receptor

According to past railway noise surveys in Japan, influence by railway noise to the facilities is expected as below.

- The areas affected by railway noise are considered to be within 100 m of horizontal distance from the centre of the nearest railway track.
- With the distance from the railway track, the railway noise measurement without influence from the other source becomes difficult in most cases due to increase of ratio of the other noise (background noise) such as traffic noises.

Sensitive Receptors (SRs) which are particularly vulnerable to the impacts of noise are defined in Ambient Noise Standards in India. They are school, hospital, and temple which require silent circumstances. The area within 100 m from those facilities is defined as Silence Zone as well where strict limits of noise level (Daytime: 50 dB, Night: 40 dB) are applied as the standards. In this survey, in the same meaning as ESIMMS, facilities where require silent and less vibration circumstance such as school, hospital, temple and residence etc. were defined as Sensitive Receptors (SRs). In addition, the distribution of SRs alongside the railway was grasped.

b) Methodology

Survey was conducted within the range of approximately 100 m from the centre of the nearest railway track on one side (about 200 m at both sides) and SRs were listed up though filed reconnaissance. For identification of Sensitive Receptors (SR), GPSs were utilized, while the satellite imagery analysis and geographic positioning system (GPS) were used for the identification of landuse. Photographs of sensitive receptor and land use category were also collected.

GPS Survey: GPS survey were conducted to confirm the land use pattern through ground truthing and collect the central line position for mapping of various features such as sensitive receptors and land use. This survey has helped in collecting the geographical coordinates of the villages falling on the alignment and there special features such as agricultural land and settlement. The SRs that falls in the alignment and within 100 m of RoW were recorded.

Satellite Data Analysis: Land use map was prepared from the LISS III satellite image using the ERDAS. A supervised classification technique was used to extract the land use information and the major land use categories considered were: agriculture, forests, settlements, wastelands, water bodies and low lying areas.

6.1.2 Results of Survey

(1) Noise Regulations and Standards

1) Regulation and Standards of Railway Noise in India

Regulations, standards or guidelines for railway noise are not yet established in India. The ambient noise standards in India which are defined in the Noise Pollution (Regulation and Control) Rules 2000 are shown in Table 6.1.3.

Table 6.1.3 Ambient Noise Level Standards in India

Area Code	Category of Area Zone	Limits in dB(L_{Aeq})	
		Daytime (6:00 – 22:00)	Night (22:00 - 6:00)
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone	50	40

Note: Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.
Source: The Noise Pollution (Regulation and Control) Rules, 2000

2) Railway Noise Regulations and Standards in Japan

In Japan, standards for railway noise levels are established for Shinkansen, a super express railway (or called as "bullet train"), and railways. For Shinkansen, in accordance with the land use categories (Zone I: residential area, Zone II: industrial area), different noise level standards are defined as shown in Table 6.1.4.

Table 6.1.4 Ambient Noise Level Standards of Shinkansen Super Express Railway in Japan

Category of Area (Zone)	Standard value (dB)
I	70 or less
II	75 or less

Note: Zone I: residential area, Zone II industrial area
Source: Environmental Agency of Japan, July.1975

For the conventional railways, the recommended standard level of railway noise has been proposed in the Guidelines for Countermeasures for Railway Noise in Case of New Constructions and Large-scale Improvement of Existing Railways, by Environmental Agency of Japan, December 1995 as shown in Table 6.1.5.

Table 6.1.5 Recommended Standard Level of Railway Noise in Japan

Case	Recommended Standard Noise Level
New Construction of Railway	Daytime (7:00 - 22:00): 60 dB (L_{Aeq}) or less Night time (22:00 - 7:00): 55 dB (L_{Aeq}) or less
	Minimize the railway noise in the residential areas as much as possible
Large-Scale Improvement of Existing Railway	Improve the railway noise level less before the construction

Note: Railway other than Shinkansen Express Railway (bullet train)
Source: Guidelines for Countermeasures for Railway Noise in Case of New Constructions and Large-scale Improvement of Existing Railways, Environmental Agency of Japan, Dec.1995

(2) Results of Field Survey on Noise

1) Background Noise Level

Measurement results of background noise level (L_{Aeq}) at each site are shown in Table 6.1.6. The background noise level is measured once in each four different time of a day, namely 10:00-12:00, 12:00-14:00, 14:00-16:00, and 16:00-18:00 when trains did not pass through. The noise level at all the sites except Panvel No.2 and Asaoti No.1 is within the limits of daytime ambient standard of residential area in India. In Panvel No.2, there is a major road with much traffic density in the neighborhood, and the area is affected by the traffic noise. In Asaoti No.1, a festival was performed at the temple of the neighborhood on the investigation day and the area was affected by the sound from the festival.

Table 6.1.6 Results of Background Noise Measurement

Station		Backgroung Noise Level LAeq [dB(A)]					Indian Ambient Noise Quality standard Day time/Night time [(dB(A)]	
	No.	10:00～12:00	12:00～14:00	14:00～16:00	16:00～18:00	Overall 10:00～18:00	Residential area	Silence zone
Panvel	1	52	55	52	52	53	55/45	50/40
	2	55	55	57	56	56		
Palgar	1	53	53	50	52	52		
	2	55	52	51	50	52		
Boisar	1	54	50	53	53	53		
	2	52	47	46	47	50		
Vapi	1	48	52	50	51	50		
	2	53	52	53	53	53		
Valsad	1	49	47	47	47	47		
	2	50	47	49	50	49		
Amalsad	1	51	50	47	49	50		
	2	49	48	47	50	49		
Kim	1	51	49	47	51	49		
	2	51	46	49	49	49		
Asaoti	1	51	48	59	58	56		
	2	48	49	48	48	48		

Note: Day time of Indian Ambient Noise Quality standards: 6:00-22:00
Night time of Indian Ambient Noise Quality standards: 22:00-6:00
Source: JICA survey team

2) Railway Noise Level (L_{AE} and L_{Amax}) from the Existing Railway

The results of railway noise level measurements mean values of L_{AE} and L_{Amax} at each site are summarized in Table 6.1.7. The results also indicate L_{AE} and L_{Amax} of different train type and direction of the trains, such as up and down directions. At the nearest measurement point from the railway, the range of 75 to 90 dB as L_{Amax} and approximately 90 dB as L_{AE} were measured. At that time, train's speed was almost 60 to 90 km/hr at each measurement site. In Panvel location, eventhough trains went through relatively slow speed of approximately 35 km/hr, noise level was almost the same values as other locations. For this reason, a high ratio of diesel train which went through in Panvel might influence.

Table 6.1.7 Rusults of Railway Noise Measurement in Parallel Section

Station	No.	date	Number of trains	train type	train direction	Average train speed [kn/hr] V	Average train length [m]	measurement distance from railway-center 〔m〕		Average Noise level [dB]			
										LAE		LAmax	
								point 1	point 2	point 1	point 2	point 1	point 2
Panvel	1	9-Oct	3	Passenger	up	45.4	437	12.5	25	98	90	91	82
			2		down	35.8	344			99	95	92	87
			5	Freight	up	23.9	557			96	88	83	75
			4		down	32.9	653			83	76	81	74
	2	9-Oct	5	Passenger	up	42.2	440	14.5	25	85	82	83	81
			4		down	39.6	360			94	92	88	85
			6	Freight	up	25.7	576			80	78	78	76
			6		down	35.9	654			84	82	76	75
Palgar	1	7-Oct	11	Passenger	up	86.7	484	12.5	25	86	79	83	76
			12		down	71.0	420			88	80	80	73
			7	Freight	up	72.9	649			88	76	84	75
			4		down	80.6	643			90	84	83	76
	2	7-Oct	5	Passenger	up	92.0	412	10	20	89	84	87	82
			5		down	80.4	475			93	88	84	79
			5	Freight	up	72.1	648			87	81	86	79
			2		down	87.0	646			100	95	86	81
Boisar	1	5-Oct	6	Passenger	up	75.2	440	12.5	23	90	83	87	81
			12		down	72.5	427			88	84	83	78
			6	Freight	up	54.0	621			84	80	80	76
			2		down	80.7	627			96	92	87	82
	2	5-Oct	10	Passenger	up	88.5	408	15	28	90	87	82	78
			11		down	91.8	436			90	92	81	78
			6	Freight	up	54.0	625			86	82	80	75
			2		down	67.7	641			91	95	79	76
Vapi	1	1-Oct	12	Passenger	up	81.8	425	12.5	25	90	82	85	77
			13		down	86.3	415			88	82	82	76
			8	Freight	up	59.8	650			90	83	84	77
			4		down	71.9	572			82	76	80	75
	2	1-Oct	11	Passenger	up	68.6	407	12.5	25	88	84	83	79
			11		down	92.4	430			87	84	80	77
			9	Freight	up	58.0	649			90	86	83	79
			5		down	62.5	592			88	83	80	76
Valsad	1	2-Oct	11	Passenger	up	58.1	438	15	25	87	88	80	80
			9		down	79.8	419			76	79	71	74
			10	Freight	up	74.5	624			94	94	84	84
			5		down	61.9	629			78	82	71	73
	2	2-Oct	10	Passenger	up	42.0	437	12.5	25	87	81	81	74
			5		down	56.6	426			80	75	75	70
			8	Freight	up	68.2	625			90	83	85	78
			4		down	52.2	625			87	83	77	72
Amalsad	1	30-Sep	11	Passenger	up	87.2	436	12.5	25	86	80	85	79
			5		down	70.5	440			86	81	83	77
			6	Freight	up	65.4	581			85	79	83	78
			7		down	90.0	592			95	90	86	80
	2	30-Sep	11	Passenger	up	87.7	440	12.5	24	86	78	83	76
			9		down	73.8	439			91	82	83	77
			6	Freight	up	71.2	581			86	78	83	76
			7		down	90.0	592			95	88	86	79
Kim	1	28-Sep	7	Passenger	up	58.1	425	12.5	25	93	91	81	78
			8		down	85.1	466			86	83	80	77
			12	Freight	up	56.3	647			96	91	85	81
			5		down	75.4	639			82	87	78	78
	2	28-Sep	3	Passenger	up	103.9	541	12.5	25	101	87	90	78
			5		down	99.1	462			88	83	83	79
			9	Freight	up	61.9	642			96	81	86	72
			4		down	69.3	580			86	84	81	78
Asaoti	1	13-Oct	15	Passenger	up	98.6	439	12.5	25	82	80	77	76
			9		down	59.4	443			83	81	79	77
			6	Freight	up	66.4	633			82	81	75	73
			6		down	60.3	643			86	84	79	77
	2	13-Oct	19	Passenger	up	88.6	395	12.5	25	81	80	75	74
			12		down	91.3	385			82	78	76	74
			4	Freight	up	72.0	640			83	82	73	71
			7		down	62.8	621			88	86	79	76

Source: JICA survey team

(3) Results of Field Survey on Sensitive Receptor

1) Sensitive Receptor

Sensitive receptros located within 100 m from the center of the railway were extracted. Sensitive Receptors in each state were given in Tables 6.1.8. As the results of this survey, 12 sensitive receptros in Rewari-Dadri Section, 100 sensitive receptors in Sections 3, 4 and 5, 20 sensitive receptors in Sections 1 and 2 have been identified respectively. Among these sensitive receptors, the closest facility was located within 5 m or less from DFC rail in Rewari-Dadri section, and on the planned DFC railway or within 5 m or less from DFC railway in Sections 4 and 5, and within 10 m or less in Sections 1 and 2, respectively.

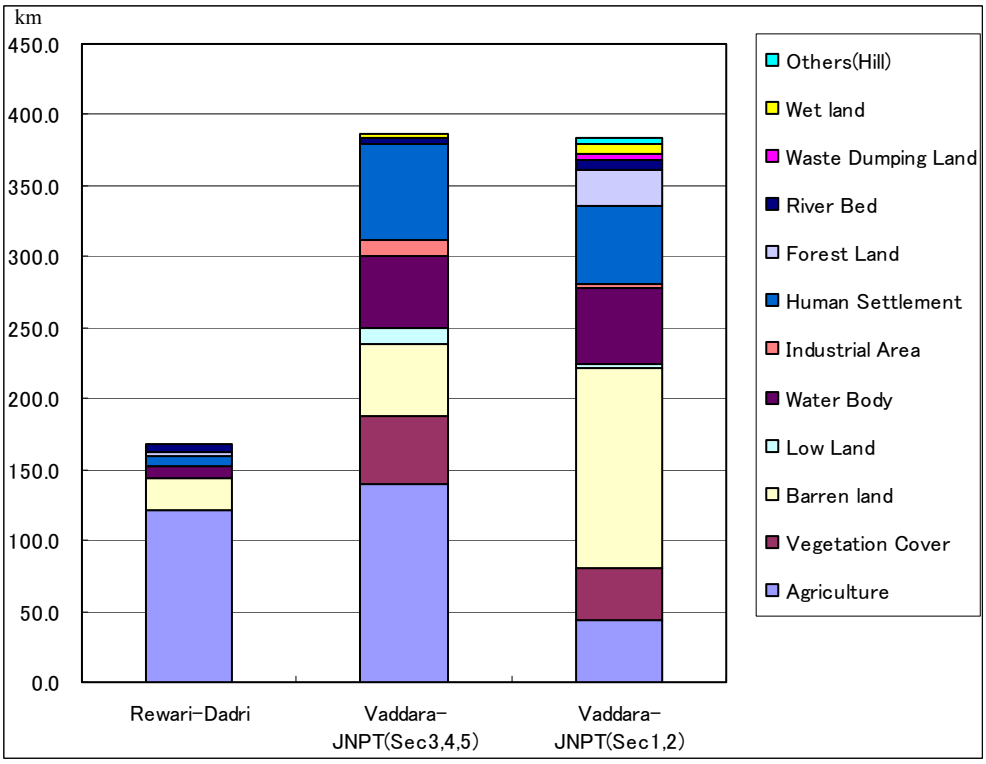
Table 6.1.8 Sensitive Receptor in Rewari-Dadri Section

Section	District	Distance from DFC			Total	No. Potentially Affected SR
		0-50 m	50-100 m	over100 m		
Vadodara-JNPT Section1and 2	Raigad	2	2	7	11	4
	Thane	5	11	13	29	16
	Subtotal(c)	7	13	20	40	20
Vadodara-JNPT Section3,4 and 5	Bharuch	2	2	3	7	4
	Navsari	35	9	6	50	44
	Surat	13	11	6	30	24
	Vadodara	3	0	0	3	3
	Valsad	18	7	2	27	25
	Subtotal(b)	71	29	17	117	100
Rewari-Dadri Section15and 16	Alwar	1	0	1	2	1
	Faridabad	7	0	1	8	7
	Gurgaon	1	3	0	4	4
	Subtotal(a)	9	3	2	14	12
Total (a)+(b)+(c)		87	45	39	171	132

Note：0-50 m: SRs located between 0 and 50m from the center of DFC track.
50-100 m: SRs located between 50 and 100m from the center of DFC track.
No. Potentially Affected SR means sum of the No. of SRs in 0-50m, and 50-100 m.
Source：JICA survey team

2) Landuse

A detailed result of land use survey is indicated in Figure 6.1.4 and Tables 6.1.9. Agriculture is the main land use in Rewari –Dadri as well as Vadodara-JNPT section. The length of DFC alignment which pass thorough the human settlement areas approximately 67.3 km in Section 3, 4 and 5, 54.2 km in Sections 1 and 2, and 6.5 km in Rewari-Dadri. Further details of the result and photographs are referred to Appendix 4a.



Note：When more than one land use was confirmed by an investigation section, an overlap is counted by distribution extension.
Source：JICA survey team

Figure 6.1.4 Result of Land Use Survey

Table 6.1.9 Distribution of Residential Area along the DFC Alignment (Unit:km)

Section / Area Category	Rewari-Dadri Section 15,16	Vaddara-JNPT Section 3,4,5	Vaddara-JNPT Section 1,2	Total
Human Settlement	6.5	67.3	54.2	128.0

Source：JICA survey team

6.1.3 Impact Assessment during Construction phase

(1) Impact

Construction of DFC structures and facilities would require the use of heavy equipment/ vehicles, and adversely affect sensitive receptors. As for ROB construction areas, increase of noise pollution is envisaged by a traffic jam due to construction work on the exsting road. There are 77 ROBs proposed in this project. 18 ROBs of these are existing on the parallel sections. There are 12 exisiting ROBs on the parallel section in Section-1, and 3, 2 and 1 existing ROBs on the parallel sections in Section-2, Section-3 and Section-4, respectively. There are no exisiting ROBs on the parallel section in Section-5, Section-15 or Section 16. Table 6.1.10 shows the number of all the ROBs in each section.

Table 6.1.10 List of ROBs proposed for DFC Western Corridor (Phase 2)

Section		Parallel		Detour	Total
		Existing	New	New	
Vaddara-JNPT Maharashtra	1	12	5	3	20
	2	3	0	0	3
	3	2	24	0	26
Vaddara-JNPT Gujarat	4	1	8	0	9
	5	0	0	0	0
Rewari-Dadri	15	0	0	15	15
	16	0	0	4	4
Total		18	38	21	77

Source: JICA Study Team

(2) Mitigation Measures

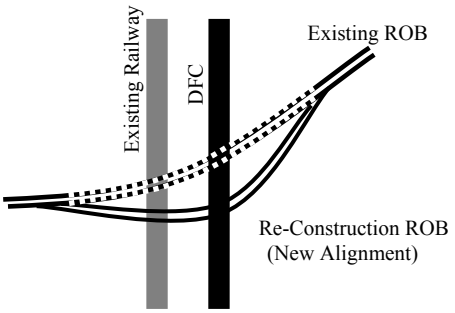
Adequate measures will be planned and provided to reduce the negative impacts of noise pollution during construction stage, such as planning the deliberate and efficient equipment use, use of the low pollution type machine, regular maintenance of construction machines. At the ROB construction site, adequate measures will be planned, such as temporary diversion road to reduce traffic jam, periodically/timely announce the progress of work to the public, etc. In addition, DFCCIL will coordinate with relevant authorities to reduce the negative impact on the traffic flow whenever necessary. Because re-construction of the existing ROB could be one of the most difficult works among the construction works for the new DFC, it is recommendable to reduce the traffic jam and to keep traffic flow smoothly by adequate construction progress as mitigation measures.

Depending upon the land availability for a new ROB to be replaced with the exisiting ROB, the different construction method should be applied. In case ROB re-construction is carried out with available land beside the exisiting ROB, the general sequence of typical ROB re-construction is as follows:

a) To construct a new ROB and approach roads beside the existing ROB on which the exisiting traffic flow is maintained. Diversion road under construction is unnecessary.

b) Divert the traffic to the new ROB after its completion.

c) To demolish and remove the existing ROB.



Source: DFCCIL

Figure 6.1.5(A) Plan for reconstruction of ROB-New Alignment

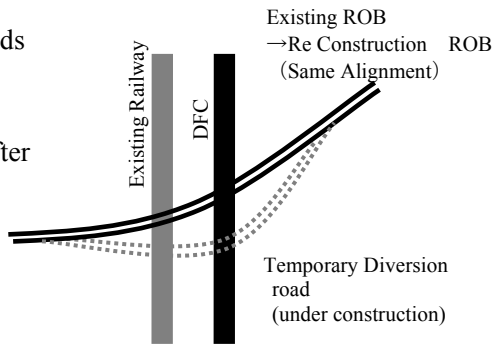
However, in case sufficient land for a new ROB is not available beside the exisiting ROB and the new ROB is constructed at the same place as the existing ROB, ROB re-construction work is to be carried out as follows:

a) To provide a temporary diversion road near the existing ROB.

b) To demolish and remove the existing ROB and approach roads, with existing traffic flow on a temporary diversion road.

c) To construct a new ROB and approach roads at the place where the existing ROB was removed.

d) To divert the traffic flow to the new ROB after its completion and remove the temporary diversion road.



Source: DFCCIL

Figure 6.1.5(B) Plan for reconstruction of ROB-Same Alignment

(3) Evaluation

This impact is short duration, direct, temporary and reversible, it can be considered minor if mitigation measures and site management practices are applied.

6.1.4 Impact Assessment during Operation Phase

(1) Noise Leve Prediction

1) Item of Prediction

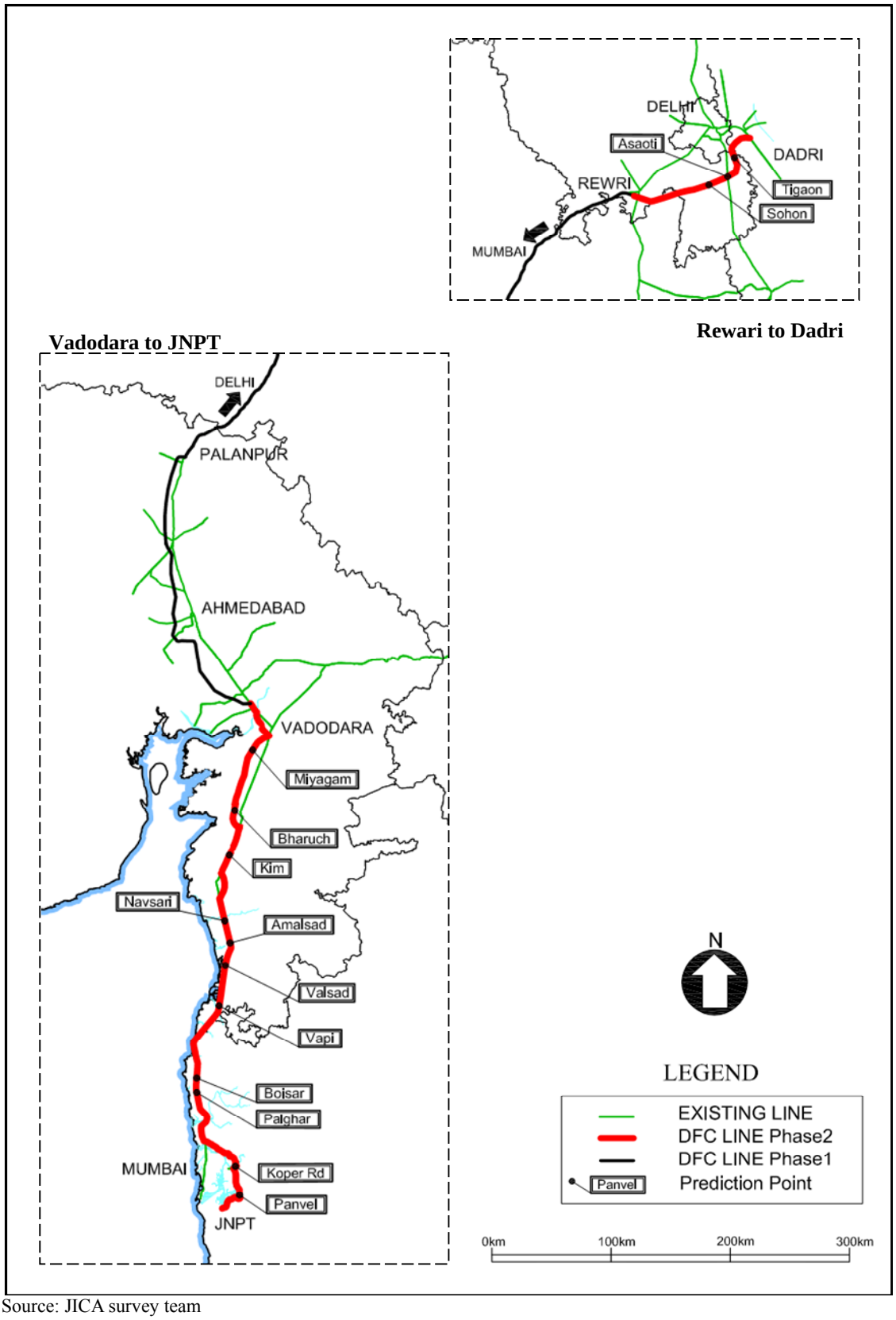
Item of prediction is railway noise level (L_{Aeq}) after DFC would be placed in service.

2) Prediction Term

As for the term of prediction, the time when the railway would be operated steadily after placed in service is targeted.

3) Locations for prediction

As for locations for prediction, ten (10) sites are selected in the parallel section, while four (4) sites are selected in the detour section. The locations where dense residential and commercial areas exist alongside the railway were selected as the representative. In the case of ESIMMS for the DFC Phase 1 section, noise prediction was carried out only in the representative location alongside the railway. While in this survey, noise prediction carried out in not only the area where sensitive receprots locate but also dense residential and commercial area in consideration of actual impact against the residents. These locations for prediction were shown in Figure 6.1.6 and Table 6.1.11.



Source: JICA survey team

Figure 6.1.6 Location of Noise Level Prediction

Table 6.1.11 Prediction Location

Section	Prediction Location	State
Parallel section	Panvel	Gujarat
	Kopar	
	Palgar	
	Boisar	
	Vapi	Maharashtra
	Valsad	
	Amalsad	
	Navsari	
	Kim	
	Asaoti	
Detour section	Bharuch	Haryana
	Miyagan	Gujarat
	Sohona	Haryana
	Tigaon	

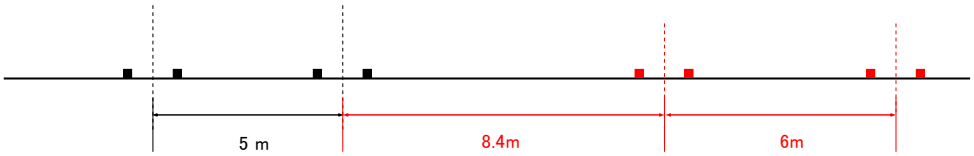
Source: JICA survey team

4) Prediction Point

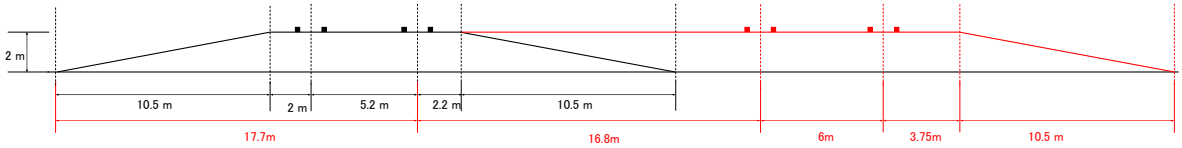
In consideration of noise impact distance from railway track, distance of 200 m from the centre of existing railway track was considered as prediction range in parallel section. Also, distance of 200 m from the centre of DFC planned railway track in detour section was set. The height of prediction is 1.2 m above the ground. The cross-section drawings at each prediction location are indicated in Figures 6.1.7 and 6.1.8. In Panvel, Palgar, Boisar, Vapi, Valsad, Amalsad, Kim and Asaoti, cross-section drawings for the prediction were determined based on actual widths measured at each site. For other sites, standard cross-section drawings were applied for the prediction.

a) Parallel Section

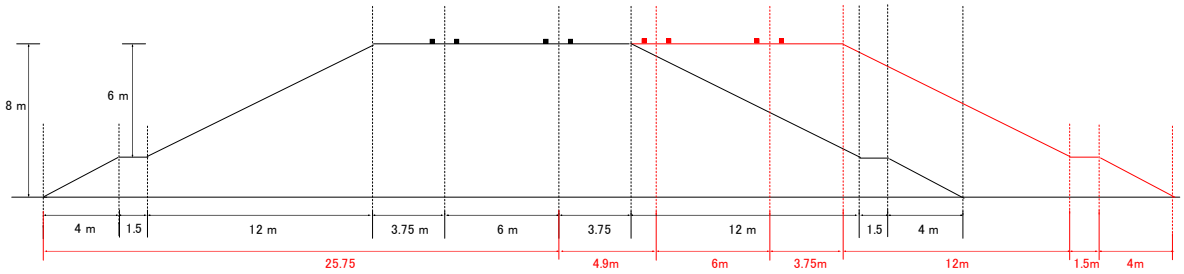
・Panvel No.1



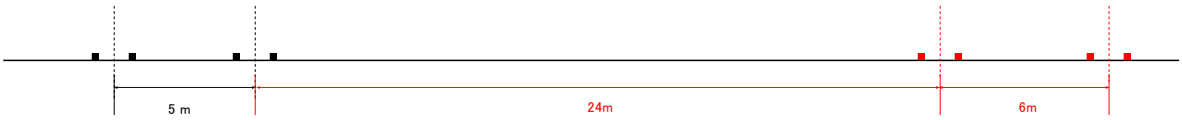
・Panvel No.2



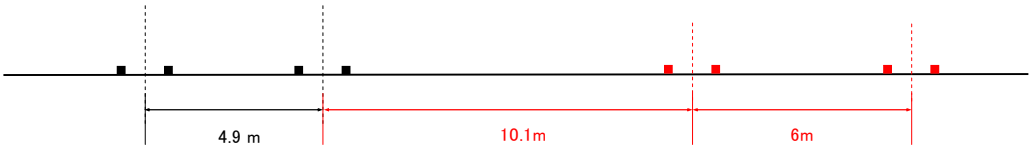
・Kopar



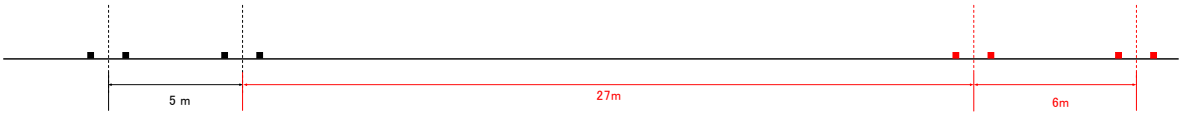
・Palgar No.1



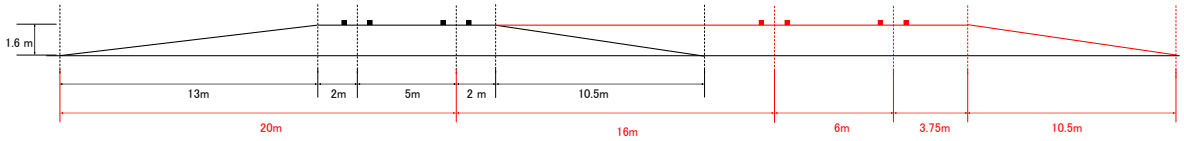
・Palgar No.2



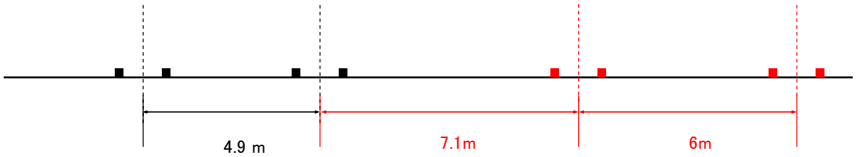
・Boisar No.1



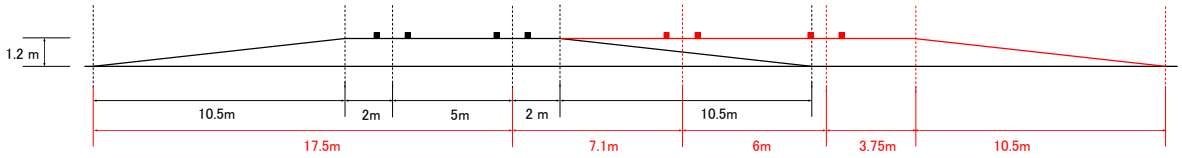
・Boisar No.2



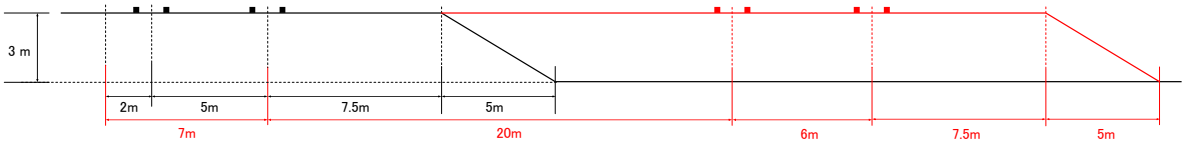
・Vapi No.1



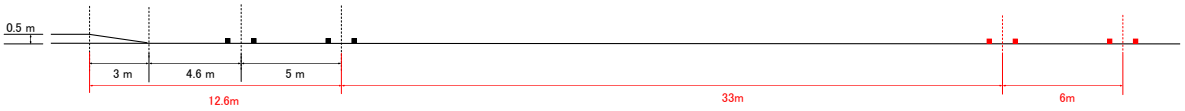
・Vapi No.2



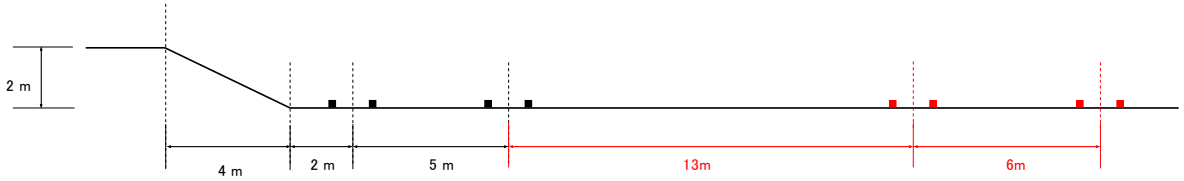
・Valsad No.1



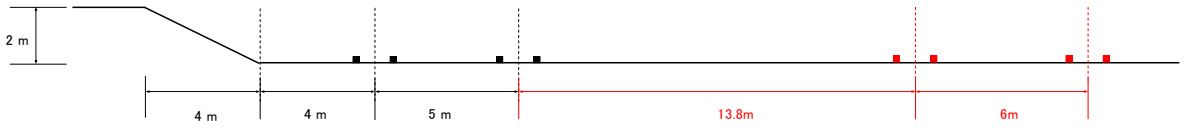
・Valsad No.2



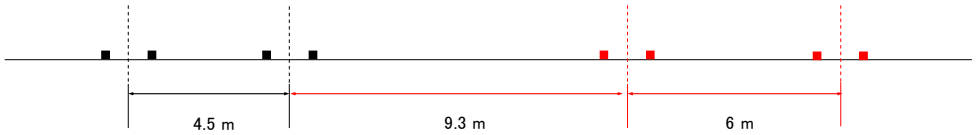
・Amalsad No.1



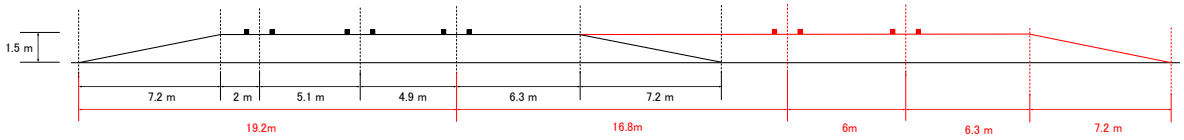
・Amalsad No.2



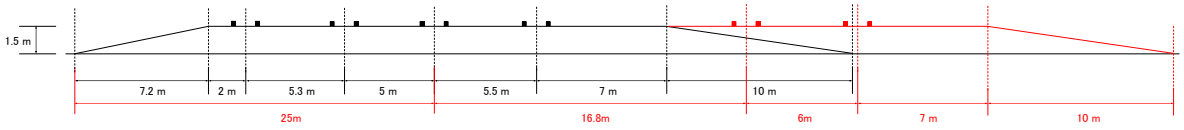
・Navsari



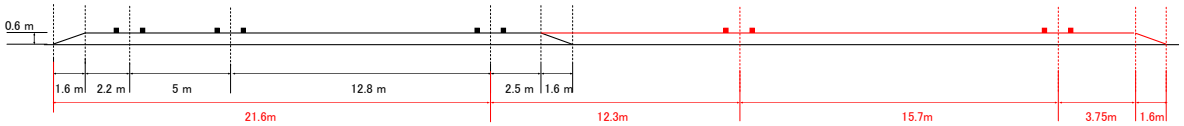
・Kim No.1



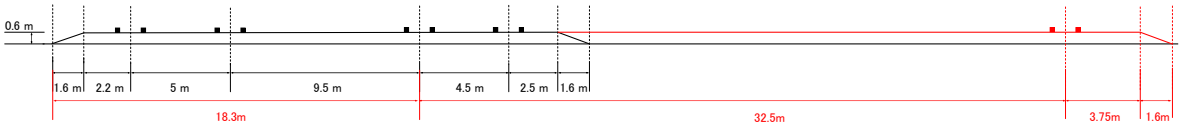
・Kim No.2



・Asaoti No.1



・Asaoti No.2

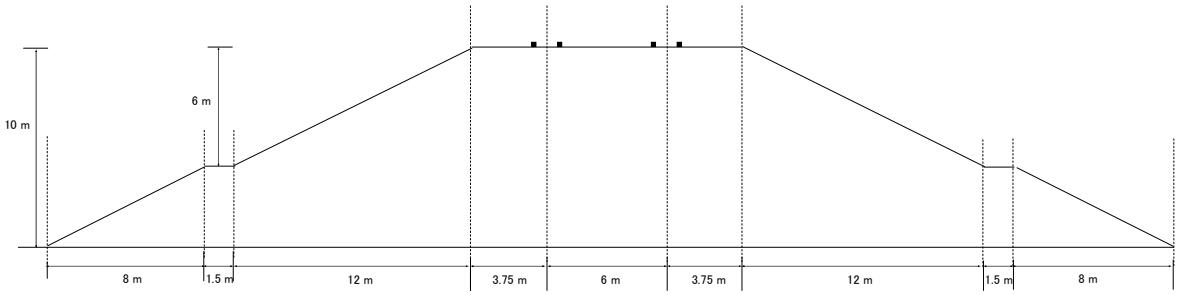


Source: Prepared by JICA survey team based on information from DFCCIL

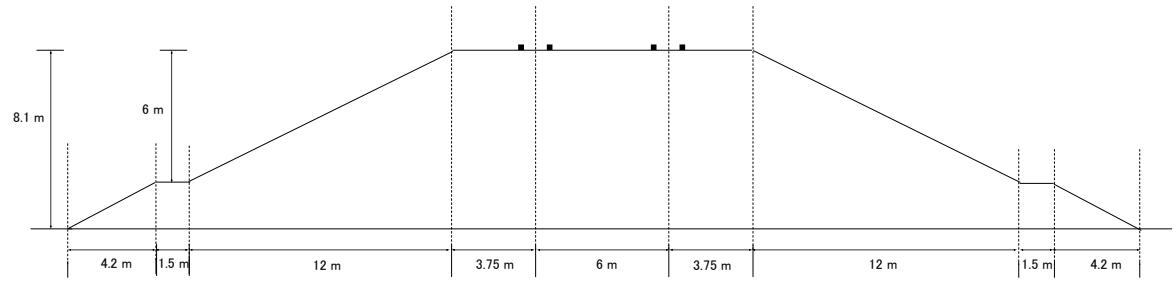
Figure 6.1.7 Cross-Section for Noise and Vibration Prediction (Detour Section)

b) Detour Section

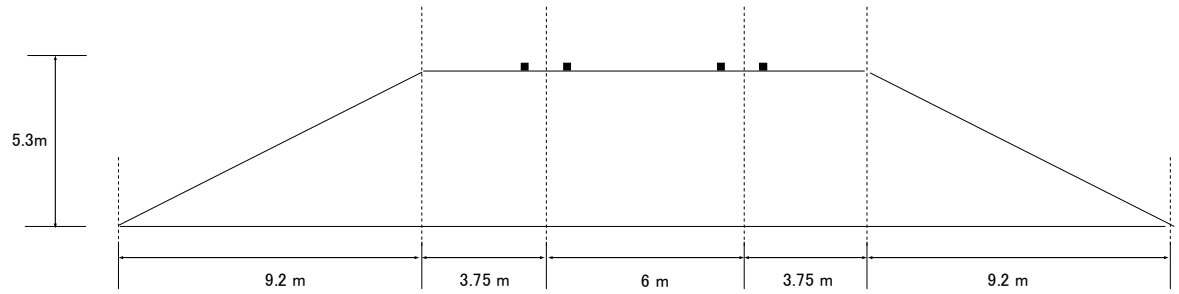
・Bharuch



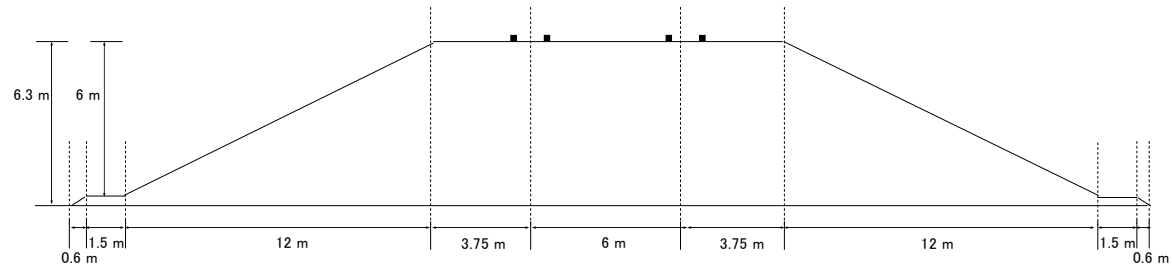
・Miyagam



・Sohna



・Tigaon



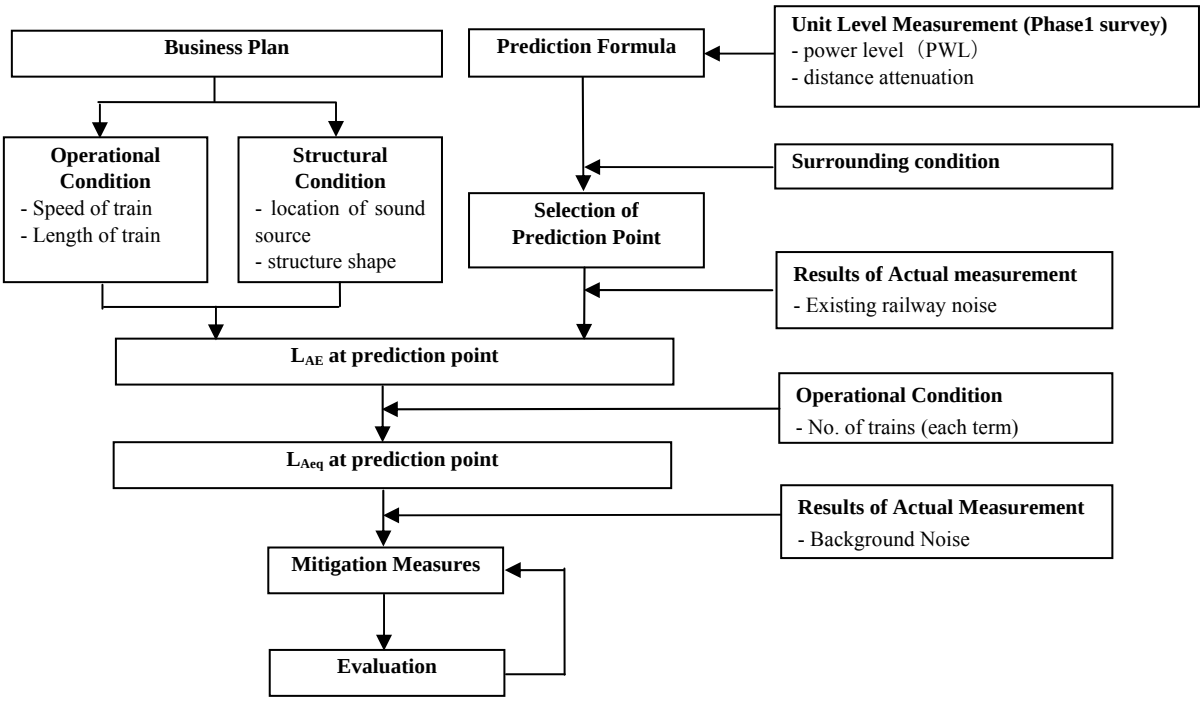
Source: Prepared by JICA survey team based on information from DFCCIL

Figure 6.1.8 Cross-Section for Noise and Vibration Prediction (Parallel Section)

(2) Method of Prediction

1) Procedure of Prediction

Procedure of prediction is shownin Figure 6.1.9. In order to predict, an empirical formula based on unit level measurement conducted in Phase 1 survey was utilized. At the same time, background noise level and noise exposure level (L_{AE}) of existing train in parallel section were utilized based on results of actual measurement. At actual measurement sites, measured L_{AE} values were used for the prediction and at the other sites, measured L_{AE} values at the nearest sites were used. The L_{AE} and ambient values used for prediction at each site are shown in Table 6.1.12.



Source: JICA survey team

Figure 6.1.9 Procedure for Prediction of Noise Level

Table 6.1.12 Setting of Result of Actual Measurement

Section	Prediction Location	Background Noise Levels used	Result of Existing Railway Noise Measurement (LAE No.of Freight Train)
Parallel section	Panvel	Panvel	Panvel
	Kopar	Panvel	Panvel
	Palgar	Palgar	Palgar
	Boisar	Boisar	Boisar
	Vapi	Vapi	Vapi
	Valsad	Valsad	Valsad
	Amalsad	Amalsad	Amalsad
	Navsari	Amalsad	Amalsad
	Kim	Kim	Kim
	Asaoti	Asaoti	Asaoti
Detour section	Bharuch	Kim	-
	Miyagan	Kim	-
	Sohona	Asaoti	-
	Tigaon	Asaoti	-

Source: JICA survey team

2) Prediction Formula

a) Noise Level of DFC

In the same way of thinking as ESIMMS for the DFC Phase 1 section regarding an empirical formula, the formula made in the DFC Phase 1 survey was utilized in this survey. The noise exposure level is estimated by using total amount of unit PWL obtained at the results of actual measurement and multiplied amount of distance attenuation coefficient and logarithms of the distance from the center of the source of sound (in the case of parallel section: track center of existing railway, in the case of detour section: track center of DFC railway) in phase1. In addition, in order to calculate L_{Aeq}, a formula indicated by the guideline for existing railway in Japan was applied. The empirical formula is shown below:

$$L_{AE} = PWL + B \log_{10}(D)$$

$$L_{Aeq} = L_{AE} + 10 \log_{10}(N/T)$$

where:

PWL : Power level ($PWL = 24.2 \cdot Log_{10}(V) + 52.4$)

D : Distance (m)

B : Distance attenuation coefficient (B = 14.9)

N : Number of trains

T : Target time [s]

Day time (7:00-22:00) T=54,000[s], Night time (22:00-7:00): T=32,400[s]

Source: Guidelines for Existing Railway in Japan

b) Noise Level of Existing Railway

An empirical formula derived from L_{AE} and distance attenuation coefficient based on the results of existing railway noise level measurements in the parallel section was applied for the prediction. In addition, in order to calculate L_{Aeq}, a formula indicated by the guideline for existing railway in Japan was applied. The empirical formula is shown below. For the locations, where actual existing railway noise levels are not measured, the values measured at the nearest measurement location are applied.

<Freight train>

$L_{AE}(D_2) = L_{AE}(D_1) - 14.9 * \log_{10}(D_2/D_1)$
$L_{Aeq}(D_2) = L_{AE}(D_2) + 10 * \log_{10}(N/T)$
<Passenger train>
$L_{AE}(D_2) = L_{AE}(D_1) - 15.7 * \log_{10}(D_2/D_1)$
$L_{Aeq}(D_2) = L_{AE}(D_2) + 10 * \log_{10}(N/T)$

where:
D_1 : Distance from center of existing railway to the nearest measurement point [m]
D_2 : Distance from center of existing railway to prediction point [m]
B : Distance attenuation coefficient
(Freight train : B = 14.9, Passenger train : B = 15.7)
N : Number of trains
T : Target time [s]
Day time (7:00-22:00) T=54,000 [s], Night time (22:00-7:00): T=32,400 [s]

3) Condition of Prediction

a) Plan of DFC Operation

As condition of prediction, the following conditions of the DFC operation are assumed in this study.

- Type of traction: electrified traction
- Maximum train length: 650 [m]
- Train speed: 100 [km/h]
- Running operation : 140 trains/direction/day with the same time interval (approximately one train for every five minutes, day time 88trains/direction/day, night time 52trains/direction/day) *day time 7:00-22:00, night time 22:00-7:00

b) Number of Existing Freight Train

In existing freight train in the parallel section, conditions of running operation are assumed in status quo.
Based on the actual measurement in the parallel section from 10:00 to 17:00 and assumption of holding the status quo, the number of freight trains is divided simply in proportion of the time of day and night. The number of freight trains is set as shown in Table 6.1.13.

Table 6.1.13 Setting of Number of Freight Train

Time / Prediction Location	Day time		Night time	
	Up	Down	Up	Down
Panvel	19	17	12	10
Kopar	19	17	12	10
Palgar	17	9	10	5
Boisar	17	9	10	5
Vapi	19	13	11	8
Valsad	17	13	13	8
Amalsad	15	13	9	8
Navsari	15	13	9	8
Kim	24	13	15	8
Asaoti	17	21	10	13

Note: Day time (7:00-22:00), Night time (22:00-7:00)
Source: Preprared by JICA survey team

c) Number of Existing Passenger Train

As for the existing passenger trains in the parallel section, based on the current time table (as of September, 2010), the number of passenger trains is decided for the prediction as shown in Table 6.1.14. The number of passenger trains may increase in the future due to decrease in the number of existing freight trains. Therefore, passenger trains presently operated at the frequency from one (1) to six (6) /week were assumed once a day.

Table 6.1.14 Setting of Passenger Trains

Time / Prediction Location	Day time		Night time	
	Up	Down	Up	Down
Panvel	18	21	10	7
Kopar	18	21	10	7
Palgar	58	55	31	34
Boisar	56	54	33	35
Vapi	53	46	27	33
Valsad	50	44	29	36
Amalsad	51	45	33	39
Navsari	51	45	33	39
Kim	56	43	36	49
Asaoti	73	67	21	26

Note: Passing trains are included in above number.
Day time (7:00-2:;00), Night time (22:00-7:00)
Source: Preprared by JICA survey team

(3) Results of Prediction

1) Parallel Section

The predicted future noise levels (L_{Aeq}) at 30 m and 50 m of distances, that is estimated average ROW end, from the centre of existing railway track in the parallel section range from 57 through 71 dB at Day time, and 55 through 71 dB at Night time at 30 m away, then 55 through 70 dB at Day time), and 54 through 70 dB atNight time at 50 m away respectively. The result is summarized in Table 6.1.15.

Table 6.1.15 Result of Prediction (LAeq) in Parallel Section

(Unit: dB (A))

Prediction location			Time	Background noise (measured value)	Railway noise（Predictive value）					
					(a) Existing railway		(b) DFC railway		(a) + (b)	
					30 m	50 m	30 m	50 m	30 m	50 m
Panvel	1	East	daytime	53	63	59	68	63	69	65
			nighttime	52	62	58	68	63	69	64
		West	daytime	53	63	59	63	60	66	63
			nighttime	52	62	58	63	60	65	62
	2	East	daytime	56	* 54	52	* 67	65	* 68	65
			nighttime	55	* 52	50	* 67	65	* 67	65
		West	daytime	56	56	52	61	59	62	60
			nighttime	55	54	50	61	59	62	60
Kopar	1	East	daytime	53	* 51	51	* 55	55	* 57	56
			nighttime	52	* 50	50	* 55	55	* 56	56
		West	daytime	53	53	52	52	51	55	55
			nighttime	52	52	51	51	51	55	54
Palgar	1	East	daytime	52	* 54	52	* 70	66	* 71	67
			nighttime	50	* 55	52	* 70	66	* 70	67
		West	daytime	52	55	52	60	59	62	59
			nighttime	50	55	52	60	58	62	59
Palgar	2	East	daytime	52	60	56	69	63	69	64
			nighttime	50	59	56	69	63	69	64

Prediction location			Time	Background noise (measured value)	Railway noise (Predictive value)					
					(a) Existing railway		(b) DFC railway		(a) + (b)	
					30 m	50 m	30 m	50 m	30 m	50 m
Palgar		West	daytime	52	60	56	62	60	64	61
			nighttime	50	59	56	62	60	64	61
Boisar	1	East	daytime	53	—	55	—	67	—	68
			nighttime	50	—	55	—	67	—	68
		West	daytime	53	58	55	60	58	62	60
			nighttime	50	58	55	60	58	62	60
	2	East	daytime	50	* 57	56	* 67	64	* 68	65
			nighttime	46	* 57	56	* 67	64	* 67	65
		West	daytime	50	59	56	61	59	64	61
			nighttime	46	59	56	61	59	63	61
Vapi	1	East	daytime	51	57	53	67	63	68	63
			nighttime	48	57	53	67	63	68	63
		West	daytime	51	57	53	63	60	64	61
			nighttime	48	57	53	63	60	64	61
	2	East	daytime	53	56	53	67	63	68	63
			nighttime	52	56	53	67	63	68	63
		West	daytime	53	56	53	63	60	64	61
			nighttime	52	56	53	63	60	64	61
Valsad	1	East	daytime	47	* 55	53	* 69	65	* 69	66
			nighttime	47	* 55	54	* 68	65	* 69	66
		West	daytime	47	57	53	61	59	62	60
			nighttime	47	57	54	61	59	62	60
	2	East	daytime	49	—	52	—	70	—	70
			nighttime	47	—	52	—	70	—	70
		West	daytime	49	55	52	60	58	61	59
			nighttime	47	55	52	59	58	61	59
Amalsad	1	East	daytime	50	56	53	70	64	70	64
			nighttime	47	57	53	70	64	70	64
		West	daytime	50	56	53	62	60	63	60
			nighttime	47	57	53	62	59	63	60
	2	East	daytime	49	58	55	70	64	71	64
			nighttime	47	59	55	70	64	71	65
		West	daytime	49	58	55	62	59	63	61
			nighttime	47	59	55	62	59	64	61
Navsari	1	East	daytime	50	56	53	68	63	69	64
			nighttime	47	57	53	68	63	68	64
		West	daytime	50	56	53	62	60	63	61
			nighttime	47	57	53	62	60	63	61
Kim	1	East	daytime	50	* 58	57	* 67	65	* 68	65
			nighttime	47	* 59	57	* 67	65	* 68	65
		West	daytime	50	60	57	61	59	64	61
			nighttime	47	61	57	61	59	64	61
	2	East	daytime	49	* 64	63	* 67	65	* 69	67
			nighttime	46	* 65	63	* 67	65	* 69	67
		West	daytime	49	66	63	61	59	67	64
			nighttime	46	67	63	61	59	68	65

Prediction location			Time	Background noise (measured value)	Railway noise（Predictive value）					
					(a) Existing railway		(b) DFC railway		(a) + (b)	
					30 m	50 m	30 m	50 m	30 m	50 m
Asaoti	1	East	daytime	56	* 50	49	* 69	65	* 69	65
			nighttime	48	* 49	47	* 69	65	* 69	65
		West	daytime	56	52	49	61	59	62	60
			nighttime	48	51	47	61	59	62	59
	2	East	daytime	48	—	49	—	65	—	65
			nighttime	48	—	48	—	65	—	65
		West	daytime	48	52	49	57	55	58	56
			nighttime	48	51	48	57	55	58	56

Note: 1) daytime (7:00-22:00), nighttime (22:00-7:00)
2) *value measured at 40m from a railway.
3) 40 m point is inside ROW.
Source: JICA survey team

2) Detour Section

The predicted noise level (L_{Aeq}) at 30 m and 50 m from the centre of DFC alignment ranges from 54thrugh 57 dB at daytime, and 54 through 57 dB at nighttime at 30 m away, then 53 through 56 dB atdaytime and nighttimeat 50 m away respectively.The result is summarized in Table 6.1.16.

Table 6.1.16 Result of Prediction in Detour Section

(Unit: dB (A))

Prediction location		Time	Background noise (measured value)	Railway noise (predictive value) DFC	
				30m	50m
Bharuch	East	daytime	49	54	53
		nighttime	46	54	53
	West	daytime	49	54	53
		nighttime	46	54	53
Miyagam	East	daytime	49	55	54
		nighttime	46	55	54
	West	daytime	49	55	54
		nighttime	46	55	54
Sohona	East	daytime	48	57	56
		nighttime	48	57	56
	West	daytime	48	57	56
		nighttime	48	57	56
Tigaon	East	daytime	48	57	55
		nighttime	48	57	55
	West	daytime	48	57	55
		nighttime	48	57	55

Note: daytime (7:00-22:00), nighttime (22:00-7:00)
Source: JICA survey team

(4) Evaluation

1) Setting of Environmental Preservation Target

a) Parallel Section

As for parallel section, it is targetred that predicted noise level which consists of DFC

railway noise level and existing railway noise level meet guideline value at 30 m and 50 m from the center of existing railway where ROW might be located. As the result, in all of location for prediction and at both daytime and nighttime, predicted values didn't meet guideline value (daytime: 60 dB, nighttime: 55 dB) except Kopar point. In fact, the result also indicates that only railway noise levels from the existing railway track already exceed the recommended standard level for the half sites at nighttime. Therefore, environmental impact due to railway noise is judged to be significant. So some mitigation measures are recommended to be taken especially along the residential areas and near the sensitive receprots.

b) Detour Section

As for detour section, it is targeted that predicted noise level which consists of DFC railway noise level meet guideline value at 30m and 50m from the center of existing railway where ROW might be located. As the result, predicted values slightly exceed the guideline value in Sohona and Tigaon at nighttime. However in other site, predicted noise level (L_{Aeq}) which consists of only DFC railway noise level meet guideline value at each prediction point and at each time. Therefore, environmental impact due to railway noise is judged to be light.

c) Sensitive Receptor

As for parallel section, it is targeted that predicted noise level which consists of DFC railway noise and existing railway noise meets guideline value within 100 m from the center of the existing railway. Also as for the detour sections, it is targeted that predicted noise level which consists of only DFC railway noise meet the guideline value within 100 m from the center of the DFC railway. As the result, regarding above a) and b) judgments of Parallel Section, it does not meet the guideline level and some points of the Detour Section also. Therefore, environmental impact due to railway noise is judged to be significant.

2) Consideration of Environmental Mitigation Measures

As environmental preservation: In a parallel section, it is necessary to establish soundproof walls. In detour section, residential areas are already considered for set-up of soundproof. Although the result of predicted noise level meets environmental preservation target, the establishment of soundproof wall and limitation of train operation at night time should be considered.

3) Result of Consideration of Environmental Mitigation Measures

a) Case Studies on Establishment of Soundproof Wall

Among conceivable environmental mitigation measures for the railway noise level, establishment of soundproof wall along the track is one of the effective measures to lowernoise levels. In order to grasp necessary height of the soundproof wall at different locations, case studies have been conducted at the prediction locations.

The results of case studies are summarized in Tables 6.1.17 and 6.1.18. If ROW is set at 30 m from the center of railway track, the soundproof walls at height of range from 0.5 m (Kopar) to 4.0 m (Panvel No.1, Palgar No. 1, Amalsad No.1, No.2) may be required at Parallel Sections and rang from 0.5 m (Tigaon) to 1.0 m (Sohona) may be required at Detour Sections. While if the ROW is set 50 m from the center of railway track , soundproof wall of height range from 0.5 m (Panvel No. 2, Kopar, Asaoti No. 2) to 4.0 m (Valsad No.2) may be required at Parallel Sections and 0.5 m (Sohona) may be required at Detour Section.

Table 6.1.17 Results of Case Studies on Soundproof Wall Mitigation Measure

(Parallel section) (Unit:dB (A))

Prediction location			Time	Recommended Standard Level	Without measure		Height of soundproof (m)		With measure	
					30 m	50 m	30 m	50 m	30 m	50 m
Panvel	1	East	daytime	60	69	65	4.0	2.0	55	55
			nighttime	55	69	64			54	55
		West	daytime	60	66	63	3.0	2.0	55	54
			nighttime	55	65	62			54	54
	2	East	daytime	60	* 68	65	* 2.5	1.5	* 54	55
			nighttime	55	* 67	65			* 54	55
		West	daytime	60	62	60	1.0	0.5	55	54
			nighttime	55	62	60			54	54
Kopar	1	East	daytime	60	* 57	56	* 0.5	0.5	* 55	55
			nighttime	55	* 56	56			* 55	54
		West	daytime	60	55	55	—	—	—	—
			nighttime	55	55	54			—	—
Palgar	1	East	daytime	60	* 71	67	* 4.0	2.5	* 55	55
			nighttime	55	* 70	67			* 55	55
		West	daytime	60	62	59	2.0	1.0	54	55
			nighttime	55	62	59			54	55
	2	East	daytime	60	69	64	3.5	2.0	55	54
			nighttime	55	69	64			55	54
		West	daytime	60	64	61	2.5	1.5	55	55
			nighttime	55	64	61			55	54
Boisar	1	East	daytime	60	—	68	—	3.0	—	55
			nighttime	55	—	68			—	55
		West	daytime	60	62	60	2.0	1.5	55	54
			nighttime	55	62	60			55	54
	2	East	daytime	60	* 68	65	* 2.5	2.0	* 55	54
			nighttime	55	* 67	65			* 55	54
		West	daytime	60	64	61	1.5	1.0	55	54
			nighttime	55	63	61			55	54
Vapi	1	East	daytime	60	68	63	3.0	1.5	55	55
			nighttime	55	68	63			55	55
		West	daytime	60	64	61	2.5	1.5	54	54
			nighttime	55	64	61			54	54
	2	East	daytime	60	68	63	2.5	1.5	55	54
			nighttime	55	68	63			55	54
		West	daytime	60	64	61	2.0	1.0	54	54
			nighttime	55	64	61			54	54
Valsad	1	East	daytime	60	* 69	66	* 2.0	1.5	* 55	55
			nighttime	55	* 69	66			* 55	55
		West	daytime	60	62	60	2.0	1.5	55	54
			nighttime	55	62	60			55	54
Valsad	2	East	daytime	60	—	70	—	4.0	—	55
			nighttime	55	—	70			—	55
		West	daytime	60	61	59	1.5	1.0	55	55
			nighttime	55	61	59			55	55

Prediction location			Time	Recommended Standard Level	Without measure		Height of soundproof(m)		With measure	
					30 m	50 m	30 m	50 m	30 m	50 m
Amalsad	1	East	daytime	60	70	64	4.0	2.0	54	55
			nighttime	55	70	64			54	55
		West	daytime	60	63	60	2.5	1.5	54	54
			nighttime	55	63	60			54	54
	2	East	daytime	60	71	64	4.0	2.0	55	55
			nighttime	55	71	65			55	55
		West	daytime	60	63	61	2.5	1.5	54	54
			nighttime	55	64	61			54	54
Navsari	1	East	daytime	60	69	64	3.5	1.5	54	55
			nighttime	55	68	64			54	55
		West	daytime	60	63	61	2.5	1.5	54	54
			nighttime	55	63	61			54	54
Kim	1	East	daytime	60	* 68	65	* 3.0	2.0	* 54	55
			nighttime	55	* 68	65			* 54	55
		West	daytime	60	64	61	2.0	1.0	54	54
			nighttime	55	64	61			54	55
	2	East	daytime	60	* 69	67	* 3.5	3.0	* 55	55
			nighttime	55	* 69	67			* 55	55
		West	daytime	60	67	64	3.5	2.0	54	55
			nighttime	55	68	65			55	55
Asaoti	1	East	daytime	60	* 69	65	* 3.0	2.0	* 55	55
			nighttime	55	* 69	65			* 55	55
		West	daytime	60	62	60	1.5	1.0	55	55
			nighttime	55	62	59			54	55
	2	East	daytime	60	—	65	—	1.5	—	55
			nighttime	55	—	65			—	55
		West	daytime	60	58	56	1.0	0.5	53	53
			nighttime	55	58	56			53	53

Note: 1) daytime (7:00-22:00), nighttime (22:00-7:00)
2) ＊value measured at 40m from a railway.
3) 40 m point is inside ROW.
4) Shaded section indicates that the noise levels exceed the recommended standard level
Source: JICA survey team

Table 6.1.18 Results of Case Studies on Soundproof Wall Mitigation Measure

(Detour section)

(Unit: dB (A))

Prediction location		Time	Recommended Standard Level	Without measure		Height of soundproof (m)		With measure	
				30 m	50 m	30 m	50 m	30 m	50 m
Bharuch	East	daytime	60	54	53	—	—	—	—
		nighttime	55	54	53			—	—
	West	daytime	60	54	53	—	—	—	—
		nighttime	55	54	53			—	—
Miyagam	East	daytime	60	55	54	—	—	—	—
		nighttime	55	55	54			—	—
	West	daytime	60	55	54	—	—	—	—
		nighttime	55	55	54			—	—

Prediction location		Time	Recommended Standard Level	Without measure		Height of soundproof (m)		With measure	
				30 m	50 m	30 m	50 m	30 m	50 m
Sohona	East	daytime	60	57	56	1.0	0.5	54	53
		nighttime	55	57	56			54	53
	West	daytime	60	57	56	1.0	0.5	54	53
		nighttime	55	57	56			54	53
Tigaon	East	daytime	60	57	55	0.5	—	55	—
		nighttime	55	57	55			55	—
	West	daytime	60	57	55	0.5	—	55	—
		nighttime	55	57	55			55	—

Note: 1) daytime (7:00-22:00), nighttime (22:00-7:00)
2) Shaded section indicates that the noise levels exceed the recommended standard level
Source: JICA survey team

b) Case Studies on Shifting Train Operation Number from Night to Day Time

For the Detour Sections where exceeded the guideline (Sohona, Tigaon), a consideration of shifting some of nighttime scheduled trains to daytime was made without changing total number of daily schedule. The result of case study is summarized in Table 6.1.19. Supposing that ROWs were set 30 m away from the center of DFC railways, shifting 22 night trains to daytime at Sohona, 16 night trains to daytime at Tigaon are required. Then if ROW at 50 m away from the center of the DFC railways, 7 trains are required to be shifted to daytime at Sohona.

Table 6.1.19 Results of Case Studies on Shifting Train Operation Number

(Unit: dB (A))

Prediction location		Time	Recommended Standard Level	Current Plan		Without Measure		Limitation Plan		With Measure	
				Up	Down	30 m	50 m	Up	Down	30 m	50 m
Sohona	East	daytime	60	88	88	57	56	110	110	58	57
		nighttime	55	52	52	57	56	30	30	55	53
		daytime	60	88	88	57	56	95	95	58	56
		nighttime	55	52	52	57	56	45	45	57	55
Tigaon	East	daytime	60	88	88	57	55	104	104	57	56
		nighttime	55	52	52	57	55	36	36	55	54
		daytime	60	88	88	57	55	—	—	—	—
		nighttime	55	52	52	57	55	—	—	—	—

Note: 1) daytime (7:00-22:00), nighttime (22:00-7:00)
2) Shaded section indicates that the noise levels exceed the recommended standard level.
Source: JICA survey team

6.2 VIBRATION

6.2.1 Study Methodologies

(1) Survey on Regulations of Vibration Pollution

The published literature and governmental documents, the existing regulations related to vibration pollution in India and those in Japan were reviewed to understand potential impacts and to consider mitigation measures.

(2) Survey of Existing Circumstance

1) Railway and Background Vibration Measurements in Parallel Section

a) Measurement Sites

Measurement sites are the same as noise survey, and the height of measurement is ground level.

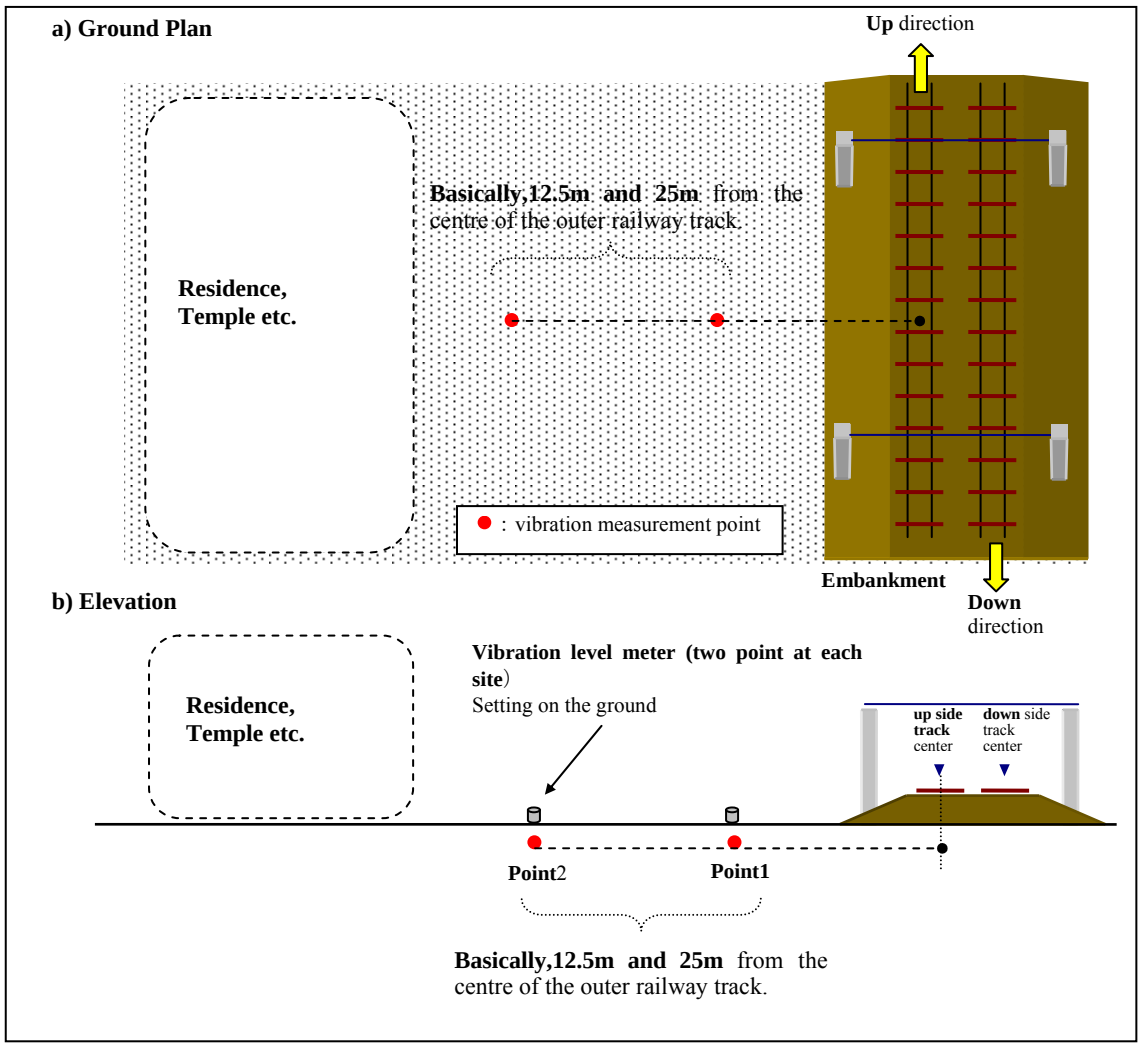
b) Methodology of Railway and Background Vibration Measurement

The measuring method of the railway vibration is not set in India. Therefore, Japanese standard of vibration measurement, JIS Z 8735 (Method of Measurement of Vibration Level) was used for vibration measurement which is accepted by the International Organization for Standardization (ISO). Since there is no relevant standard method for measuring railway vibration in India, vibration measurements are generally conducted following the International Standards. Therefore, in the similar way to have been carried out in the ESIA study, the vibration measurement based on JIS Z 8735 was conducted, and the measurement machinery used generally in Japan was utilized. Based upon distribution of facilities that needed consideration of vibration impact such as school, hospital, temple and residence etc, two measurement sites are selected in each locations. Background vibration was also measured at the same sites during the time when trains did not pass through. The measuring method is shown in Table 6.2.1. Measurement instruments are installed as shown in Figure 6.2.1.

Table 6.2.1 Measurement Method of Railway and Background Vibration in Parallel Section

Item	Specifications
Vibration Level Meter	Vibration Level Meter which complies with "JIS C 1510-1: 1995" LION VM-53A
Measurement Points	Select two points at each site. Basically, 12.5 m and 25 m from the centre of the outer railway track. The height is ground level.
Measurement Items	Railway Vibration L_p (peak level), 1/3 octave frequency analysis (1/3octave band center frequency: 1-80Hz) ・Background Vibration L_p (peak level)
Vibration Axis	X, Y, Z
Time Weighting Characteristics	630 ms
Measurement Period	2010.9.28 ~ 2010.10.13
Measurement Time	Railway vibration : 10:00-18:00 Background vibration: 10 minutes within each term (10:00-12:00, 12:00-14:00, 14:00-16:00, 16:00-18:00
Other Data	Date and time, location, train types (freight/passenger) and load (container/bulk), number of train cars, train length, passage time, train speed, pictures, information on surrounding environment, etc.

Source: JICA survey team



Source: JICA survey team

Figure 6.2.1 Schematic Plan of Railway and Background Vibration Measurements in Parallel Section

6.2.2 Results of Survey

(1) Survey of Regulation and Standards

There are no particular regulations, standards or guidelines for railway vibration level and the standards or regulations of background vibration level to be applied in India.

In Japan, the guideline values for railway vibration level are set for Shinkansen super-express railway (or called as "bullet train") as shown in Table 6.2.2, while there is no other national guideline value or recommended standard level on railway vibration level.

Table 6.2.2 Guideline Value of Vibration from Shinkansen Super Express Railway in Japan

Corrected Acceleration Level	dB (Lp)
	70 or less

Source: Environmental Agency of Japan, 1976

(2) Results of Field Survey

1) Background Vibration level (L_p: Peak Level)

The results of background vibration level (L_p) in each site are shown in Table 6.2.3. Measurement value is represented of each different time period (10:00-12:00, 12:00-14:00, 14:00-16:00, and 16:00-18:00) when trains did not pass through. At all measurement sites, the results of vibration value indicated almost about 30 dB, and below 55 dB which is the perceivable limit value.

Table 6.2.3 Results of Background Vibration Measurement

Station	No.	Backgroung Vibration Level Lp [dB]														
		10:00～12:00			12:00～14:00			14:00～16:00			16:00～18:00			Overall 10:00～18:00		
		X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
Panvel	1	32	31	<25	32	31	29	<30	<30	30	<30	<30	<25	32	31	30
	2	40	33	43	<30	32	34	33	30	40	<30	<30	36	40	33	43
Palgar	1	37	<30	26	36	<30	32	37	<30	28	37	<30	29	37	<30	32
	2	<30	<30	26	31	33	29	30	31	29	<30	<30	29	31	33	29
Boisar	1	34	<30	<25	33	30	26	32	<30	<25	<30	<30	<25	34	30	26
	2	33	<30	27	<30	33	<25	<30	33	26	31	34	26	33	34	27
Vapi	1	<30	<30	<25	33	<30	33	31	<30	28	<30	<30	27	33	<30	33
	2	<30	<30	37	31	31	26	<30	<30	<25	<30	<30	38	31	31	38
Valsad	1	<30	<30	<25	33	<30	<25	33	<30	<25	<30	<30	<25	33	<30	<25
	2	33	<30	33	<30	32	<25	<30	32	26	33	35	41	33	35	41
Amalsad	1	32	31	37	34	35	37	32	30	<25	34	<30	31	34	35	37
	2	<30	<30	<25	<30	<30	<25	<30	<30	<25	<30	<30	<25	<30	<30	<25
Kim	1	31	31	31	<30	<30	<25	32	<30	29	<30	<30	<25	32	31	31
	2	33	31	30	31	30	36	32	31	37	30	<30	<25	33	31	37
Asaoti	1	33	33	35	33	37	27	<30	<30	33	<30	<30	33	33	37	35
	2	36	35	36	38	33	31	<30	31	29	<30	<30	33	38	35	36

Note: Since measurement lower limit of vibration level meter is 30 dB for X and Y-direction, 25 dB for Z-direction, measurement value under these limit indicates with [<].
Source: JICA survey team

2) Railway Vibration level (L_p: Peak Level)

The resultof railway vibration level (L_p) at each site is summarized in Table 6.2.4. In Japan, correlation between appeal rate of damages of buildings and vibration level has been studied and it concludes that 70 dB of vibration level is the limitation so as not to damage the buildings. During the survey, it is found that at each survey point located at a distance of 12.5 m from the center of railway track, vibration measured was below 70 dB. Hence, under the present situation, no serious damages of building due to railway vibration are expected.

Table 6.2.4 Results of Railway Vibration Measurement in Pallarel Section

Station	No.	date	Number of trains	train type	train direction	Average train speed [kn/hr] V	Average train length [m]	measurement distance from railway-center 〔m〕		Average Vibration level [dB]					
										Lpx		Lpy		Lpz	
								point 1	point 2	point 1	point 2	point 1	point 2	point 1	point 2
Panvel	1	9-Oct	3	Passenger	up	45.4	437	12.5	25	53	31	54	33	62	39
			2		down	35.8	344			46	29	45	29	50	33
			5	Freight	up	23.9	557			54	32	56	33	63	39
			4		down	32.9	653			46	27	46	27	52	33
	2	9-Oct	5	Passenger	up	42.2	440	14.5	25	40	32	46	36	51	40
			4		down	39.6	360			39	34	42	35	50	40
			6	Freight	up	25.7	576			41	33	47	36	53	40
			6		down	35.9	654			37	34	40	35	49	39
Palgar	1	7-Oct	13	Passenger	up	79.6	454	12.5	25	42	48	45	41	53	43
			12		down	71.0	420			39	45	45	40	49	42
			7	Freight	up	72.9	649			44	50	48	43	56	46
			4		down	80.6	643			45	50	51	45	54	47
	2	7-Oct	16	Passenger	up	87.3	438	10	20	57	41	61	43	63	48
			8		down	75.1	433			56	40	59	41	60	47
			7	Freight	up	73.2	646			58	41	62	42	65	48
			3		down	88.2	644			58	43	62	43	63	50
Boisar	1	5-Oct	7	Passenger	up	73.2	434	12.5	23	38	50	40	43	50	47
			12		down	72.5	427			35	52	42	45	53	50
			6	Freight	up	54.0	621			38	49	41	45	51	48
			2		down	80.7	627			40	55	46	46	57	55
	2	5-Oct	8	Passenger	up	87.0	413	15	28	37	39	39	39	45	43
			10		down	94.0	440			41	45	42	43	50	47
			6	Freight	up	54.0	625			38	39	40	39	46	44
			2		down	67.7	641			42	45	43	44	49	47
Vapi	1	1-Oct	12	Passenger	up	81.8	425	12.5	25	51	46	54	50	64	52
			13		down	86.3	415			49	40	51	43	58	45
			8	Freight	up	59.8	650			51	40	54	44	64	49
			4		down	71.9	572			50	40	51	43	60	48
	2	1-Oct	11	Passenger	up	68.6	407	12.5	25	53	46	57	48	64	53
			11		down	92.4	430			53	49	54	50	61	52
			9	Freight	up	58.0	649			53	46	57	48	65	53
			5		down	62.5	592			50	45	53	47	61	50
Valsad	1	2-Oct	11	Passenger	up	58.1	438	15	25	55	49	56	49	62	56
			9		down	79.8	419			49	45	50	45	55	49
			10	Freight	up	74.5	624			56	56	57	56	64	62
			5		down	61.9	629			50	46	50	48	56	50
	2	2-Oct	11	Passenger	up	41.4	436	12.5	25	47	45	48	43	57	50
			7		down	71.5	406			43	41	48	42	58	51
			9	Freight	up	63.1	642			51	48	52	47	61	55
			4		down	52.2	625			46	42	50	46	60	53
Amalsad	1	30-Sep	11	Passenger	up	87.2	436	12.5	25	57	50	58	52	65	57
			6		down	68.5	444			52	46	55	50	62	54
			7	Freight	up	64.2	589			56	51	57	51	63	56
			7		down	90.0	592			55	50	57	53	65	57
	2	30-Sep	12	Passenger	up	87.6	436	12.5	24	57	48	58	49	63	55
			9		down	73.8	439			54	47	57	49	61	55
			7	Freight	up	64.2	589			57	51	59	52	64	58
			7		down	90.0	592			57	51	59	52	63	57
Kim	1	28-Sep	7	Passenger	up	58.1	425	12.5	25	56	52	58	48	69	58
			8		down	85.1	466			58	49	56	48	68	58
			12	Freight	up	56.3	647			59	53	61	54	70	62
			5		down	75.4	639			60	52	58	52	69	60
	2	28-Sep	3	Passenger	up	103.9	541	12.5	25	57	49	61	49	68	59
			5		down	99.1	462			52	45	56	45	67	57
			9	Freight	up	61.9	642			58	50	58	51	68	60
			4		down	69.3	580			54	49	57	49	67	59
Asaoti	1	13-Oct	19	Passenger	up	98.6	416	12.5	25	50	49	52	50	63	56
			13		down	62.4	408			52	46	52	49	65	54
			6	Freight	up	66.4	633			54	50	56	52	67	60
			8		down	60.5	624			58	52	58	55	68	63
	2	13-Oct	22	Passenger	up	93.9	401	12.5	25	55	52	57	54	66	62
			13		down	86.0	393			50	46	52	49	64	56
			4	Freight	up	72.0	640			54	51	58	54	66	62
			7		down	62.8	621			56	52	58	54	70	62

Source: JICA survey team

6.2.3 Impact Assessment during Construction Phase

(1) Impact

Construction of DFC structures and facilities would require the use of heavy equipment/ vehicles, and adversely affect sensitive receptors. As for ROB construction areas, increase of vibration pollution is envisaged by a traffic jam due to construction work on the exsting road. There are 77 ROBs proposed in this project. Table 6.1.10 shows the number of all the ROBs in each section.

(2) Mitigation Measures

Adequate measures will be planned and provided to reduce the negative impacts of vibration pollution during construction stage, such as planning the deliberate and efficient equipment use, use of the low pollution type machine, regular maintenance of construction machines. At the ROB construction site, adequate measures will be planned, such as temporary diversion road to reduce traffic jam, periodically/timely announce the progress of work to the public, etc. In addition, DFCCIL will coordinate with relevant authorities to reduce the negative impact on the traffic flow whenever necessary. The general sequence of typical ROB is shown in Figure 6.1.5.

(3) Evaluation

This impact is short duration, direct, temporary and reversible, it can be considered minor if mitigation measures and site management practices are applied.

6.2.4 Impact Assessment during Operation phase

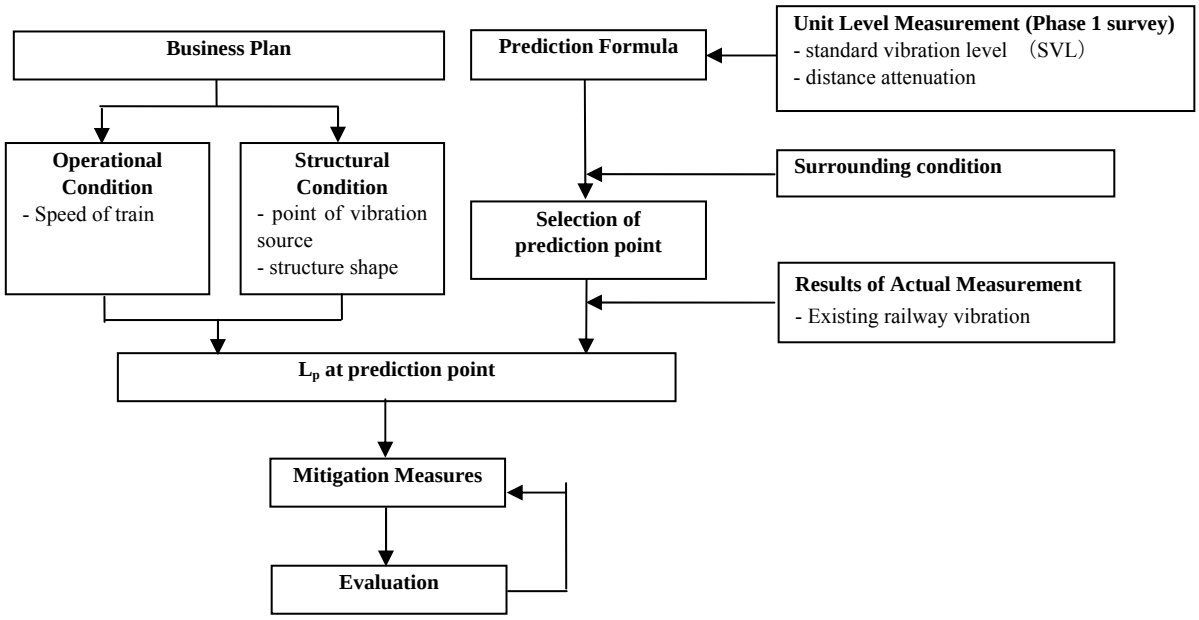
(1) Vibration Level Prediction

Railway vibration level (L_p) generated by the DFC operation was predicted at the selected ten (10) prediction locations in the parallel section and four (4) in the detour section which are same as the railway noise prediction locations. Considering influence range of vibration level generated by railway, a range of 200 m from the center of existing railway is targeted. The height of prediction is ground level. The cross-section drawings of the prediction location are same as the ones of the railway noise prediction.

(2) Method of Prediction

1) Procedure of Prediction

Procedure of prediction is given in Figure 6.2.2.



Source: JICA survey team

Figure 6.2.2 Procedure for Prediction of Vibration Level

2) Prediction formula

a) Vibration Level of DFC railway

In the same way of thinking as ESIMMS regarding an empirical formula, the formula made in Phase 1 survey was utilized in this survey. An empirical formula which consists of standard vibration level (SVL) and distance attenuation coefficient based on the results of unit level measurement was applied for the prediction. The empirical formula is shown below:

$$L_p = SVL + B \cdot LOG_{10}(D)$$

where;

SVL:standard vibration level (For X axis, SVL = $7.9 \cdot LOG_{10}(V) + 58.9$

For Y axis SVL = $10.6 \cdot LOG_{10}(V) + 58.9$

For Z axis SVL = $7.8 \cdot LOG_{10}(V) + 70.2$)

D : Distance [m]

B : Distance attenuation coefficient

(X axis B = 9.4, Y axis B = 11.4, Z axis B = 15.9)

b) Vibration Level of Existing Railway

An empirical formula which consists of L_p and distance attenuation coefficient based on the result of actual existing railway vibration measurement in the parallel section was adopted for the prediction as shown below. For the locations, where actual existing railway vibration measurement was not conducted, the value measured at the nearest measurement location was adopted as shown in Table 6.2.5.

<Freight Train>
X axis $L_p(D_2) = L_p(D_1)$-9.4* $LOG_{10}(D_2/D_1)$
Y axis $L_p(D_2) = L_p(D_1)$-11.4* $LOG_{10}(D_2/D_1)$
Z axis $L_p(D_2) = L_p(D_1)$-15.9* $LOG_{10}(D_2/D_1)$
<Passenger Train>
X axis $L_p(D_2) = L_p(D_1)$-14.1* $LOG_{10}(D_2/D_1)$
Y axis $L_p(D_2) = L_p(D_1)$-13.9* $LOG_{10}(D_2/D_1)$
Z axis $L_p(D_2) = L_p(D_1)$-18.3* $LOG_{10}(D_2/D_1)$

D_1 : Distance from center of the existing railway track to the nearest measurement point [m]
D_2 : Distance from center of the existing railway to prediction point [m]

Table 6.2.5 Setting of Result of Actual Measurement

Section	Prediction Location	Background Noise Levels used	Result of Existing Railway Vibration Measurement
Parallel section	Panvel	Panvel	Panvel
	Kopar	Panvel	Panvel
	Palgar	Palgar	Palgar
	Boisar	Boisar	Boisar
	Vapi	Vapi	Vapi
	Valsad	Valsad	Valsad
	Amalsad	Amalsad	Amalsad
	Navsari	Amalsad	Amalsad
	Kim	Kim	Kim
	Asaoti	Asaoti	Asaoti
Detour section	Bharuch	Kim	-
	Miyagan	Kim	-
	Sohona	Asaoti	-
	Tigaon	Asaoti	-

Source: JICA survey team

(3) Result of Prediction

1) Parallel Section

The predicted vibration levels at 30 m and 50 m from the centre of existing railway track in the parallel section are summarized in Table 6.2.6. The predicted point determined at 30m and 50m of distances, that is estimated average ROW end. The result of the predicted vibration levels of the existing railway ranges respectively from 42 through 64 dB (Z-axis) at 30m away, then 41 through 61 dB (Z-axis) at 50m away. The result of the predicted vibration levels of the DFC railway ranges respectively from 57 through 70dB (Z-axis) at 30m away, then 55 through 69 dB (Z-axis) at 50 m away.

Table 6.2.6 Result of Predicted Vibration Level (Lp) in Parallel Section

(Unit : dB)

Prediction Location				Background Level(measured value)	Railway Vibration (predictive value)			
					(a) Existing Railway		(b) DFC Railway	
					30 m	50 m	30 m	50 m
Panvel	1	X	East	32	51	49	64	60
			West		51	49	60	58
		Y	East	31	51	49	64	60
			West		51	49	59	57
		Z	East	30	57	54	67	61
			West		57	54	61	58

Prediction Location				Background Level(measured value)	Railway Vibration (predictive value)			
					(a) Existing Railway		(b) DFC Railway	
					30 m	50 m	30 m	50 m
Panvel	2	X	East	40	* 37	36	* 63	61
			West		38	36	59	58
		Y	East	33	* 42	41	* 63	61
			West		44	41	58	57
		Z	East	43	* 46	44	* 66	63
			West		48	44	59	57
Korar	1	X	East	32	* 50	49	* 61	60
			West		51	49	60	58
		Y	East	31	* 50	49	* 61	59
			West		51	49	60	58
		Z	East	30	* 55	54	* 63	61
			West		57	54	61	58
Palgar	1	X	East	37	* 40	39	* 65	63
			West		42	39	58	57
		Y	East	<30	* 45	44	* 66	63
			West		46	44	58	56
		Z	East	32	* 48	46	* 70	65
			West		50	46	58	56
	2	X	East	31	54	52	64	60
			West		54	52	60	58
		Y	East	33	57	54	64	60
			West		57	54	59	57
		Z	East	29	58	54	68	62
			West		58	54	60	58
Boisar	1	X	East	34	—	34	—	63
			West		36	34	58	57
		Y	East	30	—	39	—	63
			West		42	39	57	56
		Z	East	26	—	48	—	66
			West		51	48	58	56
	2	X	East	33	* 38	37	* 63	61
			West		40	37	59	58
		Y	East	34	* 38	37	* 63	61
			West		40	37	58	57
		Z	East	27	* 42	41	* 66	63
			West		44	41	59	57
Vapi	1	X	East	33	48	46	63	60
			West		48	46	60	58
		Y	East	<30	50	47	63	59
			West		50	57	59	57
		Z	East	33	58	54	63	61
			West		58	58	61	58
	2	X	East	31	50	48	63	60
			West		50	48	60	58
		Y	East	31	53	50	63	59
			West		53	50	59	57
		Z	East	38	59	56	66	61
			West		59	56	61	58
Valsad	1	X	East	33	* 52	51	* 64	62
			West		54	51	59	57
		Y	East	<30	* 53	51	* 64	62
			West		54	51	58	56
		Z	East	<25	* 57	55	* 68	64

Prediction Location				Background Level(measured value)	Railway Vibration (predictive value)			
					(a) Existing Railway		(b) DFC Railway	
					30 m	50 m	30 m	50 m
			West		59	55	59	57
	2	X	East	33	—	45	—	65
			West		48	45	58	57
		Y	East	35	—	45	—	65
			West		48	45	57	55
		Z	East	41	—	52	—	69
			West		56	52	57	55
Amalsad	1	X	East	34	52	50	65	61
			West		52	50	59	58
		Y	East	35	53	50	65	60
			West		53	50	59	57
		Z	East	37	59	55	69	62
			West		59	55	60	57
	2	X	East	<30	54	52	65	61
			West		54	52	59	58
		Y	East	<30	55	52	66	60
			West		55	52	59	57
		Z	East	<25	58	54	70	62
			West		58	54	60	57
Navsari	1	X	East	34	52	50	64	60
			West		52	50	60	58
		Y	East	35	53	50	64	60
			West		53	50	59	57
		Z	East	37	59	55	67	61
			West		59	55	60	58
Kim	1	X	East	32	* 55	54	* 63	61
			West		56	54	59	58
		Y	East	31	* 55	54	* 63	61
			West		56	54	58	57
		Z	East	31	* 62	61	* 66	63
			West		64	61	59	57
	2	X	East	33	* 54	53	* 63	61
			West		55	53	59	58
		Y	East	31	* 54	52	* 63	61
			West		55	52	58	57
		Z	East	37	* 60	59	* 66	63
			West		62	59	59	57
Asaoti	1	X	East	33	* 53	52	* 65	62
			West		54	52	59	58
		Y	East	37	* 52	51	* 65	62
			West		54	51	59	57
		Z	East	35	* 60	59	* 69	65
			West		62	59	60	57
	2	X	East	38	—	50	—	63
			West		52	50	58	57
		Y	East	35	—	51	—	63
			West		54	51	57	56
		Z	East	36	—	60	—	66
			West		64	60	57	55

Note: 1) * value measured at 40m from a railway.
2) 40 m point is inside ROW.
Source: JICA survey team

2) Detour Section

The predicted vibration level at 30 m and 50 m from the centre of existing railway in the detour section is summarized in Table 6.2.7. The result of the predicted vibration levels of the DFC railway is respectively 63 dB (Z-axis) at 30m away, then 59 dB (Z-axis) at 50 m away.

Table 6.2.7 Result of Predicted Vibration Level (L_p) in Detour Section

(Unit: dB)

Prediction Location			Backckground Vibration	DFC railway	
				30 m	50 m
Bharuch	X	East	33	61	59
		West		61	59
	Y	East	31	61	58
		West		61	58
	Z	East	37	63	59
		West		63	59
Miyagan	X	East	33	61	59
		West		61	59
	Y	East	31	61	58
		West		61	58
	Z	East	37	63	59
		West		63	59
Sohona	X	East	38	61	59
		West		61	59
	Y	East	35	61	58
		West		61	58
	Z	East	36	63	59
		West		63	59
Tigaon	X	East	38	61	59
		West		61	59
	Y	East	35	61	58
		West		61	58
	Z	East	36	63	59
		West		63	59

Source: JICA survey team

(4) Evaluation

1) Setting of Environmental Preservation Target

a) Parallel Section

As for parallel section, it is targeted that predicted vibration level (L_p) which consists of DFC railway vibration and existing railway meet guideline value (70 dB) at 30 m and 50 m from the center of DFC embankment where ROW might located.
In all of prediction location, predicted values resulted in meeting guideline value. Therefore, environmental impact due to railway vibration is judged to be light.

b) Detour Section

As for detour section, it is targeted that predicted vibration level (L_p) which consists of DFC railway vibration meet guideline value (70 dB).
In all of prediction location, predicted values resulted in meeting guideline value. Therefore, environmental impact due to railway vibration is judged to be light.

6.3 WATER POLLUTION

Water pollution is an undesirable change in characteristics of water which is harmful for biota and ecology. During a bridge construction work, runoff from the site area with stockpiles of construction materials, temporary blockage of a section of the river near construction work, wastewater discharge together with faecal contamination due to workers colony and other activities induced by the construction work may affect the river water quality, thereby impacting other users for the intended purpose in the immediate downstream direction. Therefore, it is important to assess the baseline information of the surface water near bridge construction site to know the existing quality prior to construction work so that appropriate mitigation measures can be applied to minimize potential contamination of the surface water to an acceptable or safe level.

6.3.1 Site Selection Criteria for Surface Water Quality

There are 15 important rivers (Table 6.3.1), which were crossing the DFC route and hence are expected to be affected as bridges are to be built on themin Phase 2 of DFC Project. Appropriate sampling sites were selected on these rivers to generate the baseline water quality status. On each river site, three sampling locations were selected, one each at upstream, centre (bridge alignment) and downstream. The sampling locations at upstream and downstream were mostly kept within the range of 100-150 m from the centerline. Care was taken to exclude impact of heterogeneity due to any point source of pollution such as city sewerage drains or industrial effluent outfalls within the range of sampling locations. If any such point source existed in upstream or downstream direction, the sampling locations were either increased or decreased to avoid any influence of such pollution sources in the test results. All selected sites were easily approachable for sampling under all conditions of weather and river flow either through boats or using existing railway bridge. For most of the rivers in Gujarat and Maharashtra section, the DFC bridge alignment will be parallel to the existing IR bridges.

Table 6.3.1 Sampling Period and Co-ordinates for Selected 15 Important Rivers

S.No.	River	First season Wet Period	Second season Dry Period	Sampling Location Co-ordinates		
				Upstream	Centre	Downstream
Rewar-Dadri Section						
1	Yamuna	Oct. 14, 2010	10 Feb 2011	28°27.219'N 77°25.266'E	28°22.166'N 77°25.253'E	28°27.053'N 77°25.145'E
2	Hindon		11 Feb 2011	28°28.535'N 77°27.746'E	28°28.509'N 77°27.770'E	28°28.459'N 77°27.756'E
Gujarat Section						
3	Daman Ganga	Nov 3, 2010	19 Feb 2011	20°20.572'N 77°54.402'E	20°20.580'N 77°54.342'E	20°20.588'N 72°54.223'E
4	Par	Nov 3, 2011	18 Feb 2011	20°31.490'N 72°55.603'E	20°31.491'N 72°55.564'E	20°31.494'N 72°55.514'E
5	Auranga	Nov 2, 2010	18 Feb 2011	20°37.783'N 72°56.351'E	20°37.809'N 72°56.291'E	20°37.762'N 72°56.139'E
6	South Kaveri	Nov 2, 2010	17 Feb 2011	20°44.652'N 72°58.353'E	20°44.676'N 72°58.312'E	20°44.684'N 72°58.280'E
7	North Kaveri	Nov 2, 2010	17 Feb 2011	20°44.906'N 72°58.419'E	20°44.912'N 72°58.382'E	20°44.926'N 72°58.329'E
8	Ambika	Nov 2, 2010	17 Feb 2011	20°46.937'N 72°57.919'E	20°46.945'N 72°57.905'E	20°46.937'N 72°57.930'E
9	N. Poorna	Nov 1, 2010	16 Feb 2011	20°57.788'N 72°54.620'E	20°57.792'N 72°54.517'E	20°57.805'N 72°54.445'E
10	Mindhola	Nov 1, 2010	16 Feb 2011	21°03.347'N 72°52.817'E	21°03.342'N 72°52.852'E	21°03.350'N 72°52.782'E
11	Tapi	Nov 1, 2010	15 Feb 2011	21°15.657'N 72°54.690'E	21°15.775'N 72°54.732'E	21°15.930'N 72°54.803'E
12	Narmada	Oct 31, 2010	14 Feb 2011	21°40.641'N 72°56.268'E	21°20.647'N 72°56.338'E	21°40.650'N 72°56.417'E
Maharashtra Section						
13	North Vaitarna	Nov 14, 2010	24 Feb 2011	19°32.458'N 72°51.139'E	19°32.459'N 72°51.110'E	19°32.458'N 72°51.067'E
14	South Vaitarna	Nov 14, 2010	24 Feb 2011	19°31.358'N 72°51.110'E	19°31.379'N 72°51.038'E	19°31.370'N 72°50.952'E
15	Ulhas	Nov 13, 2010	23 Feb 2011	19°14.322'N 73°04.654'E	19°14.453'N 73°04.415'E	19°14.379'N 73°04.412'E

6.3.2 Study Methodologies

As for determining river water quality characteristics at the locations of bridge construction, both primary and secondary data were used. Primary data are site specific and based on grab samples collected at one time in two different seasons where as the secondary data are based on long term sampling programme of the respective States' Pollution Control Boards or River Water Authorities at varied locations for all these important rivers. For the first season, the samples were collected towards the end of extended period of monsoon season in 2010. During the sampling period, most of the project areas received nearly 2-3% of annual average rainfall. For the second season, the samples were collected during the winter season and none of the project area received any rainfall. For rivers in Maharashtra Section, the effect of low tide and high tide on river flow conditions was also factored during the sample collection. All these rivers are perennial in nature and hence absolute dry conditions were not experienced even in dry season.

Water quality analysis was done for major baseline parameters comprising of general parameters, organic matter, nutirents, major ions, other inorganics, toxic metals and

microbiolgical. The details of parameter wise testing protocols used in the laboratory along with range of accuracy are given in Table 6.3.2. For sampling and preservation methodology, the procedures defined by the Central Pollution Control Board were mostly used. Flow velocity was measured through simple float method.

Apart from on-site measurement, secondary data on flow rate has also been collected from the respective States' Water Resource Department.

Since the grab samples collected from the river sites are liable to undergo variation in their characteristics with time and are highly dependent on activities in catchment area, the results in this report represent the concentration of a particular parameter only during the period of sampling.

Temperature, pH, conductivity, DO and flow velocity were measured on-site. For other parameters, especially for biodegradable parameters, preservation method was used. For more reliability of results, the time gap between collection from the site and testing at the laboratory was kept to a minimum. Samples were immediately transferred to the laboratory after preserving and storing them in dry ice during transportation. Preservation method is limited to pH control, chemical addition and refrigeration (Table 6.3.3).

Table 6.3.2 Testing Protocol and Range of Accuracy

S. No.	Test Parameter	Detection Limit	Test Method
1.	Temperature, ^{o}C	0.1	IS:3025(Part-9)1984
2.	Dissolved Oxygen, mg/l	0.1	IS:3025(Part-38)1989
3.	pH	0.01	IS:3025(Part-11)1984
4.	Total Suspended Solids (TSS), mg/l	0.1	IS:3025(Part-17)1984
5.	Turbidity, NTU	0.1	IS:3025(Part-10)1984
6.	Total Dissolved Solids (TDS), mg/l	1.0	IS:3025(Part-16)1984
7.	Bio-chemical Oxygen Demand (BOD) (3 days at $27^{o}C$), mg/l	0.1	IS:3025(Part-44)1993
8.	Chemical Oxygen Demand (COD), mg/l	4.0	APHA 5220C
9.	Oil & Grease, mg/l	0.05	IS:3025(Part-39)1991
10.	Free Ammonia (as N), mg/l	0.02	APHA 4500C
11.	Total Hardness (as $CaCO_3$), mg/l	0.5	IS:3025(Part-21)1983
12.	Chloride (as Cl), mg/l	0.2	IS:3025(Part-32)1988
13.	Sulphate (as SO_4), mg/l	1.0	IS:3025(Part-24)1986
14.	Calcium (as Ca), mg/l	0.2	IS:3025(Part-40)1991
15.	Magnesium (as Mg), mg/l	0.2	IS:3025(Part-46)1994
16.	Conductivity, µs/cm	1.0	IS:3025(Part-14)1984
17.	Fluoride (as F), mg/l	0.2	IS:3025(Part-60)/APHA 4500F-D
18.	Nitrate (as NO_3), mg/l	0.1	IS:3025(Part-34)1988
19.	Iron (as Fe), mg/l	0.001	IS:3025(Part-53)2003
20.	Copper (as Cu), mg/l	0.003	IS:3025(Part-2)2004
21.	Zinc (as Zn), mg/l	0.025	IS:3025(Part-2)2004
22.	Manganese (as Mn), mg/l	0.003	IS:3025(Part-2)2004
23.	Total Coliform, MPN/100ml	1.0	IS:1622-1981
24.	Faecal Coliform, MPN/100ml	1.0	IS:1622-1981

Source: Central Pollution Control Board

Table 6.3.3 Preservation Methods for Important Parameters

Parameter	Preservation Methods
Turbidity	Refrigerate at 4°C
TDS	Refrigerate at 4°C
TSS	Refrigerate at 4°C
Conductivity	Refrigerate at 4°C
Hardness	Add HNO_3 to pH < 2
Nitrate	Add $H_2SO_4$to pH < 2 Refrigerate at 4°C
Ammonia	Add $H_2SO_4$to pH < 2 Refrigerate at 4°C
Phosphate	Refrigerate at 4°C
Sulphate	Refrigerate at 4°C
DO	Fix with $MnSO_4$ and alkaline iodide on site, titration may be delayed after acidification
BOD	Refrigerate at 4°C
COD	Add $H_2SO_4$to pH < 2
Oil& Grease	Add $H_2SO_4$to pH < 2 Refrigerate at 4°C
T.Coli & F.Coli	Refrigerate, keep in incubated bottle
Zn	Refrigerate at 4°C
Cu	Refrigerate at 4°C
Manganese	Refrigerate at 4°C
Iron	Refrigerate at 4°C

Source: Central Pollution Control Board

6.3.3 Field Observations

Field observations are indicated in Table 6.3.4. Bridge construction sites for Yamuna River and Hindon River are located in Gautam Buddha Nagar District. Sampling was conducted near Dalelpur Village for Yamuna River and near Mubarakpur Village for River Hindon. Bridge construction site falls in Village Kukarwada in Bharuch District for Narmada River. River Auranga, Par and Damanganga sites are in Valsad District at Valsad Village, Haria and Vapi, respectively. Most of the other sites also fall in rural area and are mentioned in Table 6.3.4.

6.3.4 Analysis of Results

Table 6.3.5 explains the analysis result of relevant parameters for primary water quality survey for all important rivers where major bridge construction work has to be carried out. Table 6.3.5(1) and (2) shows the primary survey results for wet season in October. A dry season results in February are shown in Tables 6.3.5(3) and (4). Figures 6.3.1(1) – (5) gives graphical comparison of results for selected parameters in wet and dry season. River water quality standard based on "Designated Best Use" and primary water quality criteria for bathing as prescribed by the CPCB/MoEF is indicated in the Tables 6.3.6 and 6.3.7. Figure 6.3.2 through 6.3.3(1) and (2) show the sampling sites for water quality at proposed bridge construction sites.

Table 6.3.4 Description of Sampling Locations and Water Quality Results Analysis for Important Rivers

	Item	Description
River Ulhas	About the river	River Ulhas originates at the foothills of the Sahyadris near Karjat in the Western Ghats Range, and flows westward through Raigad and Thane districts of Maharashtra, north to Ulhasnagar and on to Kalyan, where it turns west to Thane. It flows into estuary of Vasai creek.
	Sampling Site description	River Ulhas has old double line Railway Bridge. At the time of sampling, maintenance of old track near existing bridge was going on. Proposed DFC alignment is parallel to the existing track and therefore the new bridge construction site is also adjacent to the existing bridge. The site is approachable through rail track only since no link road or kutcha road (or dirt track) is available. Pimplas and Gaodevi are the nearest villages to the bridge construction site. The sampling location is nearly 32 km away from the estuarine mouth but tidally much influenced from the Thane creek which is merely 10 km away. Thick mangroves exist on both sides of bank of the river. On left bank, agricultural fields exist on the upstream side. Also, there is a small sewerage drain falling further upstream from the sampling point.
	Natural Environmental Conditions near Sampling Site	The right bank of the river is rich with mangrove vegetation and the left bank is rich with evergreen trees and shrubs. The siteon the river is a habitat of fresh and estuarine aquatic biota. Both bank of the river has hard rocks. Apparently the water was not clean. It is affected by tidal water of Vasai creek.
	Water Quality Analysis	The Water quality results indicate that pH and conductivity are meeting the water quality criteria whereas BOD, DO and Free Ammonia do not conform to the criteria in both the seasons. The BOD values ranges from 8.6-10.4 mg/l in wet season and 7.1-9.7 mg/l in dry season. With respect to Faecal Coliform and Total Coliform counts, the river is far exceeding the permissible limit of water quality criteria for bathing reaches in river. Turbidity ranges from 57 through 71 NTU which is on higher side than the aquatic habitat wellness. However, if turbidity persists near 100 NTU for weeks or more, it has impact on the increased respiration and avoidance behavior. Heavy metal concentration is within the permissible limits.
River Vaitarna (South and North)	About the river	The North Vaitarana is the northern branch and South Vaitarna is the southern branch of the Vaitarana river. The river rises in the Sahyadri hill range. The main tributaries of River Vaitarna are Pinjal, Daherja, Surya and Tansa. River Vaitarna enters in Arabian Sea through a wide estuary off Arnala.
	Sampling Site description	Bridge construction site in North Vaitarna is near Village Wadiv Sarawalii and will be parallel to the existing railway bridge (BR-53). Section -2 of the proposed DFC corridor starts after this point. The nearest railway station to this point is Saphale. The sampling location is nearly 10 km away from the estuarine river mouth and is tidal influenced. Sand mining is rampant in many stretches of this river. Since diesel engine fitted motor boats are used for this work, possibilities of oil spillage have increased. .
	Natural Environmental conditions near Sampling Site	Thick mangrove vegetation exists on both bank of the river. Nearby agricultural fields cultivate paddy and grow banana, coconut.
	Water Quality Analysis	The Water quality results indicate that pH and DO are meeting the water quality criteria whereas BOD, conductivity and Free Ammonia do not conform to the criteria in both the seasons. The BOD values ranges from 18.4-21.9 mg/l in wet season and 9.7-10 mg/l in dry season for South Vaitarna River where as the values

	Item	Description
		ranges from 17-20.3 mg/l in wet season and 4.4-6.9 mg/l in dry season for North Vaitarna River. The higher values during wet season are attributed to monsoon flushing of land and run-off contribution. With respect to Faecal Coliform and Total Coliform counts, the river is far exceeding the permissible limit of water quality criteria for bathing reaches in river. The high values of EC and TDS in both the seasons is mainly due to inter-mixing of sea water into the fresh river water due to creek area. . The higher values during dry season as compared to wet season are due to low flow conditions and more impact of sea water. Higher values of free ammonia ranging from 3.32-4.78 and 1.2-2.0 for Vaitarna River (South and North) in wet and dry season respectively indicates possible contamination of domestic sewage or due to run off from the nearby agricultural fields. Heavy metal contamination is not noticed in any of the sample for these two sites. Comparatively higher fluoride content is noted in both branches of river in both seasons as compared to sampling locations for all other rivers in DFC Phase 2.
River Damanganga	About the river	The Damanganga River originates from Sahyadri hills near Valveri. The industrial towns of Vapi, Dadra and Silvassa in Gujarat lie on the north bank of the river, and the town of Daman occupies both banks of the river's estuary. The river receives most of the effluent load from active industries in the Vapi Industrial Estate. It is also a major source of drinking water for the nearby towns and cities.
	Sampling Site description	The proposed bridge alignment is located in the estuarine region and adjacent to the existing railway bridge. The Vapi industrial area also exists nearby. . The outfall of one of the sewage treatment plant located towards the NH is near the existing bridge. The sampling location is about 12 km away from the estuarine mouth, and is tidally influenced. The flow is mostly unidirectional towards the sea. Water flows from the barrage that exists at upstream almost 700 meters away from the sampling location.
	Natural Environmental conditions near Sampling Site	There is no vegetation on the right bank. It is rather a stony bank, and on the left bank, patchy green shrub exists near sampling point. Apparently water was clean.
	Water Quality Analysis	The results of Damanganga River show not only tidal influence but also effect of discharge from an outfall of a sewage treatment plant, particularly during wet season in the down stream direction. The Water quality results indicate that pH and DO are meeting the water quality criteria in dry season for all three sampling locations but only for location at center in wet season. At downstream location, DO was observed near zero in wet season showing influence of untreated sewerage or effluent into the river. In most of the sampling locations, BOD, conductivity and Free Ammonia do not conform to the criteria in both the seasons. The BOD meets the criteria for locations at upstream and center during wet season. The BOD value ranges from 0.6-19.8 mg/l in wet season and 4.0-10.3 mg/l in dry season. With respect to Faecal Coliform and Total Coliform counts, the river is far exceeding the permissible limit of water quality criteria for bathing reaches in river. Turbidity ranged from 18 through 179 NTU within 400 meter difference from upstream to downstream in wet season and 14 through 58 NTU in dry season. Free Ammonia value ranges from 1.4 to 4.18 mg/l from u/s to d/s location in wet season and 1.6 to 1.8 mg/l in dry season. *T.Coli* and *F.coli* values show possible contamination of untreated domestic wastewater or any other faecal contamination. Heavy metal contamination was not recorded.

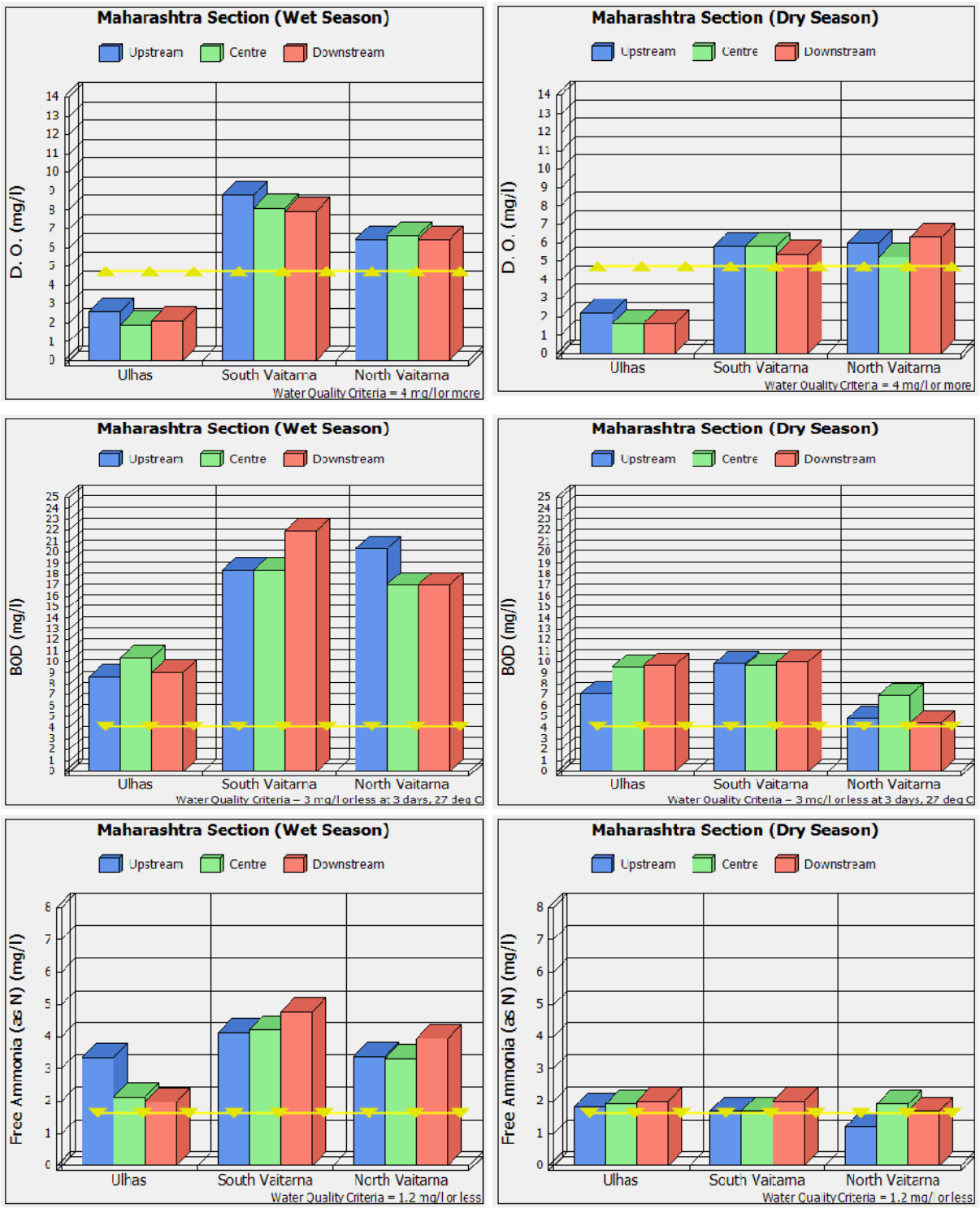
	Item	Description
		High fluctuations in certain parameters indicate the need for more rigorous spatial sampling for these locations. The dry season results show favorable value of DO for aquatic biota. An impact of effluent on water quality was low due to dilution with tidal water.
River Par	About the river	River Par originates from Shyadri Hills of Satpura Range. The river flows westward and joins Arabian Sea. Par River is a drinking water source for several villages in Gujarat including the DFC villages - Umarsadi and Haria. The river receives treated and sometimes untreated wastewater from a large industrial complex of Atul which is situated on the banks of the river in Valsad District.
	Sampling Site description	The sampling location is close to the existing railway track and nearly 4 km away from the estuarine mouth and well influenced by the tide. No remarkable features exist on the bank other than plantations. The river bank is protected by stone wall on the right bank and on the left bank. it is continuing with agricultural lands/plantations with gentle slope. The river bank is marshy due to deposition of silt during flood during wet season period.
	Natural environmental conditions near Sampling Site	Vegetation and agriculture exist on both sides of the bank. Water was apparently turbid.
	Water Quality Analysis	TDS, TSS and hardness values are found to be on higher side. In dry season, the values for these parameters are comparatively much higher than those in the dry season. This may be due to less dilution conditions during dry season period. If turbidity persists near 100 NTU for weeks or more, it has an impact on the increased respiration and avoidance behavior for aquatic life in the river. For Par river, the values ranges from 96 through 112 NTU in wet season and 282 through 342 in dry season. Contamination of river water from untreated domesticwastewater appears to be on higher side as indicated by high level of F.coli and T.coli. Free Ammonia ranges from 1.64 through 2.11 mg/l in wet season and 4.00 through 4.90 in dry season, which is beyond permissible limit for designated best use for propagation of wild life and fisheries. EC values for both the seasons also show a high influence of sea water into the overall quality of river water at proposed bridge site locations. DO levels are below the permissible limits required for aquatic biota and bathing standards. BOD values in dry season are significantly higher and are a clear indication of mixing of untreated sewage or effluent near the sampling locations.
River Auranga	About the river	River Auranga originates from Shyadri hills of Satpura Range, flows westward and joins Arabian sea. The riverhas a very little flow in major part of the year. The river banks are generally marshy due to deposition of silt during flood.
	Sampling Site description	The sampling location is close to the existing railway bridge at Valsad village and nearly 6 km away from the estuarine mouth and tidally well influenced. The downstream sampling point is nearly 100-150 meters away from a drainage channel which carries all household wastage. Very low flow was observed during dry season.
	Natural Environmental conditions near Smapling Site	Rive bed mining (sand, pebbles) was on-going at the time of sampling. On both sides of the bank, lush green vegetation exists. Apparently water was clean.
	Water Quality Analysis	The Water quality results indicate that pH and DO are meeting the water quality criteria in both the seasons for all three sampling locations. BOD and Free Ammonia do not conform to the criteria in both the seasons. However, BOD

	Item	Description
		values in dry season are only marginally higher to the permissible limits. While EC and corresponding TDS values are well within the prescribed limits in wet season, they are much higher in the dry season. This clearly shows the influence of sea water into the quality of river water. With respect to Faecal Coliform and Total Coliform counts, the river is far exceeding the permissible limit of water quality criteria for bathing reaches in river. For other inorganic parameters, the values are well within the permissible limits. Heavy metal contamination is not observed and all values were within the permissible limit.
River Kaveri (North and South)	About the river	The North Kaveri and South Kaveri is two branch of Kaveri River. It originates from Sahayadri Hills and joins the Arabian sea.
	Sampling Site description	The sampling location is almost 13 km away from the estuarine mouth at village Hondach. The river flow is narrowed to a small channel due to land filling and construction work. Sampling locations for both the rivers are close to the existing railway track.
	Natural environmental conditions near Sampling Site	No much vegetation was observed along the river banks. Apparently water was clean.
	Water Quality Analysis	The Water quality results indicate that pH, EC and DO are meeting the water quality criteria in both the seasons for all sampling locations. BOD values are close to permissible limits during wet season but exceeding the limits in dry season. Free Ammonia does not conform to the criteria in both the seasons. With respect to Faecal Coliform and Total Coliform counts, the river is far exceeding the permissible limit of water quality criteria for bathing reaches in river. Turbidity values range from 84 through 130 NTU in wet season and from 139 through 252 NTU in dry season. Heavy metal contamination is not observed in any of the sample.
River Narmada	About the river	The Narmada River rises near Amarkantak in Madhya Pradesh and has a length of about 1312 km and drainage area of 98796 Km^2 and falls into the Arabian Sea at Bay of Khambat near Bharuch in Gujarat. The river water quality was influenced by monsoon flow during wet season. Apparently there was no sign of significant water quality degradation.
	Sampling Site description	The proposed DFC corridor is in estuarine region of the river near village Kukareada. The surrounding land use is mostly semi-urban and agricultural. The Narmada River is polluted near Bharuch city in downstream direction to the proposed bridge alignment site where it is joined by its tributary, Amlakhadi. This tributary carries effluents from Ankleshwar, Jhagadia and Panoli industrial estates, the constituent units of which have high pollution potential. Though the sampling location is nearly 40 km away from the estuarine mouth yet it experiences a tide of nearly 2 m. The water is turbid. The sampling point is close to a bathing area where, people often indulge in activities such as washing clothes, bathing. . Areas around river banks are also used for grazing of animals. .
	Natural Environmental conditions near Sampling Site	The biological growth was not observed due to high turbulence in river water. Silt deposition due to flood was observed all along its banks. The water quality is influenced by a large number of human activities in the area such as open defecation from the nearly slum population, , open dumping of garbage, untreated sewerage discharge and other non-point sources of pollution.

	Item	Description
	Water Quality Analysis	The Water quality results indicate that pH, EC, DO and BOD are meeting the water quality criteria in wet season but only pH and EC in dry season. The BOD values ranges from 9.3-12.2 during the dry season and is beyond the permissible limit. Free Ammonia in none of the seasons is conforming to the criteria. With respect to Faecal Coliform and Total Coliform counts, the river is exceeding the permissible limit of water quality criteria for bathing reaches in river. The water quality results also reveal lower TDS and TSS values as compared to other tidal water affected rivers along the alignment.
River Tapi	About the river	River Tapi rises near Multai in the Betul District of Madhya Pradesh. The river flow is highly regulated due to series of dams on it and its tributaries.
	Sampling Site description	The proposed bridge alignment area on this river is mostly surrounded by agriculture. Banana cultivation was observed near sampling location at village Rambadi in Nana Varachha, Abrama. The area is fertile and intensively cultivated. Cattle grazing were one of the common activities observed in the area. The sampling location is more than 30 km away from the estuarine mouth.
	Natural Environmental conditions near Sampling Site	The biological growth was not observed as the biological communities were flushed during the flood. During sampling period it was observed that the river just receded from flood and lots of silt was deposited all along its banks. Apparently water was clean.
	Water Quality Analysis	The Water quality results indicate that pH, conductivity, DO and BOD are meeting the water quality criteria in wet season where as pH, conductivity, DO and Free Ammonia are meeting the criteria in dry season. Free Ammonia does not conform to the criteria in wet season. The BOD values ranges from 0.5-0.8 mg/l in wet season and 3.9-6.5 mg/l in dry season. With respect to Faecal Coliform and Total Coliform counts, the river is exceeding the permissible limit of water quality criteria for bathing reaches in river. Turbidity and TSS are in low concentration in both the seasons as compared to other important rivers along the alignment. Heavy metal contamination is not recorded.
River Ambika	About the river	The Ambika River originates from Satpura Hill ranges near village Kotambi of Surgana taluka in the Nasik District of Maharashtra. After flowing for a length of 136 km, it drains into the Arabian Sea. The important tributaries of the Ambika River are Kapri, Wallan, Kaveri and Kharera. Ambika River is one of the important west flowing rivers with its catchment in Gujarat and Maharashtra.
	Sampling Site description	The sampling location (near Talod village of Billimora) is almost 12 km away from the estuarine mouth and has not much tidal influence due to many shoals and restrictions along the river course. The original flow in the river is somewhat affected due to some of the on-going bridge construction activities.
	Natural Environmental conditions near Sampling Site	There is not much vegetation near river bank. Right bank is mainly agricultural area.
	Water Quality Analysis	Overall water quality during wet season is fairly good and most of the parameters are meeting the river water quality criteria. However, BOD and Free Ammonia do not meet the criteria in dry season. With respect to Faecal Coliform and Total Coliform counts, the river is exceeding the permissible limit of water quality criteria for bathing reaches in river. Heavy metals concentrations are in safe limits.
River North	About the river	The Poorna River originates in Pokhran Village which is 2 km away from Bhaisdehi in Madhya Pradesh adjoining Amravati District of Maharashtra and flows through Akola, Buldhana, Jalgaon, Jalna, and Parbhani Districts in

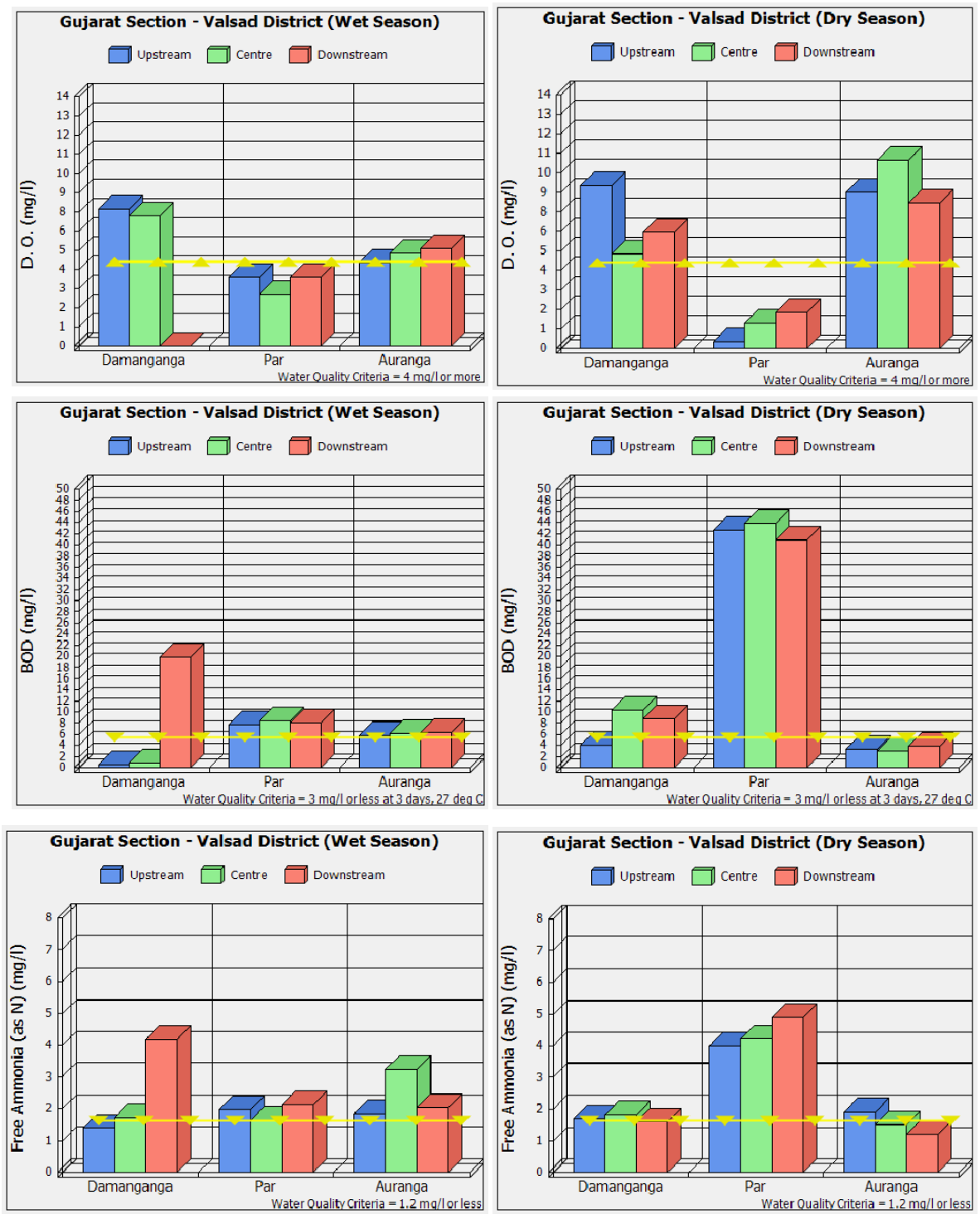
	Item	Description
		Maharashtra. The river empties into the Gulf of Khambhat near the city of Navsari in Southern Gujarat.
	Sampling Site description	Proposed bridge construction site is close to the existing track almost 16 km away from the estuarine mouth. It has low tidal dominance in the river. Sampling site is near Taudi village in Jalalpur Taluka of Navsari. Brick kilns are also being operated near the site.
	Natural Environmental conditions near Sampling Site	There was no significant growth of biological community in the river due to flushing during wet season. The silt and mud were deposited along the banks of the river. Both of the river banks are engulfed with lushy green trees/shrubs.Right bank has *Prosopis juliflora*, coconut and agricultural area. Left bank has banana cultivation. Fishing boats were seen near the site.
	Water Quality Analysis	The Water quality results indicate that pH, conductivity, DO and BOD are meeting the water quality criteria in wet season where as pH and conductivity are meeting the criteria in dry season. Free Ammonia does not conform to the criteria in both the seasons. The BOD value ranges from 2.2-2.9 mg/l in wet season and 18.0-19.5 mg/l in dry season. With respect to Faecal Coliform and Total Coliform counts, the river is exceeding the permissible limit of water quality criteria for bathing reaches in river, thereby indicating contamination due to domestic wastewater. Heavy metals contamination was not observed in any of the sampling point.
River Mindhola	About the river	The Mindhola River originates from near Doswada (Songadh) and meets in Arabian sea. Its length is 105 km and catchment area is 1,518 km^2.
	Sampling Site description	The river sampling location is 18 km away from the estuarine mouth at Kansad, Surat. Site has no influence of tide. The location is parallel to the existing rail bridge (BR 417). The width of the river is narrow. The silt and mud were deposited along the banks of the river. The river is polluted due to discharge of effluents from the industries and domestic sources. Both of the banks have agriculture area with sugarcane cultivation. Washing of clothes was also seen near site.
	Natural Environmental conditions near Sampling Site	The surrounding land at the site was mostly agricultural. The main crops grown in the area are bajra, jwar, rice, wheat and vegetables. Apparently water was dirty.
	Water Quality Analysis	The dissolved oxygen values in both the seasons are very low indicating less aeration capacity as well as high degree of pollution. BOD value ranges from 12.3 to 12.6 mg/l in wet season and 14.3 to 16.7 in dry season. pH and EC are well within the water quality criteria for both the seasons. *T.coli and F.coli* contamination is also very high in all the sampling locations. . Heavy metal contamination is not observed.
River Yamuna	About the river	The Yamuna River, a major tributary of Ganges River, originates from the Yamnotri glacier near Banderpunch peaks in Himalayas. The Yamuna River is facing serious problem of low water level and high pollution load due to over-abstraction and discharge of untreated or partially treated sewage and effluents into the river.
	Sampling Site description	In the region, the major flow of the river is diverted to Agra Canal at Okhla Barrage just 15 km upstream of the proposed bridge alignment for DFC Project. The river receives partially treated wastewater of East Delhi through Shahadara Drain just downstream of the Okhla Barrage, which is the only water flows in the

	Item	Description
		downstream during non-monsoon period. Since, in the current year, there was a good monsoon continued for a longer period, the river was in good flow for more than a month and similar conditions was observed during the sampling period.
	Natural Environmental conditions near Sampling Point	The vegetable crops, rice and sugarcane are grown in nearby agricultural fields. There was no biological growth in the river as it was all flushed out during flood. The surrounding land is fertile and is an important agricultural region of Haryana and Uttar Pradesh.
	Water Quality Analysis	In wet season, DO values ranged from 3.9 to 5.8 mg/l where as in dry season, it was near zero. BOD ranged from 3.2 to 4.2 mg/l and 57.1 to 64.5 mg/l in wet and dry season respectively. This shows the high degree of pollution level in this particular stretch of the river. Moreover, this stretch remains heavily polluted during most of the time in a year with BOD more than 30 mg/l and dissolved oxygen near zero. During wet season sampling, since monsoon was receding, the river banks were muddy due to deposited silt. Free ammonia concentration was high and ranged from 2.16 to 2.21 mg/l and 5.81 to 6.02 mg/l in wet and dry season respectively. Oil & grease, heavy metals and inorganic contamination is although not exceeding the limits but is still on a higher side. The very high BOD values in the dry season are similar to the typical characteristics of any wastewater drain. Water quality show impacts of faecal contamination and direct disposal of sewage into the river.
River Hindon	About the river	The Hindon River is a tributary of Yamuna River. It originates from Upper Shivalik in Lower Himalayan Range. The river is entirely rain fed and has a catchment area of 7,083 km^2. It flows between Ganges and Yamuna Rivers for 400 km through Muzaffarnagar, Meerut, Baghpat, Ghaziabad, Noida, and Greater Noida before it joins Yamuna River just outside Delhi. The majority of industries on its bank are agro-based comprising of sugar mills, distilleries, paper mills and allied industries. The wastewater generated from these industries is generally treated, however the treatment is not adequate and hence the river water remain brownish in color most of the time. Major part of the Hindon River is diverted to Yamuna near Ghaziabad to augment flow of the Yamuna and subsequently of Agra Canal to sustain irrigation demand and hence at proposed bridge construction site, the river has very little flow.
	Sampling Site description	Land use near the site is mostly agriculture and hence influenced by cattle wading and related activities. The vegetable crops, rice and sugarcane are grown in this area.
	Natural Environmental conditions near Sampling Site	Site is near Mubarakpur Village and surrounded by shrub and bushy vegetation. During wet season survey, the flood water in the river was receding and hence the river banks were full of deposited mud/silt (marshy condition). There was no significant biological growth as the biological communities had just flushed during the flood. The water was still turbid as residues of silt scoured from the catchment area during rain were still visible.
	Water Quality Analysis	Turbidity ranged from 147 to 158 NTU and 143 to 174 NTU in wet and dry season respectively. DO values were recorded in range of 3.3 to 3.5 mg/l in wet season. The dissolved oxygen was found much below the saturation level (nearly 40% saturation) indicating high oxygen demand with BOD around 4.1 to 6.0 mg/l. In dry season, the DO level was near zero with BOD values 36.4 to 44.4 mg/l. Heavy metals contamination was not observed in any of the samples. Free Ammonia values ranged from 1.94 to 2.2.3 mg/l and 3.35 to 3.72mg/l in wet and dry season respectively. Overall water quality shows heavy impact of faecal contamination and direct disposal of untreated and partially treated sewage.



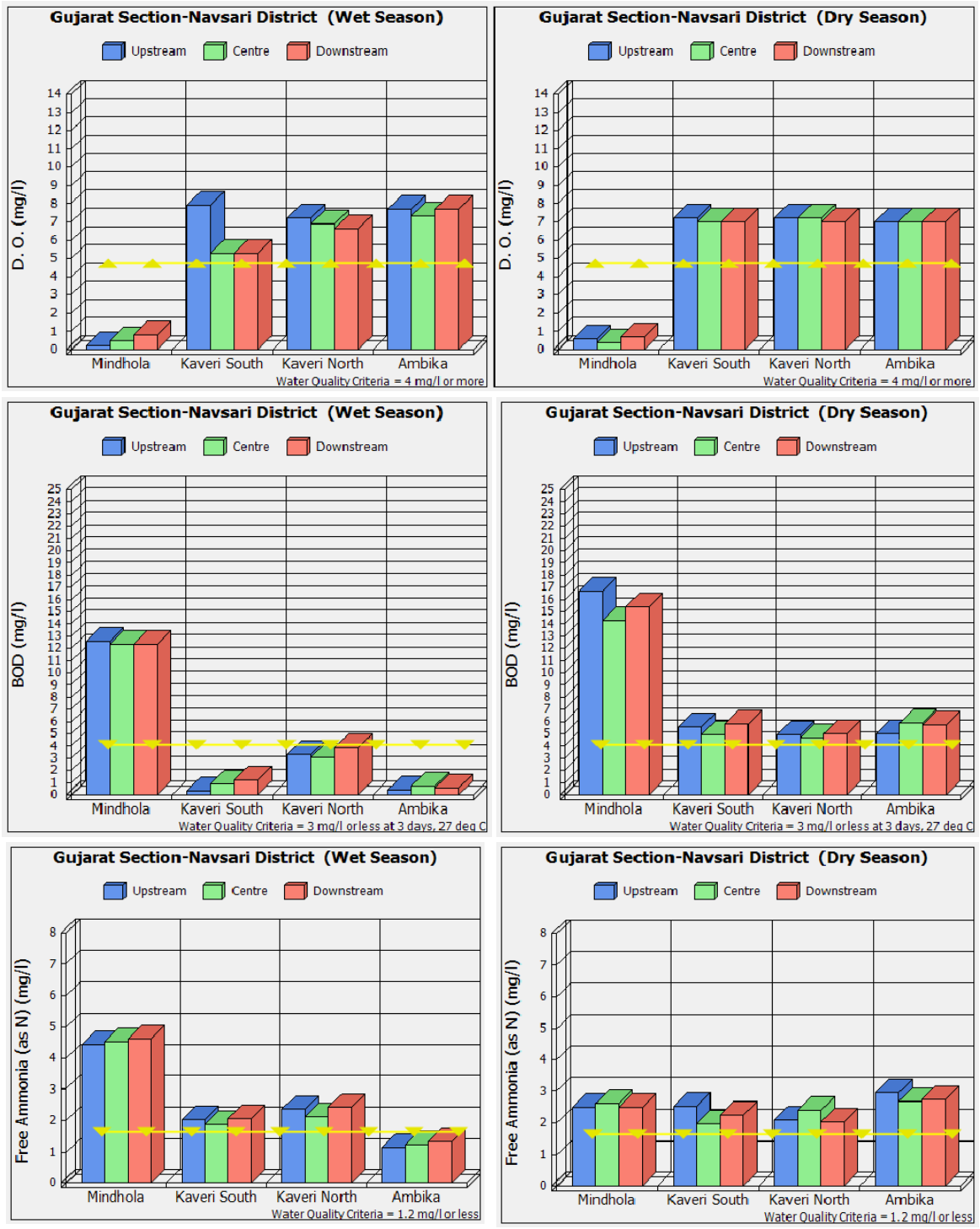
Source: JICA survey team

Figure 6.3.1(1) Comparison of Results for Selected Parameters in Wet and Dry Season



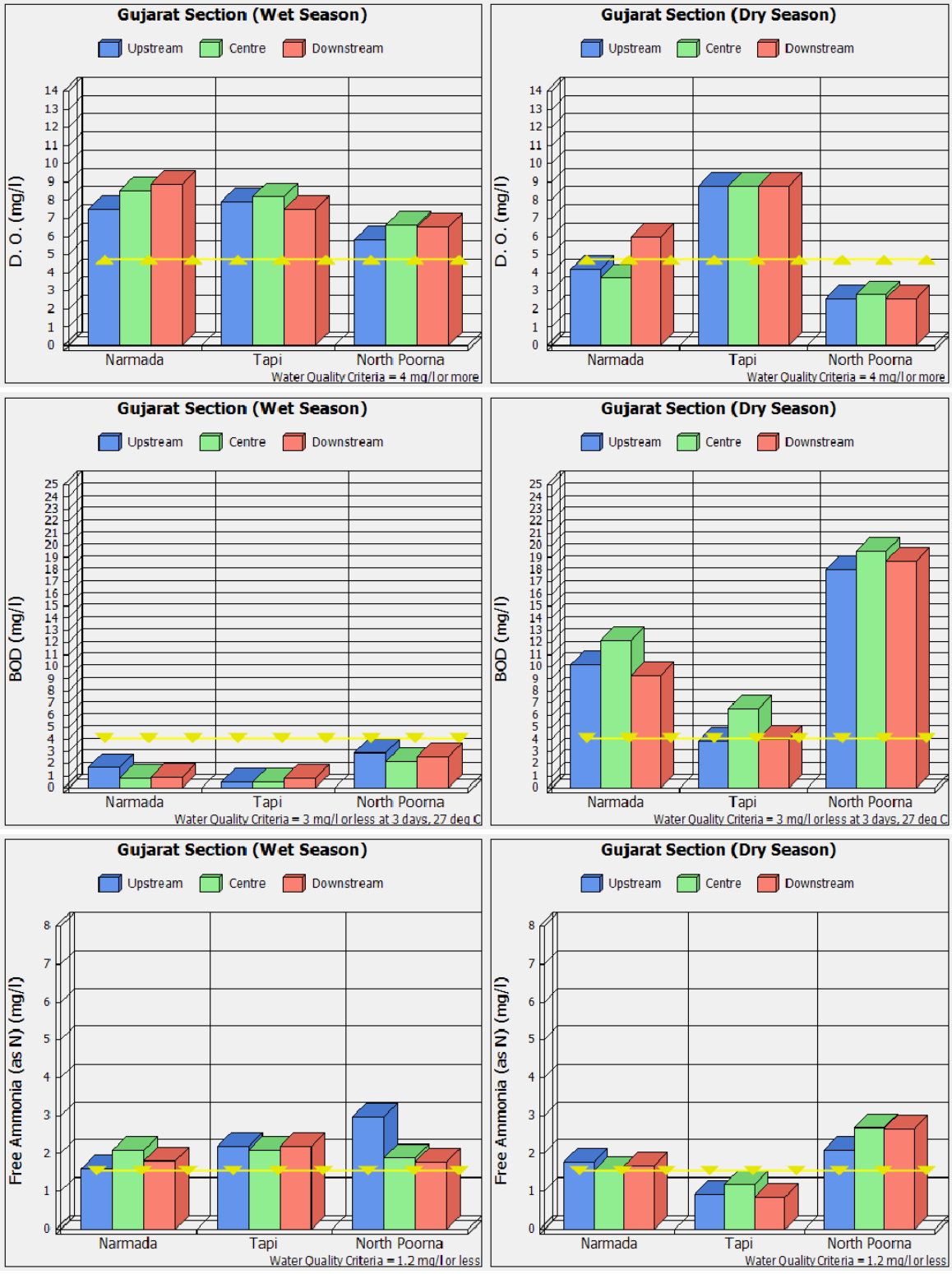
Source: JICA survey team

Figure 6.3.1(2) Comparison of Results for Selected Parameters in Wet and Dry Season



Source: JICA survey team

Figure 6.3.1(3) Comparison of Results for Selected Parameters in Wet and Dry Season



Source: JICA survey team

Figure 6.3.1(4) Comparison of Results for Selected Parameters in Wet and Dry Season

Source: JICA survey team

Figure 6.3.1(5) Comparison of Results for Selected Parameters in Wet and Dry Season

Table 6.3.5 (1) Physico-chemical and Biological Characteristics of Surface Water at Bridge Construction Sites for Major Rivers for Wet Season

No.	Name of River	Location	1	2	3	4	5	6	7	8	9	10	11	12	13
			Temp	pH	EC	TSS	TDS	Turbidity	Total Hardness	DO	BOD	COD	Nitrate	Free Ammonia	T.Coli
Unit			°C	-	µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml
1	Yamuna	Upstream	31.1	7.89	510	80	336	33	201.6	5.6	4.0	19.0	0.52	2.21	9.8×10^3
		Center	31.3	7.46	514	77	342	30	197.4	5.8	3.2	12.4	0.44	2.18	1.1×10^4
		Down Stream	31.1	7.39	513	87	354	38	197.4	3.9	4.2	20.7	0.51	2.16	1.2×10^4
2	Hindon	Upstream	28.7	7.38	510	338	336	158	201.6	3.4	6.0	29.0	0.81	2.20	5.2×10^5
		Center	28.9	7.33	514	333	342	147	197.4	3.3	4.1	19.8	0.77	1.94	4.9×10^5
		Down Stream	29.0	7.43	513	354	354	148	197.4	3.5	4.2	20.7	0.85	2.23	4.8×10^5
3	Narmada	Upstream	32.6	7.76	352	212	245	84	121.6	7.5	1.7	8.2	0.63	1.60	7.9×10^3
		Center	32.6	7.67	346	242	250	60	125.4	8.5	0.8	4.1	0.65	2.10	7.2×10^3
		Down Stream	32.5	7.81	353	238	238	84	117.8	8.9	0.9	4.1	0.56	1.80	6.7×10^3
4	Aurangа	Upstream	28.8	7.46	982	242	684	69	190	4.7	5.8	24.9	0.77	1.86	5.4×10^4
		Center	28.8	7.14	787	202	638	74	174.8	5.2	6.1	29.0	0.69	3.22	6.3×10^4
		Down Stream	28.8	7.45	831	190	649	59	167.2	5.5	6.4	29.0	0.67	2.02	6.1×10^4
5	Par	Upstream	29.7	6.95	11,160	307	6,094	112	1197	3.9	7.8	41.5	0.55	1.97	7.6×10^5
		Center	29.8	6.99	11,360	262	6,112	96	1216	2.9	8.5	49.7	0.54	1.64	7.2×10^5
		Down Stream	29.5	6.97	11,830	304	6,088	109	1178	3.9	8.1	45.6	0.61	2.11	7.3×10^3
6	Daman Ganga	Upstream	30.2	5.99	247	62	212	18	91.2	7.7	0.6	4.1	0.48	1.40	9.5×10^3
		Center	30.9	7.28	429	98	345	37	104.2	7.3	0.8	5.1	0.63	1.73	1.1×10^4
		Down Stream	32.2	7.26	3,340	342	2,192	179	551	0.0	19.8	91.3	0.87	4.18	2.2×10^5
7	Tapi	Upstream	28.5	7.92	553	16.5	396	3	174.8	7.9	0.5	4.1	0.17	2.20	2.9×10^3
		Center	28.6	8.05	552	18	384	3	171	8.2	0.5	4.2	0.16	2.10	3.2×10^3
		Down Stream	28.8	7.99	550	18	390	3	178.6	7.5	0.8	4.9	0.09	2.20	1.4×10^3
8	North Poorna	Upstream	29.0	7.6	839	140	642	62	201.4	5.8	2.9	16.4	0.67	2.98	3.6×10^4
		Center	28.4	7.57	723	155	630	65	186.2	6.6	2.2	12.3	0.55	1.88	3.9×10^4
		Down Stream	28.5	7.59	725	162	634	85	190	6.5	2.6	12.3	0.59	1.78	4.3×10^4
9	Ambika	Upstream	30.3	8.01	511	206	378	90	167.2	7.7	0.4	4.1	0.58	1.14	8.4×10^3
		Center	30.3	7.95	484	140	362	65	155.8	7.3	0.7	5.8	0.63	1.23	8.2×10^3
		Down Stream	30.2	7.96	483	184	365	84	159.6	7.7	0.6	4.1	0.61	1.32	8.7×10^3
10	Kaveri North	Upstream	28.6	7.92	490	152	384	98	174.8	7.2	3.3	16.6	0.61	2.36	5.1×10^4
		Center	28.7	7.91	486	116	396	84	167.2	6.9	3.1	12.4	0.69	2.11	5.8×10^4
		Down Stream	28.7	7.91	498	172	398	107	174.8	6.6	3.9	16.6	0.67	2.43	5.9×10^4
11	Kaveri South	Upstream	28.0	8.03	438	162	336	113	152	7.9	0.3	4.1	0.52	2.04	4.8×10^4
		Center	28.0	7.93	440	178	328	125	152	5.3	0.9	8.2	0.58	1.88	4.9×10^4
		Down Stream	28.2	7.96	436	184	340	130	152.4	5.3	1.2	12.3	0.56	2.07	4.9×10^4
12	Mindhola	Upstream	27.4	7.19	686	168	468	67	193.8	0.2	12.6	51.2	0.53	4.44	8.7×10^3
		Center	27.4	7.2	702	156	476	68	201.4	0.5	12.3	50.8	0.58	4.53	9.1×10^5
		Down Stream	27.4	7.18	695	165	465	65	197.6	0.8	12.3	51.2	0.62	4.61	9.3×10^5
13	Ulhas	Upstream	31.2	6.74	1,618	128	1,018	68	220.4	2.6	8.6	45.4	0.38	3.36	7.7×10^4
		Center	31.6	6.73	1,305	134	989	57	174.8	1.9	10.4	41.3	0.36	2.11	5.1×10^4
		Down Stream	31.6	6.79	1,307	132	994	71	171	2.1	9.0	41.3	0.42	1.98	5.2×10^4
14	South Vaitarna	Upstream	31.4	7.31	26,890	136	19,898	36	2907	8.8	18.4	99.2	1.82	4.12	5.2×10^5
		Center	31.4	7.28	26,050	134	19,749	32	2926	8.1	18.4	90.9	1.76	4.22	4.9×10^5
		Down Stream	31.5	7.52	27,900	130	19,898	30	2831	7.9	21.9	115.7	1.88	4.78	4.8×10^5
15	North Vaitarna	Upstream	31.1	7.21	25,720	130	19,038	29	2783	6.4	20.3	103.3	1.39	3.37	6.2×10^3
		Center	31.2	7.3	24,990	148	18,972	29	2679	6.6	17.0	99.2	1.44	3.32	6.8×10^5
		Down Stream	31.2	7.66	25,080	148	18,972	26	2688	6.4	17.0	95.0	1.42	3.94	7.1×10^5

Source: JICA survey team

Table 6.3.5 (2) Water Quality Characteristics of Surface Water at Bridge Construction Sites for Major Rivers for Wet Season

No.	Name of River	Location	14	15	16	17	18	19	20	21	22	23	24	25
			F.coli	Flow-Velocity	Chloride	Sulphate	Calcium	Magnesium	Fluoride	O&G	Zinc	Manganese	Iron	Copper
Unit			MPN/100 ml	m/s	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Yamuna	Upstream	5.6×10^3	0.33	71.4	32.9	48.8	19.4	0.68	N.D.	0.307	0..028	0.532	0.024
		Center	7.9×10^3	0.30	69.4	32.2	48.8	18.4	0.71	N.D.	0.321	0.021	0.556	0.022
		Down Stream	7.8×10^3	0.33	73.5	37.4	48.8	18.4	0.55	N.D.	0.321	0.022	0.554	0.018
2	Hindon	Upstream	3.9×10^5	0.43	71.4	32.9	48.8	19.4	0.56	N.D.	0.454	0.028	0.915	0.037
		Center	2.8×10^5	0.42	69.4	35.1	48.7	18.4	0.61	N.D.	0.449	0.027	0.897	0.031
		Down Stream	2.8×10^5	0.36	73.0	37.4	48.8	18.2	0.59	N.D.	0.421	0.031	0.993	0.032
3	Narmada	Upstream	5.1×10^3	0.37	29.1	16.9	25.9	13.9	0.18	N.D.	0.279	0.029	0.396	0.011
		Center	4.6×10^3	0.38	31.1	18.0	25.9	14.8	0.27	N.D.	0.311	0.021	0.392	0.007
		Down Stream	4.8×10^3	0.38	27.2	14.2	27.4	12.2	0.21	N.D.	0.288	0.034	0.378	0.008
4	Auranga	Upstream	3.9×10^4	0.29	48.6	34.0	38.1	19.4	0.18	N.D.	0.247	0.018	0.437	0.031
		Center	4.2×10^4	0.27	46.6	32.0	36.6	20.3	0.22	N.D.	0.251	0.023	0.443	0.021
		Down Stream	4.1×10^4	0.27	50.5	37.9	38.1	17.6	0.18	N.D.	0.279	0.025	0.497	0.023
5	Par	Upstream	5.8×10^5	0.16	3108.3	239.4	286.0	221.3	0.47	N.D.	0.302	0.021	0.832	0.029
		Center	5.6×10^5	0.17	3185.9	232.0	325.0	232.9	0.53	N.D.	0.312	0.018	0.799	0.038
		Down Stream	5.2×10^5	0.17	3321.9	245.2	293.9	219.4	0.53	N.D.	0.327	0.026	0.811	0.036
6	Daman Ganga	Upstream	7.4×10^3	0.48	17.5	7.4	21.3	7.2	0.59	N.D.	0.192	0.028	0.553	0.038
		Center	8.5×10^3	0.56	24.3	8.6	22.8	10.2	0.73	N.D.	0.214	0.027	0.592	0.042
		Down Stream	1.6×10^5	0.63	636.2	221.9	156.1	43.5	0.78	N.D.	0.417	0.044	0.861	0.057
7	Tapi	Upstream	2.1×10^3	Still	42.7	28.0	31.9	23.1	0.39	N.D.	0.072	0.012	0.144	0.006
		Center	2.9×10^3	Still	44.7	21.7	31.9	24.0	0.33	N.D.	0.059	0.007	0.124	0.011
		Down Stream	9.5×10^2	Still	46.6	26.4	31.6	22.2	0.37	N.D.	0.063	0.003	0.129	0.008
8	North Poorna	Upstream	2.2×10^4	0.10	118.5	41.6	36.6	24.0	0.55	N.D.	0.263	0.021	0.553	0.027
		Center	2.7×10^4	0.11	93.2	33.1	31.9	23.1	0.55	N.D.	0.270	0.016	0..499	0.029
		Down Stream	3.2×10^4	0.10	93.2	32.8	36.0	23.2	0.61	N.D.	0.264	0.019	0.571	0.029
9	Ambika	Upstream	6.8×10^3	0.50	40.5	22.8	38.1	17.6	0.36	N.D.	0.091	0.009	0.189	0.011
		Center	6.7×10^3	0.50	31.0	16.1	35.0	16.6	0.41	N.D.	0.094	0.009	0.201	0.014
		Down Stream	7.6×10^3	0.50	33.5	17.4	33.5	16.6	0.42	N.D.	0.083	0.003	0.193	0.012
10	Kaveri North	Upstream	3.7×10^4	0.60	48.6	34.0	38.1	19.4	0.32	N.D.	0.198	0.032	0.596	0.038
		Center	4.8×10^4	0.80	46.6	32.0	38.1	20.3	0.42	N.D.	0.211	0.039	0.611	0.042
		Down Stream	5.2×10^4	0.60	50.5	37.9	36.6	17.6	0.41	N.D.	0.209	0.038	0.618	0.044
11	Kaveri South	Upstream	3.5×10^4	0.60	40.8	27.9	33.5	16.6	0.39	N.D.	0.187	0.027	0.598	0.039
		Center	3.7×10^4	0.70	39.9	24.6	35.0	15.7	0.42	N.D.	0.209	0.031	0.645	0.043
		Down Stream	3.8×10^4	0.50	38.9	26.0	35.0	15.7	0.4	N.D.	0.201	0.022	0.637	0.038
12	Mindhola	Upstream	6.1×10^5	0.25	52.5	29.6	39.6	23.1	0.41	N.D.	0.433	0.046	0.912	0.057
		Center	5.9×10^5	0.30	54.4	31.8	39.6	23.1	0.41	N.D.	0.438	0.046	0.988	0.054
		Down Stream	6.2×10^5	0.27	52.5	30.4	39.6	24.9	0.39	N.D.	0.467	0.033	0.907	0.047
13	Ulhas	Upstream	4.9×10^4	Still	386.3	112.4	55.4	30.1	0.72	N.D.	0.251	0.031	0.569	0.031
		Center	3.6×10^4	0.13	299.6	98.2	46.5	27.3	0.61	N.D.	0.263	0.019	0.601	0.027
		Down Stream	3.6×10^4	0.12	299.6	98.2	45.8	27.2	0.61	N.D.	0.269	0.023	0.615	0.027
14	South Vaitarna	Upstream	3.9×10^5	0.21	8869.0	2217.0	763.4	391.5	1.12	0.8	0.419	0.059	0.783	0.048
		Center	2.8×10^5	0.21	9066.0	2264.0	771.2	397.1	1.03	0.8	0.461	0.057	0.781	0.049
		Down Stream	2.8×10^5	0.19	9598.0	2391.0	774.6	396.2	1.16	1.7	0.469	0.049	0.904	0.061
15	North Vaitarna	Upstream	4.3×10^5	0.19	8130.0	2029.0	691.7	343.6	0.92	0.2	0.415	0.039	0.712	0.038
		Center	4.9×10^5	0.21	7760.0	1958.0	696.3	356.1	1.11	0.2	0.443	0.042	0.770	0.049
		Down Stream	5.2×10^5	0.19	7785.0	1964.0	698.3	351.8	1.08	0.7	0.429	0.042	0.743	0.044

Source: JICA survey team

Table 6.3.5(3) Water Quality Characteristics of Surface Water at Bridge Construction Sites for Major Rivers for Dry Season

No.	Name of River	Location	1	2	3	4	5	6	7	8	9	10	11	12	13
			Temp	pH	EC	TSS	TDS	Turbidity	Total Hardness	DO	BOD	COD	Nitrate	Ammonia	T.Coli
Unit			℃	-	µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml
1	Yamuna	Upstream	16.9	7.53	1323	132	975	58	336.6	NIL	64.5	199.2	0.78	6.02	9.4×10^5
		Center	16.8	7.55	1301	165	982	75	323.7	NIL	57.1	170.0	0.74	5.81	9.4×10^6
		Down Stream	15.9	7.41	1239	168	971	87	317.8	NIL	64.5	190.2	0.76	5.96	9.8×10^5
2	Hindon	Upstream	15.7	7.64	1003	319	798	152	238.3	NIL	36.4	119.5	0.84	3.69	3.5×10^7
		Center	16.2	7.67	1003	386	788	174	238.3	NIL	36.4	119.5	0.93	3.35	4.0×10^6
		Down Stream	16.6	7.53	1016	273	782	143	234.4	NIL	44.4	159.4	0.91	3.72	1.1×10^7
3	Narmada	Upstream	29.5	7.8	1532	152	1,064	67	325.7	4.2	10.2	44.5	0.55	1.79	2.5×10^5
		Center	27.8	7.8	1521	178	982	82	329.7	3.7	12.2	40.5	0.46	1.56	2.7×10^5
		Down Stream	29.6	7.83	1320	212	945	79	329.7	6.0	9.3	36.4	0.57	1.68	2.7×10^5
4	Aurnaga	Upstream	23.3	8.11	28210	733	22,850	312	3972.0	8.6	3.3	10.9	0.85	1.90	3.4×10^5
		Center	24.8	8.21	30800	736	24,948	310	4170.6	10.4	3.0	11.9	0.86	1.50	4.7×10^5
		Down Stream	23.5	8.18	33000	711	25,740	312	4269.9	8.0	3.9	12.7	0.94	1.20	4.2×10^5
5	Par	Upstream	23.9	7.17	33500	649	25,460	282	5759.4	0.4	42.6	190.5	0.62	4.00	8.1×10^6
		Center	23.2	7.17	33200	820	25,232	341	5560.8	1.4	43.8	194.4	0.64	4.20	8.9×10^6
		Down Stream	26.5	7.21	34200	776	25,992	342	5560.8	2.0	40.8	182.5	0.58	4.90	1.1×10^7
		H.T	23.5	7.38	34500	635	26,220	289	5858.7	1.3	45.7	195.5	0.70	4.70	9.4×10^6
6	Daman Ganga	Upstream	22.2	8.54	219	31	192	14	87.6	9.0	4.0	11.9	0.54	1.70	8.4×10^6
		Center	23.1	7.91	3540	126	2,194	58	387.6	5.2	10.3	32.8	0.61	1.80	7.6×10^6
		Down Stream	24.9	7.94	1641	81	1,094	39	446.9	6.4	8.7	30.9	0.78	1.60	4.0×10^6
7	Tapi	Upstream	22.9	8.33	445	12	294	6	158.9	8.8	3.9	12.1	0.22	0.92	3.3×10^5
		Center	22.9	8.34	455	13	298	6	147.0	8.8	6.5	21.5	0.15	1.20	2.3×10^5
		Down Stream	22.9	8.31	433	15	288	7	143.0	8.8	4.0	16.2	0.19	0.84	3.4×10^5
8	North Poorna	Upstream	23.9	7.86	1100	341	728	143	254.2	2.6	18.0	50.8	0.74	2.08	2.1×10^6
		Center	23.8	7.79	1185	311	748	157	258.2	2.8	19.5	53.7	0.62	2.68	1.7×10^6
		Down Stream	23.9	7.85	1154	336	736	148	262.2	2.6	18.7	48.6	0.59	2.66	2.7×10^5
9	Ambika	Upstream	27.4	8.16	600	389	654	311	174.8	7.0	5.0	20.3	0.62	2.96	3.9×10^3
		Center	27.1	8.22	486	322	657	287	178.7	7.0	5.9	22.0	0.59	2.68	3.4×10^3
		Down Stream	27.1	8.2	882	442	576	294	182.7	7.0	5.7	24.0	0.66	2.74	3.3×10^3
10	Kaveri North	Upstream	26.4	8.35	1200	254	778	139	214.5	7.2	4.9	29.7	0.61	2.08	2.2×10^6
		Center	27.0	8.11	2830	510	1,562	242	238.3	7.2	4.7	28.5	0.64	2.41	3.0×10^7
		Down Stream	26.8	8.38	1186	452	732	233	198.6	7.0	5.0	30.7	0.76	2.02	3.5×10^7
11	Kaveri South	Upstream	25.8	8.36	765	543	486	252	218.5	7.2	5.6	23.7	0.55	2.52	2.0×10^7
		Center	26.8	8.35	730	478	458	245	206.5	7.0	4.9	20.2	0.53	1.96	3.0×10^7
		Down Stream	24.9	8.37	719	459	442	233	198.6	7.0	5.8	23.0	0.48	2.24	3.0×10^6
12	Mindhola	Upstream	25.4	7.23	852	132	566	61	226.4	0.6	16.7	52.6	0.69	2.48	2.7×10^5
		Center	25.4	7.11	842	138	562	67	226.4	0.4	14.3	44.5	0.63	2.60	3.3×10^5
		Down Stream	25.1	7.21	850	127	560	58	234.3	0.7	15.4	48.6	0.67	2.50	4.9×10^5
13	Ulhas	Upstream	24.1	7.43	14190	114	17,804	56	1976.1	2.2	7.1	27.2	0.43	1.80	8.1×10^5
		Center	24.2	7.37	13830	111	11,612	49	1936.4	1.6	9.5	37.9	0.39	1.90	8.9×10^6
		Down Stream	24.8	7.37	13640	94	12,246	43	1952.2	1.6	9.7	87.3	0.44	2.00	9.4×10^6
14	South Vaitarna	Upstream	23.6	7.8	34400	220	31,648	98	4766.4	5.8	9.8	30.7	2.13	1.70	3.4×10^6
		Center	23.2	7.79	35000	410	31,952	183	4468.5	5.8	9.7	30.0	2.22	1.70	3.4×10^6
		Down Stream	23.3	7.77	34600	253	31,832	123	4567.8	5.4	10.0	32.4	2.15	2.00	4.2×10^6
15	North Vaitarna	Upstream	24.0	7.85	34000	188	31,960	91	5958.0	6.0	4.8	25.7	1.72	1.20	2.2×10^6
		Center	23.5	7.8	33900	189	31,188	58	6057.3	5.2	6.9	30.6	1.74	1.90	2.7×10^6
		Down Stream	23.9	7.82	35100	132	32,292	63	5858.7	6.3	4.4	25.7	1.66	1.70	3.4×10^6

Source: JICA survey team

Table 6.3.5(4) Water Quality Characteristics of Surface Water at Bridge Construction Sites for Major Rivers for Dry Season

No.	Name of River	Location	14	15	16	17	18	19	20	21	22	23	24	25
			F.coli	Flow rate	Chloride	Sulphate	Calcium	Magnesium	Fluoride	O&G	Zinc	Manganese	Iron	Copper
Unit			MPN/100 ml	m/s	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Yamuna	Upstream	3.0×10^5	0.23	238.0	170.7	89.2	27.6	1.24	ND	0.395	0.035	0.650	0.031
		Center	3.3×10^5	0.23	238.0	171.4	87.6	26.0	0.89	ND	0.413	0.039	0.708	0.036
		Down Stream	2.9×10^5	0.23	233.1	170.9	90.7	22.1	0.94	ND	0.424	0.039	0.731	0.038
2	Hindon	Upstream	4.3×10^6	0.5	170.0	108.9	65.3	18.2	0.64	ND	0.519	0.039	0.953	0.038
		Center	2.4×10^5	0.5	175.0	102.7	66.9	17.3	0.59	ND	0.538	0.042	1.064	0.041
		Down Stream	2.9×10^5	0.65	179.7	106.1	63.7	18.3	0.68	ND	0.561	0.046	1.092	0.045
3	Narmada	Upstream	2.5×10^5	0.37	335.1	51.9	86.0	26.9	0.36	ND	0.350	0.035	0.467	0.014
		Center	1.4×10^5	0.42	301.0	47.2	87.6	26.9	0.34	ND	0.370	0.024	0.463	0.008
		Down Stream	1.7×10^5	0.39	286.5	46.8	89.2	25.9	0.41	ND	0.342	0.042	0.427	0.010
4	Aurangs	Upstream	1.7×10^5	0.33	12918.0	2252.6	1205.8	233.3	0.26	ND	0.273	0.020	0.491	0.036
		Center	3.1×10^5	0.43	13695.0	2194.7	1233.8	264.6	0.24	ND	0.285	0.026	0.497	0.025
		Down Stream	3.3×10^5	0.39	15784.0	2327.9	1313.4	240.5	0.21	ND	0.316	0.028	1.511	0.025
5	Par	Upstream	5.3×10^5	0.36	16172.0	1959.0	1512.4	481.5	0.58	ND	0.321	0.022	0.855	0.031
		Center	4.9×10^5	0.5	16124.0	1868.3	1472.6	457.4	0.53	ND	0.326	0.020	0.812	0.040
		Down Stream	4.6×10^5	0.34	16027.0	1937.3	1432.8	481.5	0.62	ND	0.351	0.027	0.829	0.040
		H.T	4.9×10^5	0.23	16804.0	1986.1	1592.0	457.3	0.57	ND	0.803	0.023	0.803	0.029
6	Damun Ganga	Upstream	4.6×10^5	0.24	48.6	112.8	19.1	9.7	0.69	ND	0.219	0.032	0.606	0.042
		Center	4.3×10^6	0.23	777.0	612.8	87.6	41.0	0.81	ND	0.231	0.030	0.650	0.044
		Down Stream	4.9×10^6	0.24	446.8	145.9	87.6	55.4	0.65	ND	0.467	0.051	0.956	0.062
7	Tapi	Upstream	2.1×10^5	0.13	43.7	24.0	39.8	14.4	0.51	ND	0.084	0.014	0.167	0.005
		Center	1.3×10^5	0.15	43.7	21.8	38.2	12.5	0.52	ND	0.067	0.005	0.145	0.012
		Down Stream	1.7×10^5	0.12	39.0	17.7	36.6	12.5	0.53	ND	0.072	0.004	0.148	0.010
8	North Pocona	Upstream	7.9×10^4	0.15	218.5	108.1	57.3	27.0	0.59	ND	0.294	0.024	0.638	0.032
		Center	7.9×10^4	0.17	223.4	116.1	60.5	26.0	0.67	ND	0.296	0.019	0.563	0.032
		Down Stream	8.4×10^4	0.16	247.7	120.8	58.5	28.2	0.64	ND	0.302	0.021	0.596	0.032
9	Ambika	Upstream	1.7×10^4	0.16	82.6	22.5	33.4	22.2	0.49	ND	0.093	0.010	0.193	0.012
		Center	1.8×10^4	0.38	53.4	18.1	35.0	22.1	0.49	ND	0.098	0.010	0.213	0.015
		Down Stream	1.7×10^4	0.36	145.7	46.5	33.6	24.0	0.94	ND	0.089	0.004	0.203	0.013
10	Kaveri North	Upstream	3.3×10^5	0.38	282.0	107.9	49.4	22.1	0.51	ND	0.207	0.030	0.663	0.042
		Center	3.1×10^5	0.39	310.8	233.1	49.8	27.6	0.48	ND	0.213	0.041	0.701	0.046
		Down Stream	3.9×10^5	0.31	377.0	91.8	42.1	22.6	0.52	ND	0.236	0.400	0.698	0.050
11	Kaveri South	Upstream	3.1×10^5	0.33	150.0	34.0	39.8	28.9	0.43	ND	0.215	0.031	0.682	0.042
		Center	3.3×10^5	0.37	131.1	27.9	40.4	25.6	0.38	ND	0.242	0.034	0.749	0.044
		Down Stream	3.9×10^5	0.31	131.1	30.7	36.6	26.0	0.44	ND	0.230	0.025	0.737	0.044
12	Mindhola	Upstream	2.1×10^5	0.36	97.1	63.9	57.3	20.2	0.54	ND	0.479	0.052	0.980	0.063
		Center	1.7×10^5	0.39	97.1	59.8	58.9	19.2	0.52	ND	0.503	0.052	0.999	0.063
		Down Stream	1.7×10^5	0.38	102.0	67.9	57.3	22.1	0.55	ND	0.523	0.037	0.975	0.053
13	Ulhas	Upstream	5.3×10^5	0.14	7770.0	936.9	565.2	137.1	0.75	ND	0.288	0.031	0.623	0.033
		Center	4.6×10^5	0.14	67285	987.0	545.3	139.5	0.68	ND	0.309	0.024	0.692	0.031
		Down Stream	4.3×10^6	0.14	8742.0	94902.0	553.2	138.6	0.71	ND	0.310	0.025	0.713	0.033
14	South Vaitarna	Upstream	4.6×10^5	0.68	19427.0	2680.7	1024.8	536.0	2.1	ND	0.471	0.063	0.873	0.051
		Center	4.3×10^5	0.71	18455.0	2687.8	935.4	517.9	1.64	ND	0.500	0.061	0.806	0.051
		Down Stream	5.3×10^5	0.68	19427.0	2683.1	955.2	530.0	1.99	ND	0.511	0.053	0.998	0.069
15	North Vaitarna	Upstream	5.3×10^5	0.55	2136.9	2673.6	1592.0	481.5	1.76	ND	0.417	0.041	0.722	0.043
		Center	4.9×10^5	0.62	18455.3	2740.8	1602.0	499.5	1.32	ND	0.453	0.043	0.792	0.051
		Down Stream	4.6×10^5	0.62	20398	2679.5	1552.2	481.5	1.43	ND	0.441	0.044	0.761	0.046

Source: JICA survey team

Table 6.3.6 Use Based Classification of Surface Waters in India

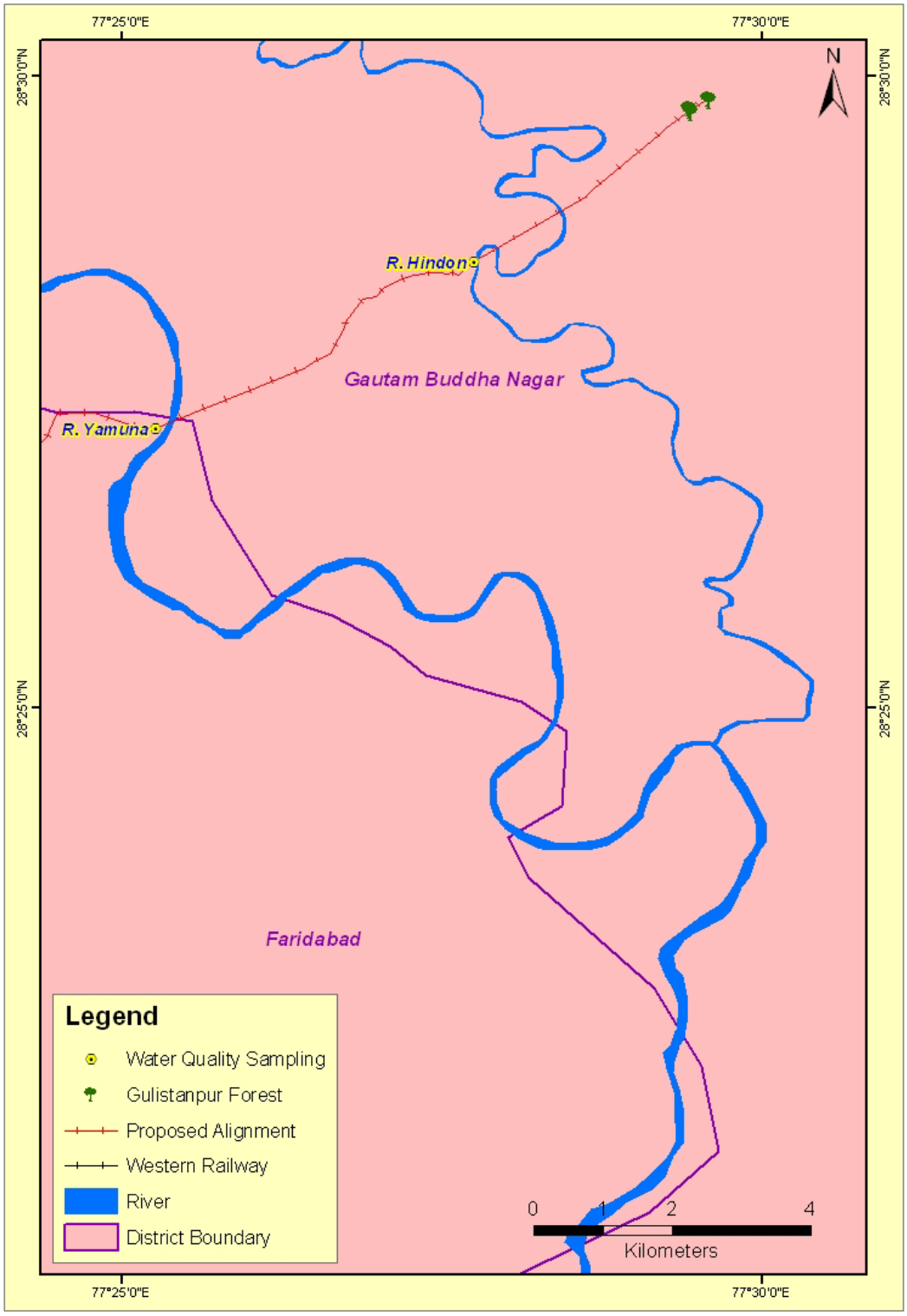
Designated Best-Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. DO 6 mg/l or more 4. BOD 5 days 20°C 2mg/l or less
Outdoor Bathing (Organized)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. DO 5 mg/l or more 4. BOD 5 days 20°C 3 mg/l or less
Drinking Water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100 ml shall be 5,000 or less 2. pH between 6 and 9 3. DO 4 mg/l or more 4. BOD 5 days 20°C 3 mg/l or less
Propagation of Wild Life and Fisheries	D	1. pH between 6.5 and 8.5 2. DO 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25°C micro mhos/cm Max. 2250 3. Sodium absorption ratio Max. 26 4. Boron Max. 2 mg/l

Source: Ministry of Environment & Forests, GoI

Table 6.3.7 Primary Water Quality Criteria for Bathing

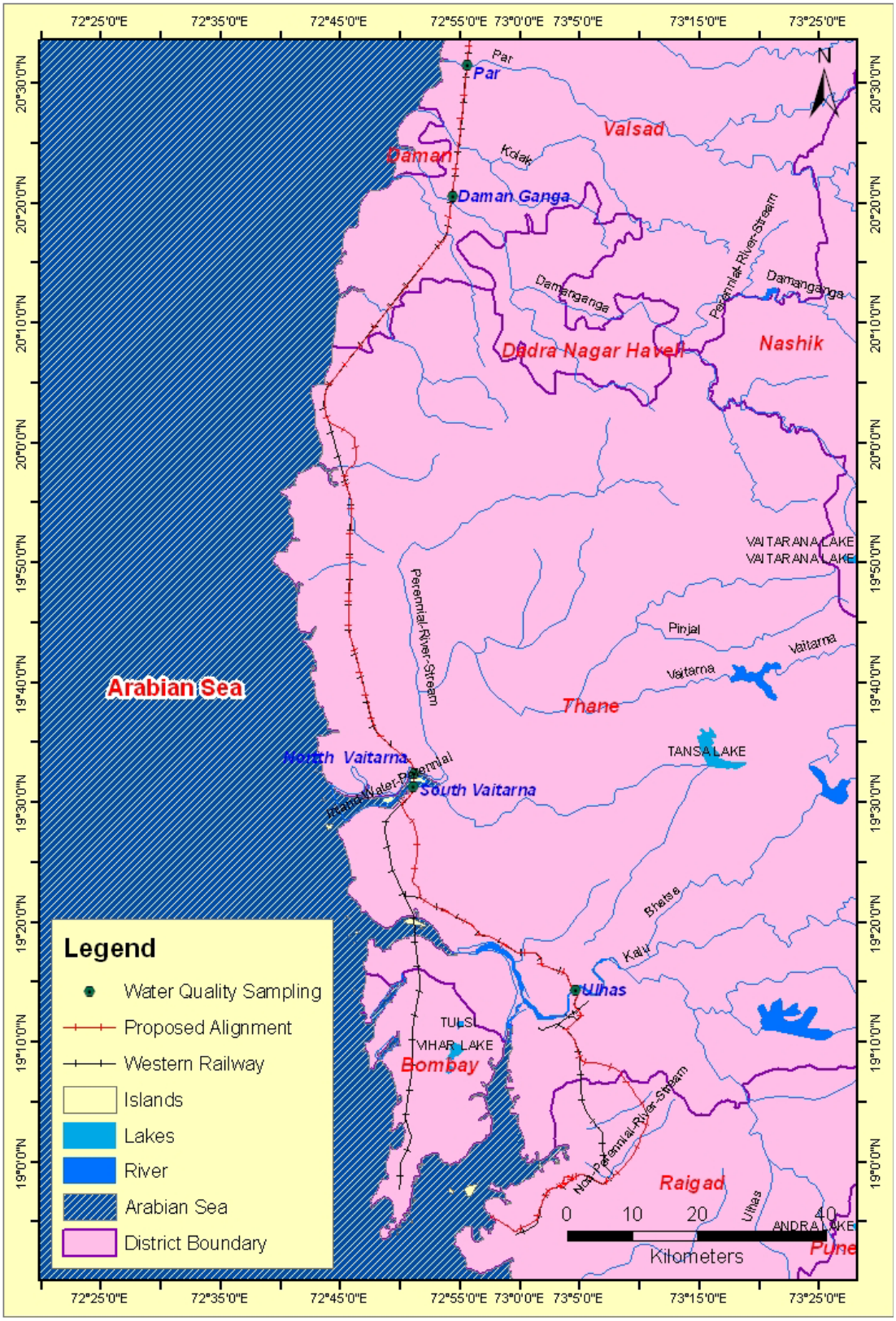
Criteria	Rationale
1. Faecal Coliform: 500 (desirable) MPN/100 ml: 2,500 (Maximum Permissible)	To ensure low sewage contamination. Faecal coliform and faecal streptococci are considered as they reflect the bacterial pathogenicity.
2. Faecal Streptococci: 100 (desirable) MPN/100 ml: 500 (Maximum Parmissible)	The desirable and permissible limits are suggested to allow for fluctuation in environmental condition such as seasonal changes, changes in flow conditions etc.
3. pH: Between 6.5-8.5	The range provides protection of the skin and delicate organs like eyes, nose, ears etc. which are directly exposed during outdoor bathing
4. Dissolved Oxygen: 5 mg/l or more	The minimum dissolved oxygen concentration of 5 mg/l ensures reasonable freedom from oxygen consuming organic pollution immediately U/s which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediments
5. Biochemical Oxygen Demand, 3 days at 27°C: 3 mg/l or less	The BOD of 3 mg/l or less of the water ensures reasonable freedom from oxygen demanding pollutants and prevent production of obnoxious gases

Source: Ministry of Environment & Forests, GoI



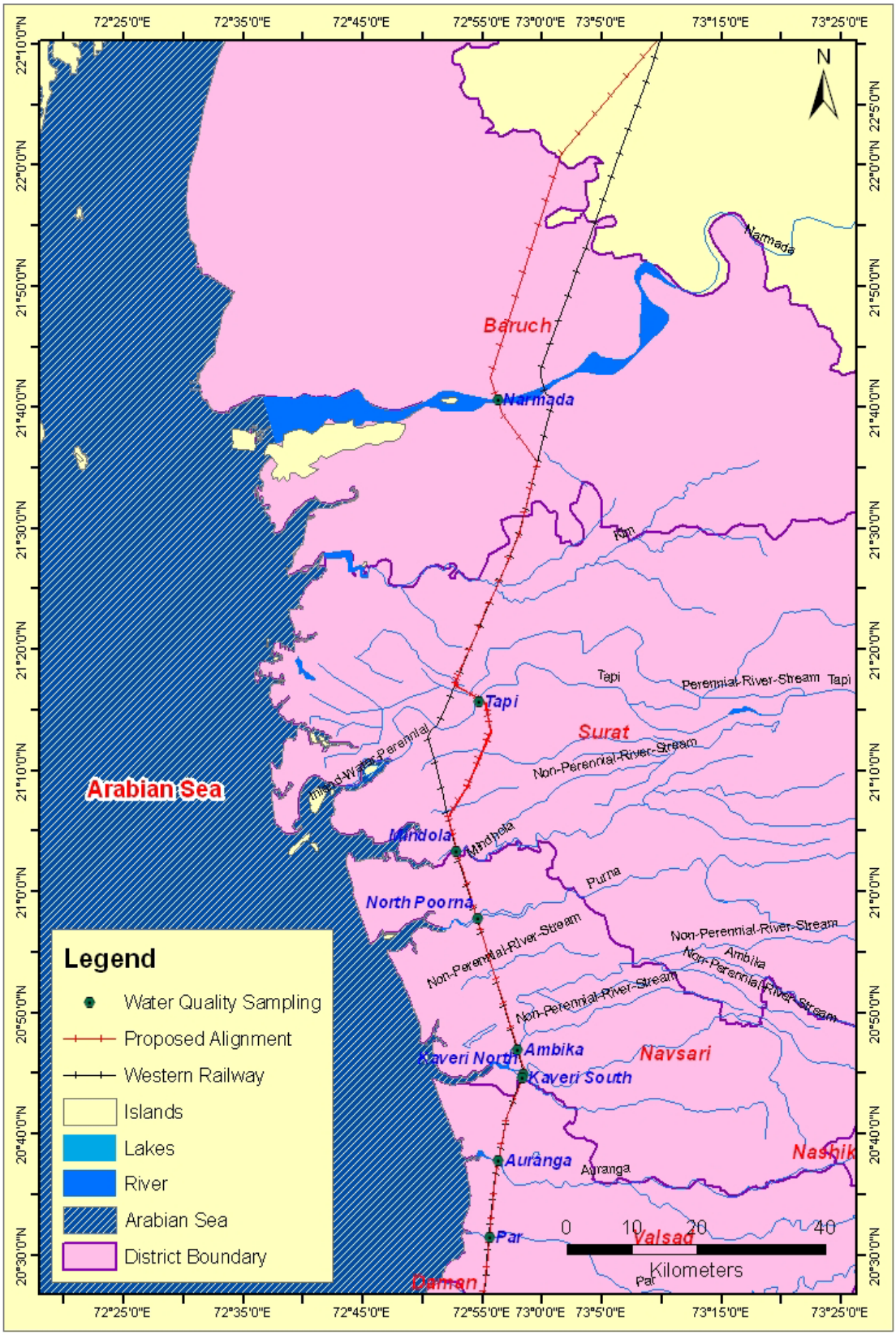
Source: JICA survey team

Figure 6.3.2 Location Map for Water Quality Monitoring for Yamuna and Hindon Rivers



Source: JICA survey team

Figure 6.3.3(1) Location Map of Sampling Sites for West flowing Rivers (South Section)



Source: JICA survey team

Figure 6.3.3(2) Location Map of Sampling Sites for West flowing Rivers (North Section)

1) JNPT-Vadodara Section

River Narmada is the largest west-flowing rivers which outfall into the Gulf of Khambhat. The water quality is monitored regularly at 21 locations along the entire stretch of the river by the State Pollution Control Board (SPCB). The long-term water quality results for pH, conductivity, DO, BOD, COD, total coliform and faecal coliform show that the river is moderately polluted. The bacterial loads are relatively low compared to the other major rivers. The secondary water quality results indicate that all the parameters more or less meet the water quality criteria at most of the locations.

River Tapi covers large areas in the States of Madhya Pradesh and some part of Maharashtra and Gujarat. The tail reaches of the river is urbanized. The secondary annual average results indicate the bacterial load can be observed in the tail reaches of the river. The pH ranges from 6.6 through 8.9 and the conductivity varies from 137 through 26,000 µmhos/cm. The dissolved oxygen ranges from 2.1 through 8.8 mg/l. Total Coliform in the river ranges from 7 through 46,000 MPN/100ml and the faecal coliform count varies from 0 to 24,000 MPN/100ml.

Secondary annual average results (Figure 6.3.4) for two successive years indicate that DO in River Damanganga varies from 3.1 mg/l to 7.2 mg/l and BOD ranges between 0.3 mg/l to 16 mg/l. The level of BOD observed in River Poorna (max. 3.9 mg/l), River Kaveri (max. 3.6 mg/l), River Mindhola (max. 5.3 mg/l) and River Ambika (max. 4.7 mg/l) does not meet the water quality criteria.

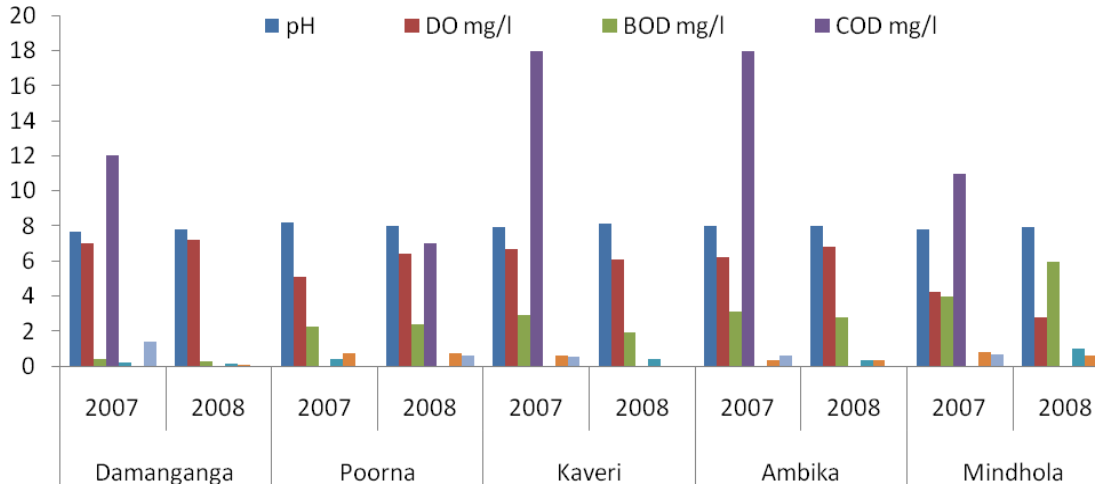
The faecal coliform is found very high in River Mindhola at State Highway Bridge, River Poorna on bridge at Surat-Navsari Highway (24,000 MPN/100ml), River Kaveri on bridge at Billimora in Valsad Road (15,000 MPN/100ml) and River Ambika at Billimora (15,000 MPN/100ml) as per the results from 2002 to 2008 by the Central Pollution Control Board.

The River Ulhas is regularly monitored by the Maharashtra SPCB. The river water meets the desired water quality criteria for bathing standards.

2) Rewari-Dadri Section

After reviewing the secondary data for a period of ten years together with the primary survey results, it is observed that the Yamuna River water quality is highly degraded and is well below a desired level for "Designated Best Use". In the dry season, distinct gradients of pollution load can be identified in the river stretch between Wazirabad and Etawah which includes the stretch in the proposed bridge location too. Okhla in New Delhi is the highly polluted area carrying the massive input of wastewater from the urban dwellers of various parts of Delhi and many waste water carrying channels are joining the river at various points into this stretch. This stretch is characterised by high bacterial count, high BOD and strong disagreeable odour. All of these indicate general depletion of oxygen level in this particular stretch of Yamuna River.

In the Hindon River also, pH, conductivity is observed higher than the desired levels. DO is mostly found near zero at various locations. Higher BOD is generally observed near the stretch at Ghaziabad and the average values are as high as 36 mg/l. The total coliform and faecal coliform do not confirmd to the water quality criteria. Table 6.3.7 gives annual average results for these rivers for Year 2006 and 2009.



Source: Central Pollution Control Board (CPCB)

Figure 6.3.4 Secondary Water Quality Results for West Flowing Rivers (2007, 2008)

Table 6.3.8 Secondary Water Quality Results for Yamuna and Hindon Rivers

Name of River	Annual Average					
	pH	DO mg/l	BOD mg/l	COD mg/l	F.Coli MPN/100ml	T.Coli MPN/100ml
Yamuna (2006)	7.3	n.a.	94.8	188	$4.1x10^6$	$8.3x10^7$
Hindon (2006)	7.2	2.2	41.9	179.4	$1.3x10^5$	$2.4x10^5$
Yamuna (2009)	7.6	n.a.	51.3	157	$2.2x10^8$	$2.5x10^9$
Hindon (2009)	7.1	1.6	29.3	79.4	$1.2x10^5$	$2.1x10^5$

Source: Central Pollution Control Board (CPCB)


Ulhas River


North Vaitarna River


South Vaitarna River


Narmada River


Par River


Auranga River


North Kaveri River


Damanganga River


Tapi River


Ambika River


Poorna River


Mindhola River


Yamuna River

Source: JICA survey team

Photo.6.3.1 Selected Photos of First Survey


Yamuna River


Hindon River


Narmada River


Ambika River


Mindhola River

Par River


Auranga River


Auranga River


South Kaveri River


Damanganga River


Tapi River


North Kaveri River

North Vaitarana River

South Vaitarana River


North Vaitarna River

Source: JICA survey team

Photo.6.3.2 Selected Photos of Second Survey

6.3.5 Potential Impacts Assessment

Analysis of water quality results of the first season or wet season, the second season ordry season together with the available secondary data for all important rivers indicate a high fluctuation in test values for important parameters in different seasons in a year. This may be attributable to changes in temperature and flow conditions, variation in activities in catchment area, and low dilution of receiving water body, especially in dry season.

The most significant impact anticipated from bridge construction activities would be increased turbidity due to earth works in and around rivers. Turbidity has remarkable impact on light penetration in the river water which causes decrease of photosynthesis and primary productivity process. Silt in the river water during construction phase needs to be minimized. The organic and bacterial loads are continued to be critical in all the important rivers. Site drainage and wastewater from toilets and washrooms would pollute surface water if discharges without adequate treatment. Therefore, during construction, a special care should be also taken so that wastewater discharge from the labour camps and construction site do not discharge directly into the river. The impacts on river water quality during different phases of the project are assessed as follows:

(1) Potential Negative Impacts

1) Preconstruction Phase

During preconstruction phase, no negative impact is envisaged on river water quality.

2) Construction Phase

A number of land based activities are associated with the construction of bridges over the rivers which could have potential negative impacts on surface water quality. The activities include:

- Site clearance
- Earthwork including construction of embankment and cutting
- Demolition activities
- Construction of approach road, footpath, associated facilities, and services
- Construction materials handling; storage,use of fuels,oils, and other potentially polluting construction materials
- Spillage anduncontrolled release of construction materials such as cement, concrete, diesel, hydraulic fluid, paint etc.

Run-off of silt and spilled materials into the river water may arise from earthworks, exposed ground, water collecting in excavations, stockpiled materials and site roads etc. Soil compaction may also occur as a result of construction bound vehicles and heavy machinery passing over previously undeveloped land. Soil compaction causes a reduction in the volume of water penetrating into the ground and increases surface run-off. The run-off would normally contain suspended silt as the compacted ground would be susceptible to erosion in the absence of vegetation cover. The areas at particular risk from compaction would include those identified as construction compounds for plant and materials, temporary access routes for construction traffic and related activities.

The deterioration of water quality during construction phase is also expected due to wastewater disposal from the workers camp and sullage generated from construction sites. If adequate arrangements are not made to ensure proper drainage of wastewater from the construction sites, such waters may form stagnant pools and aggravate soil erosion.

Stagnant pools of water promote breeding of mosquitoes and create generally unsanitary conditions. . Other impacts associated with bridge construction activities are:

- Increase of sediment load in the run off from construction sites and increase in turbidity in receiving streams/water bodies
- Shallowing of river due to silting, which may cause flood during monsoon
- Change in water quality due to accidental spillage and uncontrolled release of construction materials such as cement, concrete, diesel, hydraulic fluid, paint etc.
- Slight change in hydrology and geomorphology of the stretch of water course directly affected by the temporary blockage works at the site of new crossing

3) Operation Phase

During operation phase, maintenance gangs from sub-depots at intervals along the line will maintain and repair track, catenary and other elements. This work could pollute river water with residual oil, grease, iron fillings etc. Besides this, some other impacts on the surface water environment would occur as a result of the following:

- Increase in the volume of surface water run-off caused by an increase in impermeable surface associated with the new bridge/crossing.
- Impacts associated with maintenance and repair of bridge which may include sediment aggravation and works on the watercourse banks
- Increase in the possibility of flood risk

(2) Mitigation Measures

At the time of design, civil works required during construction phase would be designed to minimize disruption of flows and disturbance to the bed, channels and banks of the rivers. In addition, a flood risk assessment would be undertaken. The risk assessment would establish the required mitigation in detail. A flood risk assessment would enable more accurate predictions of the likelihood of inundation near the bridge locations.

All untreated contaminated drainage from construction sites and camps would be prevented from directly entering into the rivers and other waterbodies located nearby. Provision would be made to collect the drainage from all construction sites and camps in lagoons for enough time to allow most sediment to settle out before discharge to surface water. A floating oil boom would be placed on the surface water near the construction sites to prevent discharge of any trace of oil and fuel that may have entered into the drainage system. Greening of the excavated area to prevent erosion of soil is one of the mitigation measures on the content.

In order to prevent any toxic material leaking from static plant, such as pumps and generators, contaminating the ground and being washed into the drainage system; static plant would be placed on drip trays. Construction site run-off from plant and machinery may cause serious pollution if appropriate management systems from controlling discharges are not adequately followed. Facilities of washing plant and equipment contaminated with concrete and other chemicals would be provided.

All hazardous chemicals would be stored in areas with concrete floors enclosed by concrete bunds. Stockpile of dry materials would be stored at least 100 m away from the banks of the rivers, especially during the monsoon season.

Silt fencing may be provided near water bodies. Proper sanitation facilities will be provided at the construction site to prevent health related problems due to water contamination. All the construction and preparatory activities including construction of culverts and bridges would be carried out during dry seasons only. Effective storm water drainage system would be provided in every bridge to eliminate / reduce the chance of discharge of untreated storm water directly into the river.

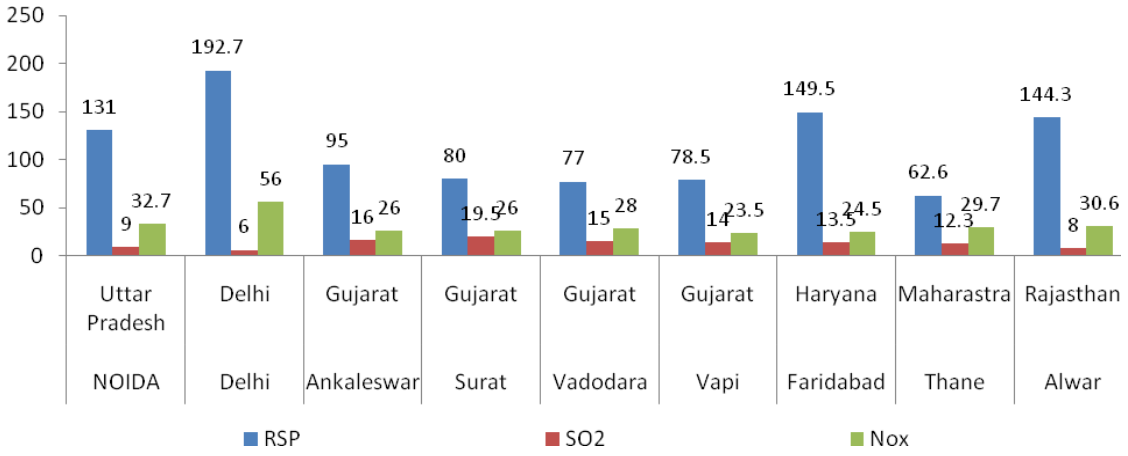
6.4 IMPACT ASSESSMENT ON OTHER ASPECTS

6.4.1 Air Pollution

(1) Present Conditions

The fright corridor would improve the air quality along the proposed areas by reducing the emissions from the vehicular traffic and the traffic congestions. The only time when the air pollutants are emitted is during the construction of the fright corridor. The pollution caused during the construction activities could be for a temporary period. CPCB and state pollution control board conduct regular air quality monitoring.

The major pollutants monitored are Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur dioxide (SO_2), Nitrogen Oxides (NOx), and Carbon Monoxide (CO) etc. The secondary data obtained from CPCB are shown in Figure 6.4.1 along the cities of proposed alignment.



Source: CPCB, 2008

Figure 6.4.1 Ambient Air Quality in Certain Districts (micrograms per cubic meter) along the Proposed Corridor

(2) Impact Assessment

1) Impact

Preconstruction Phase: During preconstruction phase, no impact is envisaged on air quality.

Construction Phase: Particulate matters would be the predominant pollutant affecting the air quality during the construction phase as it is likely to generate considerable quantities of dust, especially during dry condition by excavation, backfilling, concreting, hauling, dumping of earth materials, construction spoils, and vehicular movement along unpaved roads. Deterioration of air quality due to gaseous emissions from construction equipment and vehicular traffic could be occurred. As for ROB construction areas, increase of vibration pollution is envisaged by a traffic jam due to construction work on the exsting road. Table 6.1.10 shows the number of all the ROBs in each section. However, the impact on air quality will be localized, short term and reversible.

Operation Phase: Rail is the environment friendly mode of transport. During operation phase, the impact on air quality will be positive. At present, a major portion of the freight is transported by road but after DFC, it will reduce to a great extent. As the road traffic will decrease significantly, the vehicular pollution will be reduced and the air quality of the area will improve. Plantation along the DFC will also act as a sink of air pollutants.

2) Mitigation Meaures

The following mitigation measures are proposed especially for the construction phase:

- Proper and prior planning and appropriate sequencing and scheduling of all major construction activities shall be done, and timely availability of infrastructural supports needed for construction will be ensured to shorten the construction period vis a vis reduce pollution.
- Construction materials will be stored in covered go downs or enclosed spaces to prevent the wind blown fugitive emissions.
- If the construction site adjoins a road, service lane, settlement etc., dust barricades of appropriate height and length will be provided along the boundary of the construction area
- At the ROB construction site, adequate measures will be planned, such as temporary diversion road to reduce traffic jam, periodically/timely announce the progress of work to the public, etc. In addition, DFCCIL will coordinate with relevant authorities to reduce the negative impact on the traffic flow whenever necessary.
- Truck carrying soil, sand and stone will be duly covered to avoid spilling
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads and vulnerable areas of the construction sites from trucks or other suitable means will be undertaken to control fugitive dust during material handling and hauling activities particularly near habitation especially in the dry seasons
- Stringent construction material handling/overhauling procedures will be followed
- Low emission construction equipment, vehicles and generator sets will be used
- It will be ensured that all the construction equipment and vehicles are in good working condition, properly tuned and maintained to keep emissions within the permissible limits and engines turned off when not in use to reduce pollution.
- Air quality monitoring will be conducted once in every season, except monsoon at selected locations

6.4.2 Soil Contamination

The soil quality is likely to be affected due to the construction activities. Leakage of oil and grease can be expected from the construction equipments. The contamination can be curtailed while executing the project by implementing the environmental management plan. The impacts on soil were assessed as follows:

Preconstruction Phase: During preconstruction phase no impact is envisaged on soil quality.

Construction Phase: During construction phase, soil contamination is likely to take place due to leakage of asphalt emulsifier at pavement of road. Soil contamination may also take place during filling of oil in vehicles or leakage from vehicles. For this, asphalt emulsifier will be handled with caution and any leakage detected should be immediately rectified.

Operation Phase: During operation phase no impact is envisaged on soil quality.

6.4.3 Waste

Under the existing planning phase, type of construction waste which is expected to occur are asphalt chunks, chunks of concrete, surplus soil, construction scrap materials and others. The amount and percent composition of construction waste is not clear in this phase. However, surplus soil is planned to be reused as much as possible in construction of the DFC embankment. In addition, all other construction waste is also planned to comply with relevant Center or State laws pertaining to the waste management. Also, according to DFCCIL's Corporate Environment Policy, concept of waste utilization has to be promoted by encouraging recycling and reuse. The project will inbuilt such measures to reduce overall volume of waste generated from different construction sites linearly along the alignment.

In general, most of metal scrap and other saleable waste are disposed to authorized dealers. But concrete and masonry waste which constitute a major part of construction waste is currently not recycled. At present, private contractors remove this waste to privately owned low-lying land for a price or more commonly, dump it in an unauthorized manner along roads or other public land. Small quantities of construction waste usually get mixed with domestic waste due to lack of segregated storage and collection facilities. This improper practice will be improved in DFC Project by promoting separate collection, site storage and disposal of debris and bulk waste. Some part of this waste can be used in embankment and in road making along the embankment. Other non-usable part of such concrete and masonry waste shall be disposed in only designated low-lying sites which have been already identified by the local municipal council or committee of different cities in each State falling along the alignment.

Burning of debris, vegetation, rubber or any other form of construction waste is prohibited as per the existing legislation and no such practice shall be allowed in the project.

Other form of waste such as non-recyclable waste, packaging waste, e-waste (used catridges, toners, wires, computers, printers etc.) generated from the site offices and labour camps shall be disposed as per the existing laws.

6.4.4 Offensive odour

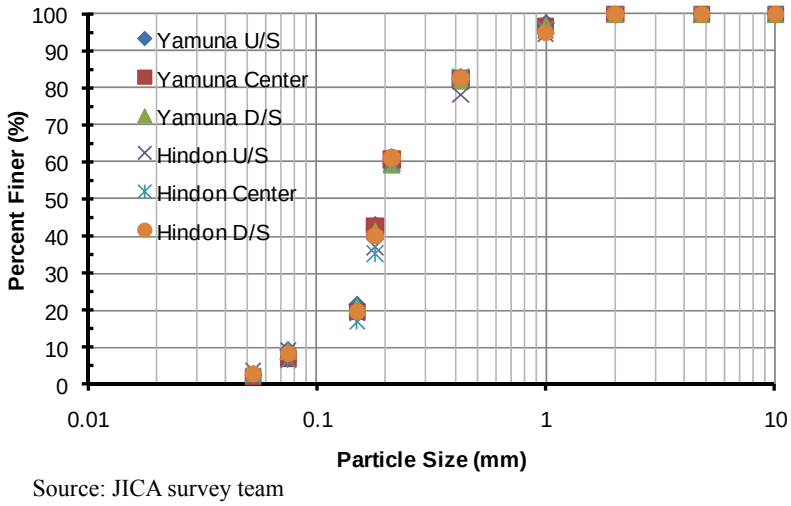
During survey for environmental and land use characteristics offensive odour problem was not encountered at any of the location of the proposed corridor. During construction phase due near drains and rivulet it may be encountered. Cleanliness must be maintained at construction site during construction and at stations during operation phase to avoid any foul odor.

6.4.5 Bottom Sediment

(1) Present Conditions

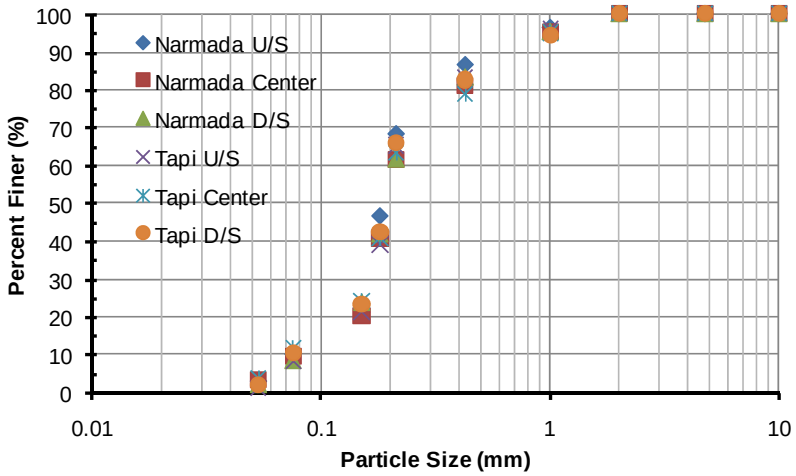
Bottom sediments comprise of particles that have been transported by water and air and deposited on a floor of river in addition the deposited particles some more particulate matter is added up by the chemical and biological processes. Bottom sediment samples were also collected from all the major rivers at the upstream, centre and the downstream while water quality sampling of the rivers. Bottom sediment samples were analyzed for river bed characteristics.

The important component of the river bed characteristics is determined in the form of Particle Size Distribution using the mechanical analysis. The particle size distribution curves (PSDC) at sampling sites are shown in Figures 6.4.2 through 6.4.6. Using the PSDC, the d_{10}, d_{50} and d_{75} values were determined and given in Table 6.4.1 and shown in Figure 6.4.7. Value of d_{10} refers to grain diameter at 10 cumulative percent by weight. Based on the analysis of the river bed samples, soil of all the river bed can be categorized as sandy. However, the rivers of Damanganga and Vaitarna have coarse sand to gravely bed.



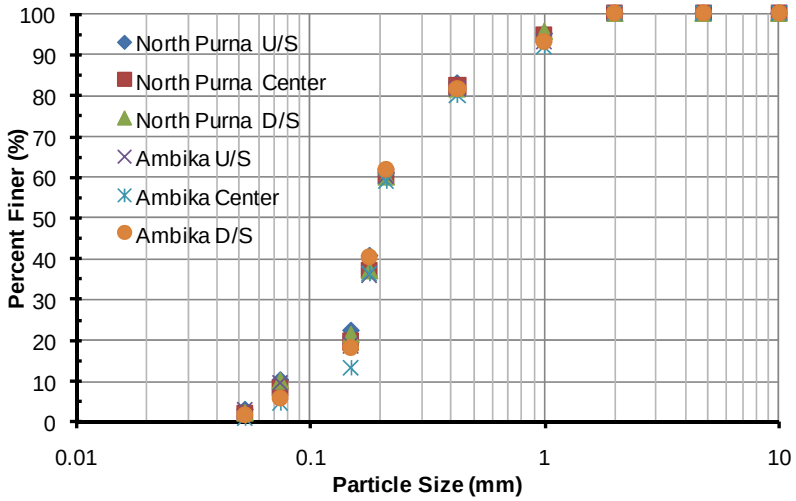
Source: JICA survey team

Figure 6.4.2 Particle Size Distribution Curves for Yamuna and Hindon Rivers



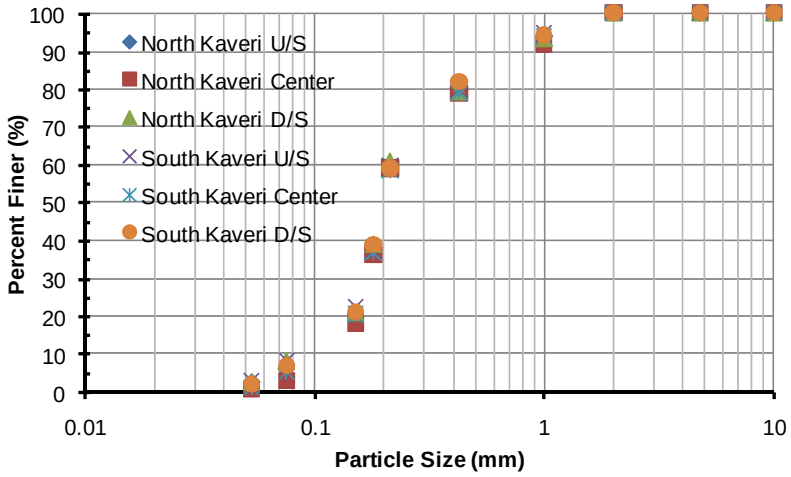
Source: JICA survey team

Figure 6.4.3 Particle Size Distribution Curves for Narmada and Tapi Rivers



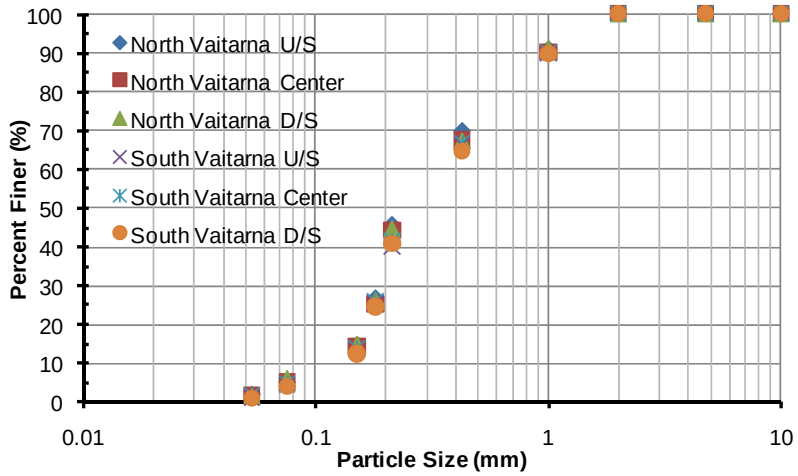
Source: JICA survey team

Figure 6.4.4 Particle Size Distribution Curves for N. Purna and Ambika Rivers



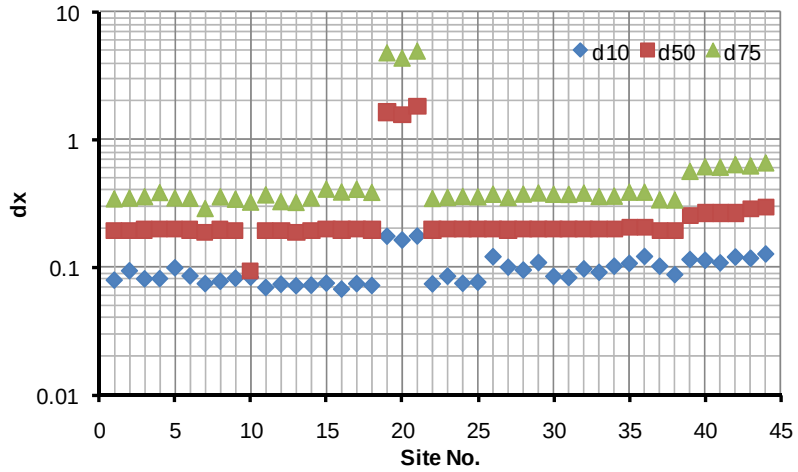
Source: JICA survey team

Figure 6.4.5 Particle Size Distribution Curves for North and S. Kaveri Rivers



Source: JICA survey team

Figure 6.4.6 Particle Size Distribution Curves for North and S. Vaitarna Rivers



Source: JICA survey team

Figure 6.4.7 Values of d_{10}, d_{50} and d_{75} at the Sampling Sites

Table 6.4.1 River Bed Sampling Sites and Values

S. No.	Site	d_{10}	d_{50}	d_{75}	S. No.	Site	d_{10}	d_{50}	d_{75}
1	Yamuna U/S	0.0793	0.1921	0.3455	23	North Purna Center	0.0850	0.1977	0.3546
2	Yamuna Center	0.0937	0.1928	0.3508	24	North Purna D/S	0.0749	0.1981	0.3609
3	Yamuna D/S	0.0812	0.1953	0.3595	25	Ambika U/S	0.0766	0.1983	0.3584
4	Hindon U/S	0.0816	0.1980	0.3872	26	Ambika Center	0.1205	0.1994	0.3760
5	Hindon Center	0.0988	0.1993	0.3509	27	Ambika D/S	0.1000	0.1945	0.3541
6	Hindon D/S	0.0855	0.1950	0.3490	28	North Kaveri U/S	0.0950	0.1990	0.3765
7	Narmada U/S	0.0745	0.1850	0.2905	29	North Kaveri Center	0.1086	0.1991	0.3843
8	Narmada Center	0.0777	0.1945	0.3590	30	North Kaveri D/S	0.0848	0.1960	0.3760
9	Narmada D/S	0.0821	0.1931	0.3435	31	South Kaveri U/S	0.0830	0.1982	0.3746
10	Tapi U/S	0.0836	0.0931	0.3259	32	South Kaveri Center	0.0970	0.1994	0.3837
11	Tapi Center	0.0695	0.1929	0.3714	33	South Kaveri D/S	0.0913	0.1976	0.3602
12	Tapi D/S	0.0738	0.1904	0.3288	34	Mindola U/S	0.1017	0.1990	0.3632

S. No.	Site	d_{10}	d_{50}	d_{75}	S. No.	Site	d_{10}	d_{50}	d_{75}
13	Auranga U/S	0.0718	0.1855	0.3245	35	Mindola C	0.1070	0.2020	0.3902
14	Auranga Center	0.0725	0.1930	0.3518	36	Mindola D/S	0.1211	0.2018	0.3900
15	Auranga D/S	0.0752	0.1993	0.4124	37	Ulwas U/S	0.1017	0.1916	0.3389
16	Par U/S	0.0676	0.1951	0.3915	38	Ulwas C	0.0875	0.1908	0.3384
17	Par Center	0.0745	0.1973	0.4109	39	North Vaitarna U/S	0.1146	0.2511	0.5674
18	Par D/S	0.0721	0.1956	0.3885	40	North Vaitarna Center	0.1130	0.2644	0.6165
19	Daman Ganga U/S	0.1737	1.6312	4.8164	41	North Vaitarna D/S	0.1081	0.2624	0.6123
20	Daman Ganga Center	0.1622	1.5525	4.3784	42	South Vaitarna U/S	0.1198	0.2647	0.6410
21	Daman Ganga D/S	0.1741	1.7984	4.9732	43	South Vaitarna Center	0.1172	0.2825	0.6267
22	North Purna U/S	0.0741	0.1947	0.3482	44	South Vaitarna D/S	0.1265	0.2932	0.6613

Source: JICA survey team

The median particle diameter is chosen for texture size selection because it is used in empirical relations to predict other soil properties, and as such is a useful parameter to know. Particles are grouped according to their size into what are called soil separates. The smallest particles are *clay* particles and are classified by the United States Department of Agriculture (USDA) as having diameters of less than 0.002 mm. Texture is combination of the most abundant particle sizes.

Soil	Diameter mm
Clay	less than 0.002
Silt	0.002–0.05
Very fine sand	0.05–0.10
Fine sand	0.10–0.25
Medium sand	0.25–0.50
Coarse sand	0.50–1.00
Very coarse sand	1.00–2.00

On the basis of the soil texture classification of USDA, most of the soil at the bridge construction sites falls under the category of fine sand. Few sites come under category of very coarse sand (R. Damanganga).

(2) Impact Assessment

1) Impact

Preconstruction Phase: During operation phase, no impact is envisaged on bottom sediment.

Construction Phase: The DFC alignment crosses the rivers, during construction of bridge over the river, sediment pollution may occur.

Operation phase, no significant impact is envisaged except accidental spillage.

2) Mitigation Measures

As one of mitigation measures, silt fencing will be provided to restrict runoff into the water for during construction phase.

6.4.6 Electromagnetic Radio Wave Interference

In case of parallel section, vertical alignment of DFC will be designed in the same level almost as the existing railway/ground level to reduce the modification as well as considering the technical and operational limitation basically. Therefore it's predicted that received of electromagnetic radio wave is no big changes from the current situation.

In case of detour section, the proposed alignment will designed to avoid from the residential areas. Most of the filling bank may be designed such that the height is less than 6 m, and this is suitable for a house of the ground 2 building. Therefore it's predicted that there are no negative impact to the residential area along the proposed line.

6.4.7 Obstruction of Sunshine

In case of parallel section, vertical alignment of DFC may be designed in the same level almost as the existing railway/ground level to reduce the modification as well as considering the technical and operational limitation basically. Therefore it's predicted that sunshine is no big changes from the current situation.

In case of detour section, the proposed alignment was designed to avoid from residential area. The filling bank may be designed such that the slope dose not exceeds 1:2 (vertical to horizontal). The shade of DFC structure might be predicted in the ROW, when Indian sun altitude is considered. Therefore it's predicted that there are no negative impact to the residential area along the proposed line.

6.4.8 Disaster

1) Impact

- The Rewari-Dadri section of DFC Phase 2 falls in the seismic zone IV as per seismic zoning map of India which makes the area susceptible to moderate to high intensity of earthquakes and is considered as High Risk Zone. This has the potential to impact civil structures during seismic disaster.

- The Aravalli rocky hill ridge between Dhulawat and Rojka Villages in Mewat District is made up of quartzite which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure map showing major as well as minor faults passing through the area. Since the area falls in seismic zone IV, the deep rock cutting up to the depth of 28 m and removal of thick overburden could result in unstable conditions such as slippage of rock blocks, exposing weak joints with increased possibility of collapse of slopes during seismic disaster.

- Embankment structure along the major part of the DFC corridor could trap rain water and cause flood around the project area.

- In Vasai detour, though no major faults or shear zones are reported in the area (seismic zone III), the seismic activities at moderate level could enhance the rock-joint rupture hazard during rock cutting and excavation during construction of tunnel work.

2) Mitigation Measures

- The seismic factors should be appropriately incorporated in the civil and structural designs of major structures in DFC project.

- An engineering geologist should identify any slope instability potential among the uniform rock structure along the Aravalli ridge where deep rock cutting will be done. DFCCIL should take up such study through suitable experts/institutes during detailed engineering stage.

- Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.

- Although the geological succession of the Vasai detour area along with the topography indicates that the hill block is fit for underground tunnel as the minimum 25 m overburden height is available for closed loop to provide arch section of the tunnel, any unstable or rock-joint rupture hazard should be identified by an engineering geologist.

CHAPTER 7
NATURAL ENVIRONMENT

CHAPTER 7 NATURAL ENVIRONMENT

7.1 General Introduction

The natural environment conditions along the DFC alignment route are not homogenous but vary as the track passes through different ecological and agro-climatic zones. In the DFC Phase 2 section nearly 45% of the alignment route passes through cultivated agricultural area, barren land and wasteland. Besides this, the alignment crosses a number of important, major, and minor rivers and streams and also traverses through many recorded forest areas. The alignment passes through 1.6 km of forested areas in Gulistanpur Reserved Forest in Gauttam Buddha Nagar District of Uttar Pradesh and 9.2 km of forested areas in Thane District of Maharashtra. Most of these forest areas have been degraded due to encroachment and increased human activities.

In the Rewari-Dadri section, the forests in Haryana State are classified under reserved forests, protected forests, unclassed forests, closed u/s 38 of Indian Forest Act and areas closed u/s 4 and 5 of Land Preservation Act. Alwar includes a rich forest area. There are a total of 214.89 ha of Reserved forests in Gurgaon District, 16.19 ha in Mewat District, 314.24 ha in Faridabad District and 514.04 ha in Rewari District. However, the proposed DFC alignment route does not affect any forest areas in these districts.

The Phase 2 section also passes through the state of Gujarat which boasts a rich diversity of fauna and flora. Gujarat is comprised of a wide variety of ecosystems and landscapes, ranging from dry deciduous forests to majestic grasslands, wetlands, coastal habitats and rich moist deciduous forests. The state is home to a number of rare and endangered species including the Asiatic lion which is found only in the Gir forest, while the wild ass is found in the Rann of Kutcch. In addition, the great Indian bustard, the world's only four-horned antelope, the black buck, the dugong and the boralia are all found in different habitats across the state. Valsad District falls under the Sahyadri region. This is the northern part of the Western Ghats, which is recognised as a global biodiversity hotspot. But again, none of such forest areas are affected by the proposed DFC alignment route.

In the Maharashtra section, Thane and Raigad Districts fall within the Western Ghats mountain complex. The area is home to a splendid diversity of plant and animal life. The area is rich in fauna since there are a variety of forest types. The wildlife found here includes leopards, barking deer, sambar, wild boar, langur, and hyena. Among the birds, Malabar grey hornbill, Quaker babbler, Malabar whistling thrush, green pigeon, black eagle, and grey jungle fowl are common. The endemic Indian giant squirrel (the world's largest tree squirrel) is also found here.

Detailed biodiversity surveys were conducted in the Phase 2 section in addition to the collection of secondary data and interviews with relevant authorities. Field surveys for fauna and flora mainly focussed on the affected Recorded Forest Areas including both reserved and private forest located along the DFC alignment as well as wildlife sanctuaries. The alignment passes by near to the boundary of the Sanjay Gandhi National Park (SGNP) in Thane district. The alignment also passes through the buffer zone but some distance from the actual boundary of the Tungareshwar Wildlife Sanctuary, where the first field survey was implemented. The DFC alignment route does not directly affect the flora of the Tungareshwar Wildlife Sanctuary and for this study forest surveys inside the sanctuary were not required for impact analysis. The field survey areas were identified on the basis of interviews with the State forest authorities and are shown on the Final Location Survey Map and Land Plan for the DFC. In this field survey, non-forest areas such as village areas,

fields and/or other places were not surveyed because biodiversity in the forest areas are likely to be more susceptible to project impacts than non-forest areas.

A tree-census survey was also carried out for the entire alignment including forest areas and non-forest areas. The number of trees which will be removed for the railway construction in selected recorded forest was estimated. The survey data is useful for assessing biodiversity values of non-forest areas.

In addition, specialized surveys for two Eco-Sensitive Areas were implemented. The DFC alignment will include a detour route (called the "Vasai detour") of total length 21.1 km between Juchandra and Vaitarana Stations to overcome a wide array of problems including social and environmental issues. The Dahanu Taluka Eco-sensitive area is included in this detour. The detour route which is proposed in the project will involve construction of one closed tunnel between DFC Ch94.4 km and Ch95.4 km having a length of 540 m on a straight alignment and falling in the forest villages of Bhatpadi and Shirgaon in Vasai Taluka, Thane District. Initially, it was planned to build another closed tunnel of length 240 m at a distance of 1 km from the first tunnel (towards Juchandra Station) between DFC Ch91.9 km and Ch93.4 km but stone cutting activities over the last year have totally opened up this particular hill.

A preliminary hydrogeological study was also carried out for the Aravalli Geo-sensitive rocky hill ridges b/w DFC Ch 44+870 to Ch 49+200 from Banban Village to Keherani Village in Tijara Block, Alwar District and Ch 61+780 to Ch 69+760 from Dhulawat Village to Rojka Village in Mewat District to identify the potential issues and assess the possible impacts of the various activities and constructions in the proposed DFC project on the geology and ground water aspects in the alignment route between Rewari and Dadri.

An outline of the fieldwork conducted for assessing project impacts on the natural environment is shown below.

Table 7.1.1 Outline of Main Contents of Natural Environment Assessments

Contents	Survey methods	Field survey Area	Number of site	Survey Period
Flora	Field survey, Analysis of secondary data, Interview of experts	Recorded Forest area (Reserved Forests and Protected areas (Sanjay Gandhi National Park) on the DFC alignment line	20 forests	Summer, Winter
Fauna	-ditto	-ditto	-ditto	-ditto
Biodiversity	-ditto	-ditto	-ditto	-ditto
Tree-census survey	Field survey	Forest and Non-forest area on all RoW area	All RoW area	-
Eco-sensitive area	Field survey, Analysis of secondary data,	Dahanu Taluka, Aravalli	2	-

Source: JICA survey team

Other aspects relevant to the natural environment including, topography and geographical features, soil erosion, groundwater, hydrology situation, coastal zones and climate change is implemented through supplemental studies of secondary data and interview surveys.

Considering the importance of monsoon season in biodiversity study in recorded forests areas, supplemental survey was conducted in the monsoon season from August to September 2011 in all 20 forest patches (including mangrove) comprising 11 sites of Section 1 (JNPT to Vaitarna), 8 sites of Section 2 (Vaitarna to Bhilad) and 1 site of Section 16 (Rewari to Dadri). The study aimed to confirm if presence of any critical (rare/endangered/endemic) species exist or not in the survey area based on the results of the previous surveys which were conducted in January (winter) and April (summer) 2011 and recheck the status with IUCN, RET[1] species and WPA India .

7.2 Biodiversity

7.2.1 Flora

(1) Study Methodology

1) Survey Areas

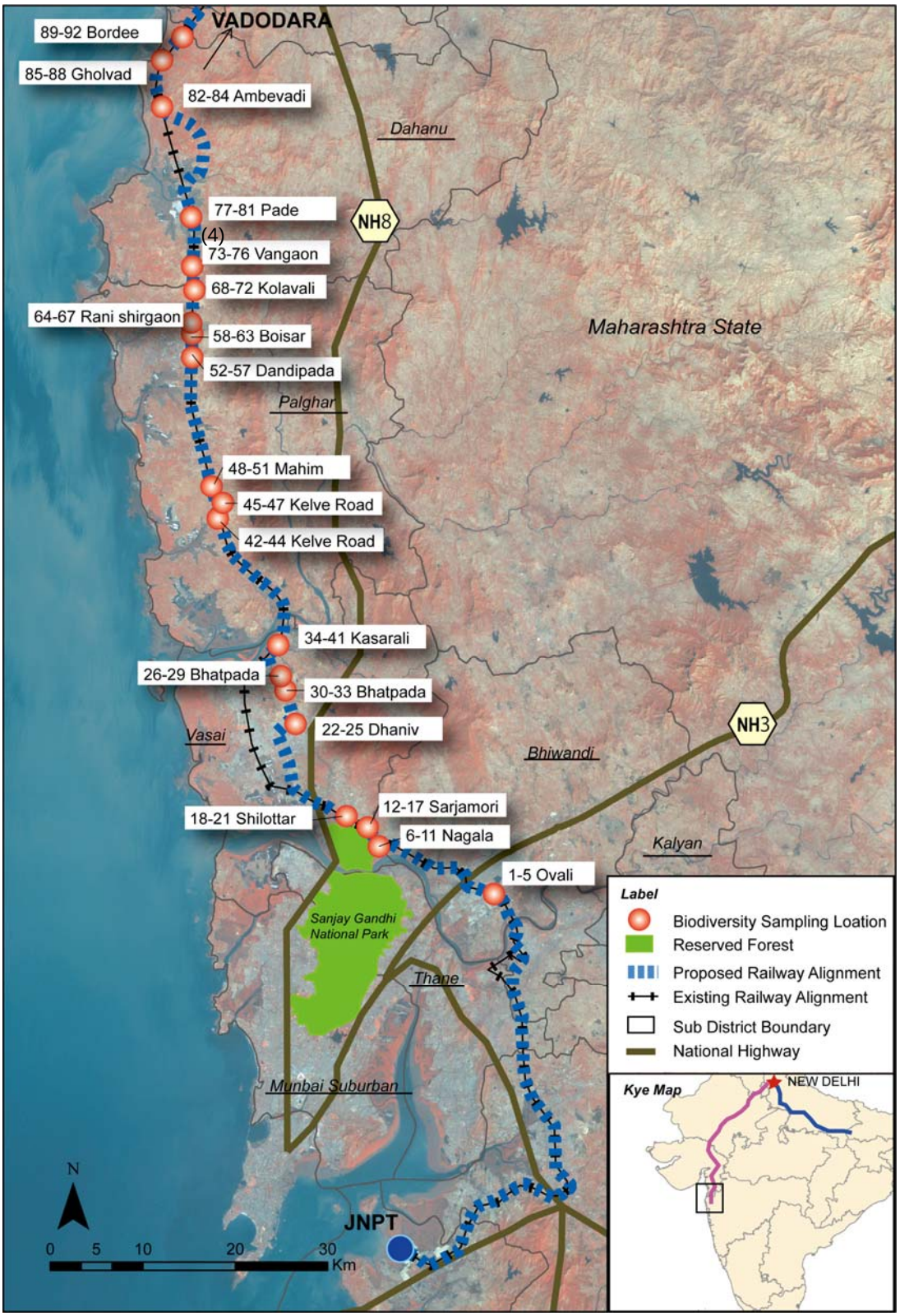
The field survey was conducted in the potentially affected 'natural' areas of the DFC alignment. The survey areas were identified on the basis of interviews with the State forest authorities and are shown on the Final Location Survey Map and Land Plan of the DFC. Forest and protected areas directly affected by the proposed DFC alignment were identified in the Vadodara-JNPT and Rewari-Dadri sections of Phase 2. Sites were selected near the proposed alignment area so that an accurate assessment of the status and likely potential impacts on fauna and flora could be made. Point locations of the sampling sites are provided in Table 7.2.1 for all the forest areas surveyed. Figures 7.2.1 and 7.2 2 show the location of sampling points in non-forest areas.

Tree enumeration was conducted within the RoW (60 m) for all villages falling within the proposed corridor.

Table 7.2.1 Location of Forest and Protected Areas in Thane and Gautam Buddha Nagar

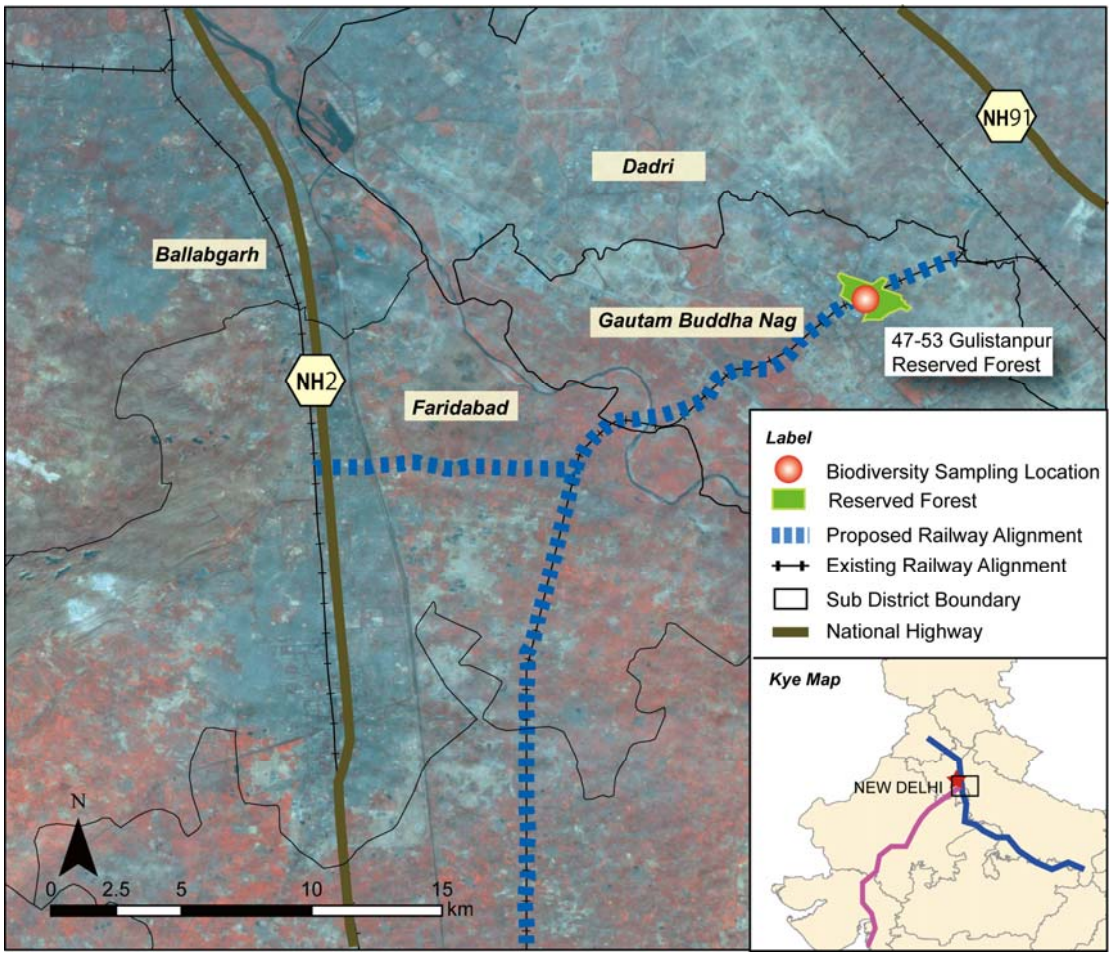
No.	Forest Village	Plot	No.	Forest village	Plot
1	Ovali (Thane Forest Division)	1,2,3,4,5	11	Dandipada (Thane Forest Division)	52,53,54,55,56,57
2	Nagala (SGNP)	6,7,8,9,10,11	12	Boisar (Dahanu Forest Division)	58,59,60,61,62,63
3	Sarjamori (SGNP)	12,13,14,15,16,17	13	Rani Shirgaon (Dahanu Forest Division)	64,65,66,67
4	Shilottar(SGNP)	18,19,20,21	14	Kolavali	68,69,70,71,72
5	Dhaniv (Thane Forest Division)	22,23,24,25	15	Vangaon (Dahanu Forest Division)	73,74,75,76
6	Bhatpada Dandipada (Thane Forest Division)	26,27,28,29	16	Pade (Dahanu Forest Division)	77,78,79,80,81
7	Bilalpada (Thane Forest Division)	30,31,32,33	17	Ambevadi (Protected Area)	82,83,84
8	Kasarali (Thane Forest Division)	34,35,36,37,38,39,40,41	18	Gholvad (Dahanu Forest Division)	85,86,87,88
9	Kelve road (Dahanu Forest Division)	42,43,44,45,46,47	19	Bordee (Dahanu Forest Division)	89,90,91,92
10	Kasbe Mahim (Dahanu Forest Division)	48,49,50,51	20	Gulistanpur Reserved Forest (Gauntam Buddha Nagar)	93,94,95,96,97,98,99

[1] RET refers to rare, endangered and threatened species



Source: JICA survey team

Figure 7.2.1 Biodiversity Sampling Location in Forest Area of the JNPT to Vadodara Section



Source: JICA survey team

Figure 7.2.2 Biodiversity Sampling Location in Forest Area of the Rewari to Dadori Section

2) Survey Periods

A biodiversity study requires seasonal inventories as certain species' occurrence in specific areas may be seasonal (notably migratory or transient avian fauna or mammals dependent on particular water sources, salt licks, etc.). The present study is based on surveys carried out in 2 seasons, winter and summer for the forest areas. However, for non-forest areas surveys were conducted in only the post monsoon period (Table 7.2.2). The study area is situated in a biogeographic zone, where substantial changes occur between seasons particularly with respect to ground flora, which differs significantly between dry season and during monsoon.

In this study, the vegetation and faunal surveys in the forests to be impacted by the project were conducted in the winter and summer seasons. The actual survey periods were determined based on the common classification of the Indian Metrological Department (IMD) i.e. January-February for winter months, March – May for pre-monsoon (Summer) months, June – September for Monsoon Season (Southwest Monsoon Season) and October – December for Post Monsoon Season in the India[2].

[2] Web-page of the Indian Metrological Department, 2011, http://www.imd.gov.in/section/nhac/dynamic/Monsoon_frame.htm

Table 7.2.2 Field Survey Schedule

Season	Period	Surveyed Forest
First season (Winter)	11-Jan-11	Ovail, Nagla(SGNP), Shilothar (SNGP), Sarjamori (SGNP), Mori (SGNP)
	12-Jan-11	Dhaniv, Bhatpada, Bilalpada, Shirgaon
	13-Jan-11	Kasarali, Rani Shirgaon
	14-Jan-11	Kelve Road, Dandipada, Boisar, Kasbe Mahim
	15-Jan-11	Bordee, Kolavadi, Pade< Vangapn-PF, Gholvad, Ambewadi
	23-Nov-10	Gulistanpur Reserved Forest
Second season (Summer)	01-Apr-11	Gulistanpur Reserved Forest(G.B.Nagar), Bordee, Kolavadi, Pade, Vangapn, Gholvad, Ambewadi
	02-Apr-11	Rani Shirgaon, Kelve Road
	03-Apr-11	Boisar, Dandipada, Kasbe Mahim
	04-Apr-11	Ovail, Nagla(SGNP),
	05-Apr-11	Shilothar (SNGP), Sarjamori (SGNP), Mori (SGNP)
	06-Apr-11	Dhaniv, Bhatpada
	07-Apr-11	Bilalpada, Shirgaon, Kasarali

Source: JICA survey team

Source: JICA survey team

Photo 7.2.1 Selected Photos of Biodiversity Sampling in Summer Season (April 2011)

Source: JICA survey team

Photo 7.2.2 Selected Photos of Biodiversity Sampling in Winter Season (January 2011)

3) Measurement and Analysis Method

Flora: For the study, the quadrat (10 m x 10 m) method was used. Square sample plots were laid for detailed analysis of the tree and shrub and 1 m x 1m quadrat plots were laid for grass species in order to determine the floral pattern along the proposed corridor. A minimum of three plots were laid per sampling site. The encountered vegetation of the study area was analyzed to calculate density, frequency & abundance (Curtis and

McIntosh, 1950). Total abundance, density and frequency with respect to individual species for a particular location were calculated in order to understand the vegetation structure and relative importance of the sampled areas. Species diversity was calculated by using a measure, which combines the two components viz. richness and abundance. The Shannon-Wiener Index and Simpson's Index were also used to compare diversity indices between different sampled locations including forest and non-forest areas.

In the first season, a total of 154 quadrats were laid along the alignment of the proposed corridor in Gujarat, Thane and Raigad for flora sampling. In Gulistanpur 12 quadrats were laid. In the summer season, 110 quadrats were laid for flora sampling.

Interview surveys for preparing checklist of flora, fauna and status of biodiversity were conducted with forest experts, academics and villagers.

The data from the vegetation sample plots was used to analyse forest composition and condition. The following indicators and terms were used for forest species data analysis:

Abundance shows the number of species present with respect to the sampled quadrat. It is a basic parameter for evaluating the species composition in a forest area.

Species richness is the number of species in the forest area. Local species richness can be influenced by ecological factors. For example, species richness is often higher in areas with higher productivity. Ecosystem effects of species richness for example, variation in primary productivity depends strongly on temperature and precipitation at the global scale and on soil resources and disturbance regime at the landscape to local scales. Factors that increase productivity, such as nutrient addition, often lead to lower species richness because more productive species out compete less productive ones.

Species diversity is an index that incorporates the number of species in an area and also their relative abundance and as such is a more comprehensive value than species richness. In forest habitats species diversity provides an indication of ecosystem health, integrity and sensitivity.

Diversity indices: To analyse the forest biodiversity and to understand the status of forest in terms of stability, diversity indices such as species dominance, species diversity, similarity index and abundance are important.

Species evenness is a measure of species diversity, which quantifies how equal the community is numerically.

Species diversity analysis also informs of the presence of rare and endangered species for which special conservation measures may be required. Higher numbers of invasive species shows impact of degradation and lack of conservation or sustainable forest management in the forest area.

Table 7.2.3 Indices for Flora Diversity Analysis

Item	Technique	Formula
Species dominance	Simpson's index	$C_d = \sum_t p_i^2$ where, p_i is the proportional abundance of i^{th} species in the community. $p_i = \frac{n_i}{N}$ where: n_i = number of individuals in ith species, N = total number of individual of all species
Species diversity	Shannon's index	$H' = \sum_t p_i \times log_2(p_i)$
Index of Similarity	Sorenson,1948	$S = \frac{2C \times 100}{A + B}$ where, A = number of species in one stand, B = number of species in another stand, and C = number of species common in both stand
Curtes & Mc Intosh, 1950		$IVI_i = Relative\ density_i + Relative\ dominance_i + Relative\ frequency_i$ **where:** $Relative\ dominance = \frac{Dominance\ of\ a\ species}{Total\ dominance\ of\ all\ species} \times 100$ $Relative\ frequency = \frac{Frequency\ of\ a\ species}{Total\ frequency\ of\ all\ species} \times 100$ $Dominance = \frac{Total\ cover\ or\ basal\ area\ of\ a\ species}{Area\ sampled}$ $Frequency = \frac{Number\ of\ stand\ in\ which\ species\ A\ occurs}{Total\ number\ of\ stand\ sampled}$ $Density = \frac{Number\ of\ individual\ species}{Area\ sampled}$
Species Richness (S)		Total number of species in the community
Species Evenness (E)		$E = H / ln(S)$
Abundance		$Abundance = \frac{1}{H/J}$ where, H = total no. of individual species in all the quadrats, J = no. of quadrats in which the species occurred.

(2) General Features of the State Area where the DFC will pass through

Forest types found in the proposed corridor area are shown in Table 7.2.4. Flora species found in (1) Vadodara-JNPT section in Gujarat and Maharashtra States (2) Rewari –Dadri section in Rajasthan, Haryana and Uttar Pradesh States, are also listed and briefly described below:

1) JNPT-Vadodara Section

Maharashtra State: In Maharashtra, the DFC begins at JNPT in Raigad District and passes through Thane District. In this state, the alignment mainly passes through the Konkan coastal plain which runs in a north-south direction and is located at the western foot of the Western Ghats with an approximate breadth of 50-80 km. The DFC proposed alignment is planned to be parallel to the existing railway. The area is comprised of flat lowland plain with swampy areas in parts along the coast and river mouth and rocky areas along the edge of the Western Ghats.

Gujarat State: In Gujarat the alignment passes through the flat coastal plain to the north of the Konkhan Region beginning at Valsad District after Thane district in Maharashtra. The alignment passes through a flat area in Valsad, Navsari, Surat, Ankaleshwar, Bharuch and it is planned to join the Phase-1 section of DFC i.e, Vadodara-Rewari section, at Vadodara District. Land use in the proposed corridor is mainly agricultural with the specific alignment avoiding densely populated cities such as Surat and Vadodara. Although it is a non forest area, some plant species were found along river banks and barren land including *Prosopis juliflora, Sesbania, Zizyphus nummularia, Dandrocalamus strictus, Abelmoschus manihot,* and *Balanites aegyptiaca* (Appendix-7a).

2) Rewari-Dadri Section

The DFC alignment in the Rewari-Dadri section passes through agricultural land on both sides of the Aravalli range, starting at Rewari in Haryana province and passing through three (3) provinces, Rajasthan and Uttar Pradesh. These areas were originally covered by Tropical Dry Deciduous Forests and the Tropical Thorn Forests (Table 7-3) found in semi-arid climatic conditions.

Haryana: Five districts of Haryana fall within the corridor for Phase 2. The Rewari district study revealed the presence of *Prosopis cineraria, Acacia nilotica, Dalbergia sissoo, Ailanthus excels, Morus alba, Zizyphus mauritiana,* and *Azadirachta indica*as as common species recorded during the survey. In Mewat district *Acacia nilotica, Dalbergia sissoo, Ailanthus excels, Morus alba, Zizyphus mauritiana, Melia aradarch, Albizzia lebbeck, Holoptelia intrgrifolia and Cassiasiamea were* the common species recorded. Palwal District survey revealed *Ficus religiosa, Eucalyptus, Azadirachta indica,* and *Morus alba* as common species occurring near the alignment.

Rajasthan: Alwar district of Rajasthan falls under the proposed corridor alignment. *Ficus religiosa, Azadirachta indica, Prosopis cineraria, Acacia nilotica, Dalbergia sissoo, Ailanthus excela, Morus alba, Zizyphus mauritiana* and *Eucalyptus* are the common species found in the alignment.

UttarPradesh: Gautam Buddha Nagar district falls in the proposed corridor. The Reserved forest area of Gautam Buddha Nagar also falls within the alignment. *Prosopis juliflora, Butea monosperma, Ficus religiosa, Eucalyptus, Mangifera indica, Psidium guajava, Dalbergia sisso, Albizzia lebbeck* are the common species.

Table 7.2.4 Original Forest Type in the Districts at Proposed Corridor Area

State	Forest type	Area
Gujarat	Tropical Moist Deciduous Forest	Surat, Valsad
	Tropical Dry Deciduous Forest	Navsari, Bharuch, Vadodara
	Littoral and Swamp Forest	Mangrove forests are found in the coastal creeks
Maharashtra	Southern Tropical Semi- Evergreen Forests	Thane, Raigad
	• Southern Tropical Moist Deciduous Forests • Moist Teak bearing Forests	Thane, Raigad
	Littoral and Swamp Forests	Thane, Raigad
Haryana	Tropical Dry Deciduous	Faridabad, Gurgaon, Palwal, Rewari, Mewat
	Tropical Thorn Forests	Rewari, Mewat
Rajasthan	Tropical Dry Deciduous Tropical Thorn Forest	Alwar
Uttar Pradesh	Tropical Dry Deciduous	Gautan Buddha Nagar

Source: JICA survey team

Table 7.2.5 Species Diversity in Gujarat Non Forest Area Falling under the Proposed Corridor

Diversity Indices	Vadodara	Bharuch	Ankleshwar	Surat	Navsari	Valsad
Shannon-Wiener Diversity Index	3.88	2.41	2.45	2.24	2.92	3.13
Species Richness	79	20	24	11	33	39
Total Species Abundance	926	98	212	36	238	234
Simpson Index	0.03	0.14	0.15	0.12	0.11	0.08
Evenness	0.89	0.81	0.77	0.94	0.84	0.85

Source: JICA survey team

3) Protected Floral Species in the Area

The following species of fauna and flora occurring within the proposed corridor area are protected by law.

Table 7.2.6 Threatened Flora and Protected Fauna in Thane, Raigad and Gautam Buddha Nagar

Thane and Raigad Districts		Gautam Buddha Nagar District	
Threatened Flora [1) 2)]	**Protected Fauna** [3)]	**Threatened Flora**	**Protected Fauna**
Endangered Flora *Corypha Species* *Cycas beddomei* *Decalepis hamiltonii* *Madhucca diplostemon* *Madhuca bourdillonii* *Myristica species* *Pterocarpus santalinus* *Syzygium travancoricum* *Adinsonia digitata,* *Sterculia urens,* *Mappia foetida* *Aegle marmelos* ***Threatened*** *Ceropegia anantii* *C. attenuate* *C. oculata* *C. mahabalei* *C. vincaefolia* *Lannea coromandelica,* *Diospyros melanoxylon,* *Sterculia urens,* *Mitragyna parviflora,* **Rare** *Exacum wightianum* *Lilium neilgherrense* *Elaeocarpus blascoi* *Ceropegia attenuate* *Ceropegia maccannii* *Ceropegia odorata* *Gymnema khandalense* *Flemingia gracilis* **Vulnerable** *Eriocaulon humile* *Iphigenia magnifica* **Red data list** *Aegle marmelos* *Salacia oblonga* *Piper longum* *Terminalia arjuna* *Gloriosa superb* *Smilax zeylanica* **Endemic** *Dipterocarpus indicus,* *Mastixia arborea,* *Agrostystachys longifolia* *Myristica* *Pinanga dicksonii,*	**SchII** *Jackal* *Hispid hare (caprolagus hispidus).* *Indian Wolf (Canis lupus)* *Common langur* *Common mongoose* *Fruit bat* *Leopard or Panther (Panthera pardus* ***Sch II,*** *Monitor Lizard* *Pythons* ***Sch III*** *Barking deer or Muntjac (Muntiacus muntjak* *Red fox (Vulpes vulpes* *Wild boar* *Blue bull* ***Birds*** *Minivets* *Partridges (Phasianidae* *Falcons (Falconidae)* *Flamingoes* ***Sch IV*** *Palm Squirrel* *Indian porcupine* *Indiam hare* **Sch- V, Vermin** *Common crow,* *Common fox,* *Fruit bats,* *Jackal,* *Mice,* *Rats,* *Voles*	*Dicliptera abuensis,* *Strobilanthes hallbergii,* *Bonnaya bracteoides,* *Oldenlandia clausa,* *Veronica anagallis,* *Ceropegia odorata,* *C. hirsuta,* *C. vincaefolia,* *Ischaemum kingii,* *Rosa involucrata,* *Sterculia villosa,* *Eulophia ochreata,* *Aerides crispum,* *A. multiflora,* *A. maculosum,* *Nervilia oragonna,* *Vanda testacea,* *Anogeissus sericea var. nummularia,* *Blumea bovei,* *Chlorophytum bharuchae,* *Commiphora wightii,* *Convolvulus auricomus,* *C. stockii,* *Gloriosa superba,* *Heliotropium rariflorum,* *Tribulus rajasthanensis,* *T. jamnagarensis,* *Butea monosperma* *Tecomella undulate* *Berberis asiatica* *Tecomella undulate* *Bombax ceiba* *Withania somnifera* *Veronica agrestis* *Bacopa monnieri*	***Sch II*** *Jackal* *Rhesus macaque* ***Sch III*** *Blue bull* ***Sch IV*** *India hare* *Fruit bat* *Palm squirrel*

Thane and Raigad Districts		Gautam Buddha Nagar District	
Threatened Flora [1) 2)]	**Protected Fauna** [3)]	**Threatened Flora**	**Protected Fauna**
Piper hookerii, *Cyathea nilgirica* ***IUCN categorized*** *Celastrus paniculata* *Curculigo orchoides* *Gymnema sylvestre* *Hemidesmus indicus* *Mucuna monosperma* *Rauvolfia serpentine* *Saraca asoca* *Tylophora indica* *Flemingera peltata* *Holarrhena superb* *Artocarpus hirsutus*			

Source: 1) Threatened Plants of Maharashtra, Red Data Book Plants of India (Nayar & Sastry 1987-88)
2) Special Habitats and Threatened Plants of India, WII, 2008
3) WPA, 1972

In Gautam Buddha Nagar, Gulistanpur reserved forest consists of a plantation of semi-arid and arid species. The occurrence of endangered flora species in this reserved forest is minimal. However, in Thane district village forest area, some of the above mentioned species were observed during primary surveys.

Abelmoschus manihot *Ipomoea aquatica* *Maytenus emarginata* *Desmodium sp.*

Ficus hispida *Sida alba* *Sida cordata* *Vitex negundo*

Tectona grandis *Delonix regia* *Bombax ceiba*

Diospyros melanoxylon *Butea monosperma* *Terminalia arjuna*

Callistemone *Acacia catechu* *Cassia fistula*

Photo 7.2.3 Few Plant Species found in the Proposed Corridor Area

4) Interview Results

Interviews with experts in the field of forestry and biodiversity and villagers were conducted in order to triangulate and verify survey findings as well as provide additional information on the biodiversity status and occurrence of particular species of fauna and flora in the proposed corridor area. Key comments and opinions from these interviews are reflected in Table 7.2.7. Also, the Experts provided comments on the possible impact of the proposed corridor on the forests and biodiversity and possible mitigation measures. Their proposed mitigation measures are shown Section 7.2.2 (4).

Table 7.2.7 Key Expert Opinions on Flora Status for the Phase 2 of the Western Corridor

Name and Designation	Important Flora
Shri N.A Sheikh, DY.Conservator of Forest (Retd.) Bharuch	*Prosopis, Neem, Peepul, Desi Babul,Gorasaamli, Khati Aamli, Vad* *Subabul, Peltophorum, Eucalyptus, Kasid Bengali babul*
Shri B.J.Solanki, Range Forest officer, Kamerej SF Range, Kamerej	*Mango, Chiku, Neem, Teak, Khijado, Saragavo, Amali, Arjun Sadad, Boradi* **Threatened/Endangered**: *Papas piplo, Manudo, Adinsonia digitata, Khair, Sterculia urens, Terminalia arjuna, T. tomentosa,*
Shri N.D. Patel Dy.Conservator of Forests, SF Navasari Division	*Cesuerina, Eucolyptus, neem, Vad, Piper Babul, Simalo, Teak, Khijado, Gulmahor, Saryavi, raintree, amla, amali* *Mango, chimu, Arjun Sadad, Butea* ***Endangered flora:*** *Rakta chandan*
V.C.Sharma Asstt.Conservator of Forests Flying Squad Panipech Jhotwara Rd, Jaipur	*Babool,shisham, Neem,mango,khejri,ardu,* *bakayan,churel,* *Panwar,dhamangrass,moonja.lantana,adhasisi,kair, aankara*
Madhusan Tiwari, IFS, Director Cum Dy.Secretary to the Govt. of Rajasthan,	***Tree:*** *Acacia nilotica, Dalbergia sissoo, Azadirachta indica, Mangifera indica, Prosopis cineraria, Ardu,Bakayan,Churel,are also common.* ***Grass****: panwar, Dhaman grass,moonja. adhasisi, hingot,aankara,*
Shakti Mohan Singh , R.F.S , Ex. Dy Conservator of Forests and Director Forestry Training Institute, JLN Marg, Jaipur	*Babool, Shisham, Neem, Mango,khejri,ardu,bakayan,churel,and among grasses and* ***shrub****s-panwar,dhamangrass,moonja.lantana,adhasisi,kair, hingot,aankara*
Dr Asad R Rahmani, Director, Bombay Natural History Society, Mumbai	*Baheda kusum mango arduso Shisam mango Tad, ashok Arduso herda teak badam amla sadad palas bamboo* ***Endangered****: Khair*
Mr PN Munde, Director, SGNP, Borivalli	*Baheda, Kusum Shisam, Arduso Mango, Herda teak badam amla sadad Palas bamboo*
Dr Dilip Gujjar, DCF ,WL, Thane	*Mango , Herda, Tad , arduso,* *Mahua Khajuri badam Amla, Baheda, Palas, Teak, Shisham* ***Endangered****: Khair,*
Mr Ashok Kumar, Forest Range Officer, Gautam Buddha Nagar	*Pongamia pinnata, Holoptelia, Hardwickia, Mangofera indica, Azadirachta indica,Ficus religiosa, F. bengalensis, Acacia nilotica, Embelica officinalis, Tamarindis indica, Delonix, Pithecellobium dulce* are common species on Gautam Buddha Nagar. In Gulistanpur reserved forest, *P.juliflora (not natural), is the main species.* Other species include *Butea monosperma, Dalbertgia sisoo, Pongamia, Holoptelia and an old khajur tree.* Among bushes and ground vegetation *Zizyphus mauritiana, Datura stramonium, Argemone maxicana, Acharynthus, Cannabis*, can be seen.
Mr Suneel Pandey,IFS, Chief Conservator of Forest, Meerut	*Pongamia pinnata, Holoptelia, Hardwickia, Mangofera indica, Azadirachta indica, Nerium indicus, Phoenix, Parkinsonia, Ficus religiosa, F. bengalensis, Acacia nilotica, Embelica officinalis, Tamarindus indica, Delonix, Pithecellobium dulce* are common species on Gautam Buddha Nagar.
Mr R.G. Soni, Retd PCCF,IFS Avifauna Expert Rajasthan	*Acacia nilotica, Azadirachta indica, Morus alba, Pongemia, Holoptelia, Mangifera indica* are common species.
Mr M.S. Mallik,DCF, Gurgaon	*Babool, Shisham, Shahtoot, Neem, mango* ***Endangered****: Khair*
Mr KC Meena, Conservator of Forest,Gurgaon	*Babool, Shisham, Shahtoot, Neem, mango* ***Endangered****: Khair*
Dr Dilip Jadeja Agriculture University, Navsari	*Baheda kusum mango arduso Shisam,* *ashok Arduso herda teak badam, amla sadad palas, Bamboo* ***Endangered****: Khair,*
Mr GK Anarse, DCF,Vig. Thane	*Ashok Arduso Amla, Herda Teak, Badam, Bamboo Sadad, Shisham, Kusum, Palas*

Name and Designation	Important Flora
Mr Satyajit Gujjar, DCF Planning CCF Office, Thane	*Ashok Arduso Amla, Herda Teak, Badam, Bamboo Sadad, Shisham, Kusum, Palas* ***Endangered**: Mappia foetida(Narkya) medicinal tree, Madhuca bourdillonii, Syzygium travancoricum* *Endemic: Dipterocarpus indicus, Mastixia arborea, Agrostystachys longifolia and Myristica malabarica an undergrowth palm Pinanga dicksonii, a species of pepper Piper hookerii, a tree fern Cyathea nilgirica*

Source: JICA survey team

(3) Major Findings

1) JNPT-Vadodara Section

(i) Overall situation (including Tree Census Results)

Approximately 45,000 trees will be required to be removed for the corridor in the JNPT-Vadodara section. The census was carried out for a 60 meter strip along the alignment i.e. within the RoW. For each of the district the total number of trees to be removed is provided in Table 7.2.8. Details of girth class distribution and major tree species have been given in Appendix -7b. Bharuch district has the highest number of trees within the RoW. In addition, there is no mangrove vegetation in the Proposed DFC alignment.

Table 7.2.8 Tree Census in Vadodara - JNPT Section

District	No. of Trees
Vadodara	2,376
Surat	5,490
Bharuch	22,332
Navsari	1,193
Valsad	2,940
Thane*	9,915
Raigadh	951
Total	45,197

Note: *Incomplete in Vasai detour
Source: JICA survey team

(ii) Protected Areas

i) Sanjay Gandhi National Park (SGNP)

(a) General situation of the park and DFC alignment

The SGNP is known for its dense forests, vast bird life, butterflies, and a small population of tigers. It has a total area of about 104 km^2. The region is hilly with elevations between 30 - 480 m. 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 park supports a rich avian fauna including the following rare/endangered species of conservation concern: *Jungle Owlets, golden orioles, racket-tailed drongos, minivets, magpies, robins, hornbills, bulbuls, sunbirds, peacock,* and *woodpeckers*. Migratory and local birds such as the paradise flycatcher and various species of kingfishers, mynas, drongos, swifts, gulls, egrets, and herons are common. The park encompasses two lakes, Vihar Lake and Tulsi Lake, which meets part of the city's water requirements.

The proposed corridor area touches the northern boundary of the SGNP near the Kaman Station. There is one existing railway track and on the other side is National Highway (see

Figure 7.2.1). A small drain, Ratyachi nadi, flows through this area. Four villages of the national park fall within the alignment however since the proposed corridor is aligned between the existing railway track and National Highway, no major additional impact on the natural environment is expected for the SGNP villages or the park itself.

(b) Results of the Winter Season Biodiversity Survey

The survey results are provided in Table 7.8 for villages of the SGNP. The villages of Nagale, Shilottar, Sarjamor (Thane District) are located along the northern boundary of SGNP. Within the area, two (2) sites were surveyed in winter season (Jan). Three (3) tree species, Two (2) herbal species, three (3) grass species and 8 flora species in total were found in the Shilottar village forest area. Nine (9) tree species, one (1) shrub species, eight (8) herbal species, four (4) grass species, two (2)climber, one (1) woody climber species and 25 species in total were found in the Sarjamori village forest area. An endangered tree species, *Sterculia urens* was found in Sarjamori.

(c) Results of the Summer Season Biodiversity Survey

In the summer season (April) survey, three (3) sites were surveyed within the area. In Nagale village forest area, (3) tree species, (1) shrub species, (1) herbal species and (5) species in total were found at the site. Three (3) tree species, two (2) herbal species, three (3) grass species and eight (8) species in total were found in Shilottar village forest area. Seven (7) tree species, three (2) shrub species, three (3) herbal species and 12 species in total were found in Sarjamori village forest area including an endangered tree species, *Sterculia urens*.

Table 7.2.9 Result of Field Survey on Flora in Sanjay Gandhi National Park Area

Village	Area (ha)	Lengths	Winter	Summer
Nagle	0.1871	95	No survey in winter.	3 tree species, 1 shrub species, 1 herbal species and 5 species in total are found in the site. Those are; 1.*Bombax ceiba* 2.*Calotropis procera* 3.*Combratum* sp. 4.*Holarrhena antidysenterica* 5.*Tectona grandis* No endangered species is found in the area.
Shilottar	0.3569	108	3 tree species, 2 herbal species 3 grass species and 8 species in total are found in the site. Those are; 1.*Abelmoschus manihot* 2.*Apluda mutica* 3.*Azadirechta indica* (sap) 4.*Bauhinia racemosa* 5.*Celosia argentea* 6.*Ficus hispida* 7.*Tele gavat* 8.*Themeda quadrivalvis* No endangered species is found in the area.	3 tree species, 2 herbal species 3 grass species and 8 species in total are found in the site. Those are; 1.*Acacia nilotica* 2.*Azadirechta indica* (sap) 3.*Bauhinia racemosa* 4.*Butea monosperma* 5.*Ficus hispida* 6.*Wrightia tinctoria* No endangered species is found in the area.

Village	Area (ha)	Lengths	Winter	Summer
Sarjamori	0.6100	410	9 tree species,1shrub species, 8 herbal species, 4 grass species, 2 climbmer, 1 woody climber species and 25 species in total are found in the site. Those are; 1.*Abelmoschus manihot* 2.*Abelmoschus moschatus* 3.*Acacia catechu* 4.*Achyranthes aspera* 5.*Alysicarpus monilifer* 6.*Apluda mutica* 7.*Bombax ceiba* 8.*Bothriochloa pertusa* 9.*Cissampelos pareira* 10.*Corchorus capsularis* 11.*Cynadon dactylon* 12.*Dalbergia sissoo* 13.*Dioscorea bulbifera* 14.*Gemelina arborea* (sap) 15.*Gliicidia sepium* 16.*Grewia* Sp. 17.*Hemidesmas indicus* 18.*Holarrhena antidysenterica* 19.*Ipomea clumoclit* 20.*Sida acuta* *21.Sterculia urens*	7 tree species, 2 shrub species, 3 herbal species, and 12 species in total are found in the site. Those are; 1.*Abelmoschus manihot* 2.*Abelmoschus moschatus* 3.*Acacia catechu* 4.*Bombax ceiba* 5.*Combratum* sp. 6.*Dalbergia sissoo* 7.*Helicteres isora* 8.*Holarrhena antidysenterica* 9.*Sterculia urens* 10.*Syzyium cumini* 11.*Tectona grandis* 12.*Zizyphus xylopyra* (sap)
Total	1.154	613		

iii) Forest area

The forest area in Thane district and sampling dates are provided in Table 7.2.10 and Table 7.2.11. The majority of the forest areas are characterised as open scrub with bushes and sparse vegetation cover. The two season studies in the forest village area falling under the proposed corridor revealed the presence of the following endangered plant species, *Sterculia urens*, and the Red data listed *Terminalia arjuna*, and plants of Ethno-botanic importance *Anona squamosa and Dioscorea bulbifera.*

Appendix-7a provides details on forest composition and establishes various indices for the forest areas. The forest areas in the villages of Dahanu and Vasai taluk generally do not show remarkable forest cover with the exception of Sarjamori, Bhatpada, and Ovli village forest areas.

(a) Results of Winter Season field surveys

In Thane district, Sarjamori, Umroli, Bhatpada and Ovli village forest areas were found to contain greater species diversity (Table 7.2.10). However, diversity cannot be considered to be high in any of the forest villages within the corridor alignment. The reason for this is likely to be because the majority of village forests affected by the RoW are already split by or next to the existing railway track. Details of the quadrat study have been provided in Appendix-7a. Flora diversity indices have been used to present the results of the primary study. As most of the area was bushy, scrub and barren land therefore other detailed botanical analysis was not deemed appropriate for the study.

Table 7.2.10 Assessment of Floral Diversity Indices in Forest of Proposed Corridor in Winter Season

Village	Shannon-Wiener Diversity Index		Species Richness (S)		Total Abundance		Simpson Diversity Index		Evenness	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1.Ovali	1.91	0.19	7.67	1.45	22.33	4.26	0.17	0.03	0.96	0.02
2.Nagala (SGNP)	-	-	-	-	-	-	-	-	-	-
3.Sarjamori (SGNP)	1.82	0.1	9.5	0.65	51.5	4.73	0.23	0.02	0.81	0.03
4.Shilottar(SGNP)	1.32	0.28	5	1.53	29.33	4.48	0.33	0.08	0.86	0.02
5.Dhaniv	1.12	0.22	4	0.58	18	3.21	0.39	0.08	0.8	0.07
6.Bhatpada Dandipada	1.69	0.19	6.33	1.2	23.33	6.01	0.21	0.04	0.94	0.01
7.Bilalpada	1.31	0.13	4.33	0.33	23	5.2	0.31	0.05	0.89	0.04
8.Kasarali	1.05	0.33	3.8	1.07	11.6	2.2	0.46	0.15	0.93	0.02
9.Kelve road	0.29	0.18	2.00	0.58	11.33	5.55	0.84	0.1	0.47	0.07
10.Kasbe Mahim	1.01		3.17		9.50		0.42		0.88	
11.Dandipada	0.79	0.17	2.67	0.67	19.33	7.33	0.5	0.08	0.87	0.06
12.Boisar	0.44	0.22	1.67	0.33	15.33	6.57	0.69	0.16	0.96	0.03
13.Rani Shirgaon	1.48	0.2	6	0.58	22.33	6.17	0.28	0.06	0.82	0.07
14.Kolavali	1.38	0.1	4.33	0.33	16	4.16	0.27	0.03	0.95	0.03
15.Vangaon	1.49	0.32	6	1.73	37.33	10.9	0.29	0.09	0.87	0.04
16.Pade	0.60		2.5		6.75		0.66		0.76	
17.Ambevadi (Protected Area)	0.08	0.50	1.50	12.5	15.5	0.03	0.97	Na	0.22	Na
18.Gholvad	1.41	0.07	6.33	0.33	42.33	15.93	0.30	0.01	0.77	0.05
19.Bordee	1.43	0.19	5.50	1.50	34	10.03	0.30	0.03	0.83	0.03
20.Gulistanpur Reserved Forest	1.94	0.05	8.69	0.40	160.54	10.44	0.17	0.01	0.90	0.01

Source: JICA survey team

(b) Results of Summer Season field survey

During the summer season (April) sampling was done for the forest areas within the proposed corridor only. A total of 79 species were recorded in the forest area in the summer season, which is lower than the recorded number of species in the winter season (114 plant species). There were 29 species which were recorded in the winter season, but not observed in the summer season sampling. Similarly 6 species were noted in the summer season, which were not recorded in the winter season (January) sampling. These species were mainly saplings, shrubs and herbaceous plants. Floral diversity is highest (1.53) in Gulistanpur reserved forest (Table 7.2.11). In Thane district, Gholvad, Kolavali, Bilalpada and Sarjamori village forest areas were noted to contain higher species diversity as compared with other village forest areas. Species abundance was highest in Gulistanpur. The summer season survey revealed lower species diversity than the winter season.

Table 7.2.11 Assessment of Floral Diversity Indices in Forest of Proposed Corridor in Summer Season

Village	Shannon-Wiener Diversity Index		Species Richness (S)		Total Abundance		Simpson Diversity Index		Evenness	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1.Ovali	0.63	0.26	2.2	0.49	4.6	0.68	0.62	0.16	0.96	0.02
2.Nagala (SGNP)	0.66	0.16	2.17	0.31	3.67	0.72	0.57	0.1	0.92	0.03
3.Sarjamori (SGNP)	1.13	0.13	3.83	0.4	11.83	2.98	0.38	0.05	0.85	0.04
4.Shilottar(SGNP)	0.86	0.14	2.5	0.29	4.75	1.44	0.45	0.07	0.95	0.05
5.Dhaniv	0.88	0.22	3	0.41	8	2.97	0.49	0.13	0.78	0.15
6.Bhatpada Dandipada	0.88	0.17	2.75	0.48	5.25	1.38	0.46	0.07	0.91	0.04
7.Bilalpada	1.18	0.2	3.5	0.65	3.75	0.63	0.33	0.07	0.99	0.01
8.Kasarali	0.81		2.43		4.71		0.48		0.93	
9.Kelve road	0.58	0.2	2	0.37	2.67	0.72	0.62	0.12	0.98	0.02
10.Kasbe Mahim	0.42	0.26	1.75	0.48	2.5	0.65	0.73	0.16	0.93	0.01
11.Dandipada	0.74	0.18	2.5	0.43	4.33	0.72	0.55	0.1	0.89	0.03
12.Boisar	1.02	0.24	3.33	0.67	4.17	1.05	0.43	0.12	0.97	0.01
13.Rani Shirgaon	0.98	0.21	3.25	0.75	6.25	1.55	0.43	0.07	0.91	0.06
14.Kolavali	1.2	0.2	3.80	0.6	10.00	1.40	0.30	0.10	1.00	0
15.Vangaon	1.07	0.29	4.25	1.11	12.5	3.88	0.46	0.12	0.76	0.07
16.Pade	0.5	0.2	1.50	0.6	8.8	4	0.7	0.10	0.80	0.10
17.Ambevadi (Protected Area)	1.03	0.25	4.25	0.85	17.25	6.54	0.45	0.12	0.77	0.14
18.Gholvad	1.2	0.2	4.5	0.90	9.80	2.40	0.40	0.10	0.80	0.10
19.Bordee	0.4	0.3	2.8	1.00	12.80	4.30	0.80	0.10	0.60	0.03
20.Gulistanpur Reserved Forest	1.53	0.24	8.29	1.54	74.14	14.4	0.33	0.09	0.73	0.08

Source: JICA survey team

a) Ovali Reserved Forest (No. 1)

A total 18 of species were recorded in Ovali. The forest is located on the north side of the existing railway. Approximately 350 m of total length and 0.1288 ha of the land is likely to be affected by conversion to railway.

The area is dominated by herbal and grass plant species with no endangered or otherwise protected species.

Species classification	Winter season	Summer season
Total No.of species	17	8
Tree species(T)	0	0
Shrub specis(S)	4	5
Herbal species(H)	8	2
Grass(G)	3	0
climber (C)	2	1
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

b) Nagale Forest (No. 2)

Nagale forest plot falls within SGNP.

Approximately 95 m of total length of the land is located adjacent to the northside of the existing railway.

The area is dominated by herbal and grass plant species with no endangered or otherwise protected species.

Species classification	Winter season	Summer season
Total No. of species	NA	5
Tree species(T)	NA	3
Shrub species(S)	NA	1
Herbal species(H)	NA	1
Grass(G)	NA	0
climber (C)	NA	0
Woody Climber(WC)	NA	0
others	NA	0

Source: JICA survey team

c) Sarjamori Forest (No. 3)

The forest is located within Sanjay Gandhi National Park.

Approximately 110 m of total length of the land is located adjacent to the north side of the existing railway. One (1) Endangered plant species, Sterculia urens (Sarjamori) was found in the area.

Species classification	Winter season	Summer season
Total No. of species	25	12
Tree species(T)	9	7
Shrub species(S)	1	2
Herbal species(H)	8	3
Grass(G)	4	0
climber (C)	2	0
Woody Climber(WC)	1	0
others	0	0

Source: JICA survey team

d) Shilottar Forest (No. 4)

Shilottar area forest plot falls within SGNP. Approximately 108 m of total length of the land is located adjacent to the north side of the existing railway.

The following tree species, *Aplauda mudica*, *Azadirachta indica*, and *Bauhenea racemosa* were observed in Shilottar forest plot. Herbal and grass plant species were only observed in the winter season.

Species classification	Winter season	Summer season
Total No. of species	8	6
Tree species(T)	3	6
Shrub species(S)	0	0
Herbal species(H)	2	0
Grass(G)	3	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

e) Dhaniv Forest (No. 5):

In Dhaniv forest plot, 8 plant species were recorded as classified below. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	8	7
Tree species(T)	3	5
Shrub species(S)	1	1
Herbal species(H)	2	1
Grass(G)	2	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

f) Bhatpada Forest (No. 6)

13 plant species in winter and 6 species in summer were observed during the field surveys. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	13	6
Tree species(T)	6	5
Shrub species(S)	0	0
Herbal species(H)	5	1
Grass(G)	2	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

g) Bilalpada Reserved Forest (No. 7)

A total of 8 species were recorded in Bilalpada. No endangered species were found during the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	10	9
Tree species(T)	2	5
Shrub specis(S)	0	0
Herbal species(H)	5	4
Grass(G)	3	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

h) Kasarali Forest (No. 8)

A total of 9 species were recorded in Kasarali forest area. Mangrove vegetation is also found in the lowland area of this village. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	9	8
Tree species(T)	2	3
Shrub species(S)	1	1
Herbal species(H)	4	4
Grass(G)	1	0
climber (C)	1	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

i) Kelve Road Forest (No. 9)

Very little vegetation was observed. The forest land area can be described as open scrub or barren land. Only 3-4 plant species were noted. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	3	6
Tree species(T)	1	4
Shrub specis(S)	0	1
Herbal species(H)	1	1
Grass(G)	1	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

j) Kasbe Mahim Forest (No. 10)

The Mahim plot of forest land area is open scrub. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	NA	4
Tree species(T)	NA	2
Shrub species(S)	NA	2
Herbal species(H)	NA	0
Grass(G)	NA	0
climber (C)	NA	0
Woody Climber(WC)	NA	0
others	NA	0

Source: JICA survey team

k) Dandipada Forest (No. 11)

There are no trees in Dandipada forest plot, only invasive species and grasses were recorded. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	5	10
Tree species(T)	0	3
Shrub species(S)	0	1
Herbal species(H)	3	5
Grass(G)	2	0
climber (C)	0	1
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

l) Boisar Forest (No. 12)

Boisar Forest is categorized as protected forest. The area is characterised by open, barren land with no vegetation cover present. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	4	8
Tree species(T)	0	4
Shrub species(S)	0	2
Herbal species(H)	2	1
Grass(G)	2	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	1

Source: JICA survey team

m) Rani Shirgaon Forest (No. 13)

A total of 13 species were recorded in Rani Shirgaon.

No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	13	6
Tree species(T)	3	3
Shrub specis(S)	2	2
Herbal species(H)	5	1
Grass(G)	3	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

n) Kolavali Forest (No. 14)

9 plant species in winter and 6 species in summer were recorded in the field survey at Kolavili. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	9	6
Tree species(T)	5	5
Shrub species(S)	1	1
Herbal species(H)	1	0
Grass(G)	2	0
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

o) Vangaon Forest (No. 15)

Vangaon village forest area is categorized as protected forest. *Acacia auriculiformis, Agave americana, Lantana camara* and *Zizyphus oinoplia* were species recorded in Vangaon. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	14	7
Tree species(T)	1	1
Shrub species(S)	3	3
Herbal species(H)	6	2
Grass(G)	3	0
climber (C)	1	1
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

p) Pade Forest (No. 16)

This site is characterized by sparse mangrove vegetation. Only 1 tree species in winter and 3 plant species were recorded in the field survey. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	1	3
Tree species(T)	1	1
Shrub species(S)	0	0
Herbal species(H)	0	1
Grass(G)	0	1
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

q) Ambevadi Forest (No. 17)

2 species in winter and 9 species in summer were recorded in field surveys.

Species classification	Winter season	Summer season
Total No. of species	2	9
Tree species(T)	1	3
Shrub species(S)	1	2
Herbal species(H)	0	3
Grass(G)	0	1
climber (C)	0	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

r) Gholvad Forest (No. 18)

Gholvad forest area is parallel to the existing track. Bushes, grasses and a few tree saplings were recorded in the alignment area. *Acacia leucocephala* and *Phoenix sylvestris* and *Prosopis juliflora* were among the recorded species during the survey. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	14	13
Tree species(T)	3	5
Shrub species(S)	2	3
Herbal species(H)	3	4
Grass(G)	5	0
climber (C)	1	1
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

s) Bordee Forest (No. 19)

During the field surveys 9 plant species in winter and 5 species in summer were recorded in Bordee forest plot. No endangered species were found in the field survey at this site during either season.

Species classification	Winter season	Summer season
Total No. of species	9	5
Tree species(T)	3	3
Shrub species(S)	0	0
Herbal species(H)	1	1
Grass(G)	4	1
climber (C)	1	0
Woody Climber(WC)	0	0
others	0	0

Source: JICA survey team

(c) Conclusion

- A total of 133 plant species were recorded in the two seasons survey.
- Winter season (January) as well as summer season (April) analysis reveals that biodiversity is low in the village forest area falling in the proposed corridor.
- Species diversity in the winter season was higher than in the summer season.
- The village forest areas of Gholvad, Kolavali, Bilalpada and Sarjamori contained the

greatest species diversity although the Gulistanpur Reserve of Gautam Buddha Nagar exhibited the highest species diversity of all the sites surveyed.

- The proposed DFC corridor alignment will have a minor impact on forest ecosystems and the natural environment in the Vasai detour village forest areas.
- In other village forest areas the DFC corridor will also only have a minor impact on the natural environment as these areas are not rich in vegetation cover.

2) Rewari-Dadri Section

(i) Overall situation

Based on the Rewari-Dadri section tree census it is estimated that a total 3,100 trees are located in the corridor and will require felling (Table 7.2.12). The Reserved Forest area of Gulistanpur is dominated by *Prosopis juliflora, Dalbergia sissoo* and *Butea monosperma.* The corridor will bisect the reserved forest.

Table 7.2.12 Tree Census in Rewari-Dadri

S.No.	District	No. of Trees
1	Rewari	415
2	Alwar	146
3	Mewat	350
4	Gurgaon	253
5	Palval	216
6a	Faridabad	1,066
6b	Faridabad-new	520
7	Gautam Buddha Nagar*	134
	Total	3,100

Note: *Does not include the reserved forest trees.
Source: JICA survey team

(ii) Forest Areas

(a) Gulistanpur Reserved Forest

The Gulistanpur Reserved Forest is located close to the industrial area of Surajpur and is not a natural forest but a result of plantation work by the forest department. Mainly *Prosopis juliflora*, *Acacia arabica, Dalbergia sissoo*, *Butea monosperma* and *Calotropis procera* were observed. The corridor will pass through 1.6 km of the reserved forest and it is estimated that a total of 476 trees will be cut (Appendix-7b). The maximum number of trees expected to be removed are *P.juliflora* (310), followed by *Dalbergia sissoo* (115), *Butea monosperma* (51) and *Acacia arabica* (13). However, this plantation forest consists mainly of semi-arid and arid plants for greenery development. Therefore, the corridor will not damage any critical habitat. Further plantation can be carried out to restore the area and compensate for the loss of forest cover

(4) Impact Assessment

1) Impacts

(i) Loss of forest cover/tree cover:

Loss of forest cover/tree cover due to felling of private and government trees within the proposed ROW is anticipated. Approximately 45,197 trees in JNPT-Vadodara section and 3,100 trees in Rewari-Dadri section are required to be felled, although there is only one endangered species.

(ii) Diversion of Forest Land:

- It is estimated that, approximately 30 hectares of forest land in the JNPT-Vadodara section and 10 ha in Rewari-Dadri section will be converted for use as ROW for the DFC. The area includes part of Sanjay Gandhi National Park and other recorded forests.

2) Mitigation measures

(i) Loss of forest cover/tree

- Tree cutting is to proceed only after all the legal requirements including Formal Clearances from the Haryana State Forest Department are completed and subsequently a written order is issued to the Project Proponent/ Contractor.
- Appropriate compensatory plantation should be carried out to compensate for the vegetation loss due to felling of trees for site clearing. For trees to be cut, sufficient compensatory plantation, about 2 times the number of trees felled, will be carried out. If adequate space for compensatory plantation is not available along the DFC corridor, plantation may be carried out along State Highways (SH), Major District Roads (MDR), and Other District Road (ODR) or in degraded forest land.
- For trees to be felled in private land, compensation for land and trees will be given to the owners. The rate of compensation for trees lost will be decided by the State Forest Department.
- Compensatory afforestation and reforestation will follow preferences for mixed plantations consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value.
- Under the plantation programme, more valuable tree species will be planted in place of existing non-valuable mono crops of the project area, where appropriate.

(ii) Diversion of Forest Land

- Monetary compensation should be provided to Forest Dept. towards the cost of forest land to be diverted and costs of compensatory afforestation.
- Before starting any activity within the Forest area, Forest Clearance must be obtained as per the Forest Conservation Act, 1980 and it's amendments from the State Forest Department.
- An action plan for tree felling should be prepared to avoid uncontrolled and indiscriminate tree felling.
- Appropriate compensatory plantation should be initiated to compensate for the vegetation loss due to felling of trees for site clearing. For trees to be cut, sufficient compensatory plantation should represent approximately 2 times the number of trees felled.
- Preferential mixed plantation consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value should be carried out.
- Under the plantation programme, more valuable tree species should be planted in place of existing non-valuable mono crops of the project area, if any.

3) Key Expert Opinions on Impact and Mitigation measure

The Experts who belong to forestry and biodiversity authorities provided comments on the possible impact of the proposed corridor on the forests and biodiversity and possible

mitigation measures. Their opinion of expected impact due to DFC and proposed mitigation measures are shown below table.

Table 7.2.13 Key Expert Opinions on Mitigation Measures for the Phase 2 of the Western Corridor

Name and Designation	Impact due to DFC	Mitigation measures
Shri N.A Sheikh, DY.Conservator of Forest (Retd.) Bharuch	• Forest area will not be affected in Gujarat. • Vegetation clearance for railway line will degrade the nearby land. • No impact on faunal/floral diversity in general.	Plantation of native species which have economic importance need to be planted.
Shri B.J.Solanki, Range Forest officer, Kamerej SF Range, Kamerej	Forest area is not within the DFC alignment.	Green belt should be developed. Villages should be involved for participation.
Shri N.D. Patel Dy.Conservator of Forests, SF Navasari Division	DFC does not affect the forest area. However, tree cutting will have an impact on environment and economy.	Green belt should be developed as compensation. Selection of trees should be of native plants and of economic value.
V.C.Sharma Asstt.Conservator of Forests Flying Squad Panipech Jhotwara Rd, Jaipur	The area will take a turn on the line of development. Local people on the one hand will get a healthy amount in the form of compensation of land on the other hand their agricultural area will shrink.	Fast running traffic could lead to an increased number of animal-related accidents where it coincides with livestock grazing areas. Sufficient measures are required. As far as flora and fauna is concerned it's suggested to create a thick barrier of live tree hedge including herbs, shrubs, and trees which can provide food and shelter to local fauna and birds.
Madhusan Tiwari, IFS, Director Cum Dy.Secretary to the Govt. of Rajasthan,	Forest area is not affected by phase 2. No major impact on biodiversity.	Green belt of should be created along the track. This green barrier will maintain the micro-climate and ecosystem of the area. Thus, the environment will not degrade.
Shakti Mohan Singh , R.F.S , Ex. Dy Conservator of Forests and Director Forestry Training Institute, JLN Marg, Jaipur	As this freight corridor will pass mostly through the agricultural area, the people of the area should be taken into confidence for conserving the ecosystem through participatory management.	Fast running of freight trains will create noise pollution in the locality. For remediation it is suggested to plant a green barrier of trees, herbs and shrubs along the corridor. The people of the area should be educated to take care of such trees so that environmental degradation can be prevented.
Dr Asad R Rahmani, Director, Bombay Natural History Society, Mumbai	In Thane reserved, protected, sanctuary, national park, wetland and ecosensitive area are dominant forest resource type and proposed DFC is likely to affect these.	-Develop green belt in the same area along rail line or other place - During construction and operation measures must be taken to ensure the safety of fauna -DFCC to create a conservation fund. - Path to move in the area having forests on both side or sanctuary be provided -Damage to mangrove avoided. If not possible compensate through afforestation -Avoid NP/Sanct. If unavoidable stilts[3] should be considered. - Study of impact be done on fauna of NP and on corridor -During construction steps for prevention of degradation of air and water should be taken
Mr PN Munde, Director, SGNP, Borivalli	Eco-sensitive and protected areas will be affected by the proposed corridor.	-Green belt in the same area along corridor - Control measures for safety of fauna during construction and operation phase - DFCCIL to provide funds for environment

[3] Ground level portion of construction consisting of structural column supporting the super structure done without any enclosures.

Name and Designation	Impact due to DFC	Mitigation measures
		conservation. -Path to move in the area having forests on either side or sanctuary be provided -Compensatory afforestation for mangrove areas in cases where cutting is unavoidable.
Dr Dilip Gujjar, DCF ,WL, Thane	Reserved, protected, sanctuary, national park, wetland and ecosensitive area are coming in the proposed corridor area. DFC is likely to affect these.	-DFCC to create a fund for environment conservation. -During construction and operation measures be taken for safety of fauna -During construction steps for prevention of degradation of air and water be taken -Damage to mangrove avoided. If not possible compensate through afforestation.
Mr Ashok Kumar, Forest Range Officer, Gautam Buddha Nagar	-DFC will completely destroy the Gulistanpur reserved forest.	-Restocking of the area with broad leaved indigenous species. -Raising of herbaceous flora as understory/ground vegetation so as to have multi tier natural vegetation in the due course.
Mr Suneel Pandey,IFS, Chief Conservator of Forest, Meerut	-Reserved forest of Gulistanpur will be completely damaged. -Surajpur wetland may also have some impact although DFC is 2.5 km far from the site and lot of industrial development already exists in between.	-Compensatory afforestation.
Mr R.G. Soni, Retd PCCF,IFS Avifauna Expert Rajasthan	Mainly agricultural land is affected by DFC. Panchayat land and revenue is also coming. No major impact on biodiversity.	-Tree cutting should be compensated by afforestation/reforestation.
Mr M.S. Mallik, DCF, Gurgaon	Forest area does not fall within the proposed corridor.	-Green belt development in ground clearing area along the corridor. - DFCCIL to assure funds for environment restoration.
Mr KC Meena, Conservator of Forest, Gurgaon	Forest area does not fall within the proposed corridor.	-Develop green belt in the same area along rail line or other place -Compensate by flora/fauna conservation -DFCCIL to provide funds for environment conservation. -Along with public consultation to know about the various aspects of forest studies and information about uses of various plant species by villagers, local plant species which are important for maintaining the habitat around the stretch should be identified. These will improve ecology and the socio-economic status of the area.
Dr Dilip Jadeja Agriculture University, Navsari	In Gujarat forest area does not fall within the proposed corridor. However, tree cutting will be significant mainly for private land, orchards etc.	-During construction and operation measures must be taken for the safety of fauna. -DFCC to make compensatory afforestation. -During construction steps for prevention of degradation of air and water should be taken. -Safety of villagers during movement of earth machines to be considered. -South Gujarat has mangroves, conservation steps to be taken**.**
Mr GK Anarse, DCF,Vig. Thane	Reserved forest, protected forest, Mangrove forest, ecosensitive area and wetland will be affected due to the proposed corridor in Thane area.	Green belt development for compensation to forest. -DFCCIL should make funds available for the mitigation measures. -Path to move in the area having forests on both sides to be provided

Name and Designation	Impact due to DFC	Mitigation measures
Mr Satyajit Gujjar DCF Planning CCF Office, Thane	Reserved forest, protected forest, Mangrove forest, ecosensitive area and wetland will be affected due to proposed corridor in Thane area.	Green belt development as compensation to forest. -DFCCIL should make funds available for the mitigation measures. -Path to move in the area having forests on both sides to be provided

Source: JICA survey team

7.2.2 Fauna

(1) Study Methodology

1) Survey site

Fauna species were also surveyed in the forest areas of Thane and Gautam Buddha Nagar. Faunal surveys were also conducted in some non forest areas of Gujarat and Maharashtra falling within the proposed alignment. The location map of the survey is provided in the Flora description.

The results presented are from the two season study of the forest area. Because the study was conducted in the area of forest to be directly affected by the DFC to identify the impact, the results are only limited to this area and therefore does not represent the entire forest/park areas. For instance the faunal species composition and diversity near the outer portion of SGNP, which forms part of the proposed corridor is not the same as it is within the core zone of the national park.

As most of the affected forest area is adjacent to the existing railway track, the total fauna such as seasonal migration and seasonal behaviour, etc. cannot be represented with the forest area being affected. Especially in case of birds, reptiles and insects, it is common that they show seasonal migration and avoidance mechanisms. Therefore, the findings are limited to the corridor affected area only.

2) Survey Period

The surveys were conducted in the winter and summer season. In the winter season a more detailed study was conducted, that was not limited to the forest area. In the summer season only the forest area of the Phase 2 proposed corridor area was studied.

3) Measurement and analysis method

While laying the sample plots for flora, the presence of fauna such as various reptiles, birds and mammal species was also recorded. Linear transect treks were made for identifying scat, feathers, nests, and other signs. Species richness was analyzed for the fauna species. Findings are detailed in Appendix-7c.

Fauna species in the forest area and in nearby areas were recorded on the basis of direct sightings or observation of tracks and signs such as footprints, scat, nests, wings and feathers of birds were recorded as evidence of fauna in the area. Experts and local villagers were also consulted to confirm the presence of particular species.

(2) Major Findings

1) JNPT- Vadodara section

The major fauna species in the districts studied included: Blue bull (Nil gai), Jungle cat, Jackal (Shiyal), Indian Fox (Lomdi), Common Langur (Hanuman langur), Indian Rat Snake (Dhaman), Checkered Keel back (Dendavo), Common Indian Krait (Kadotaro),

Common cobra (Nag), Red sand Boa (Andhadi chakad), Pale Hedgehog (Shelo), Common mongoose (Noliyo), Indian Porcupine (Shahudi), Indian Hare (Sasalu), Indian Flying fox (Vagol), Indian Cricket Frog, Indian palm squirrel, Indian mud or lap shell turtle (Kacher), Common Indian Monitor (Patala Gho) Marsh crocodile.

In terms of **Avifauna** the following species were commonly found; Asian koel, Rose ringed parakeet, White breasted kingfisher, pied kingfisher, Small blue kingfisher, Small bee eater, Common hoopoe, Common golden backed woodpecker, Coppersmith barbet, Black drongo, Common myna, House crow, Red vented bulbul, Common babbler, Purple sunbird, White wagtail, Yellow wagtail, Baya weaver, House sparrow..

Birds: During the study a total of 54 bird species were observed in the study area including both resident and migratory species. Of these recorded bird species, a total of 43 species of birds were common and are resident species which are known to breed in this region as well as in the study area (Table 7.2.14). A total of 11 species that were recorded during the study, were known to be winter migratory. These migratory birds are also common species and spread across the state and India during winter. The terrestrial birds were recorded mainly from non-forested or degraded forest areas in the surrounding landscape interspersed with agriculture, scattered wetlands and ponds. The bird species groups observed included species preferring open scrubland areas such as Passarines, Shrikes and Francolin and wetlands birds such as Sandpipers, Egrets and Herons. The majority of the birds observed in the study area represent birds of semi arid non-forested landscapes with several small ponds and lakes in the villages. Moreover, the majority of the bird species reported in the present study are common even in human dominated landscapes such as nearby areas of urban cities in lakes and ponds etc.

Table 7.2.14 Bird Species Recorded during the Survey near the Proposed Alignment in JNPT-Vadodara Section

Common Name	Scientific Name	Status
Bay backed shrike	*Lanius vittatus*	Resident Breeding
Black drongo	*Dicrurus macrocercus*	Resident Breeding
Black shoulder kite	*Elanus caeruleus*	Resident Breeding
Black winged stilt	*Himantopus himantopus*	Resident Breeding
Blue rock pigeon	*Columba livia*	Resident Breeding
Cattle egret	*Bulbulcus ibis*	Resident Breeding
Citrine Wagtail	*Motacilla citreola*	Migratory
Common babbler	*Turdoides caudatus*	Resident Breeding
Common hawk cuckoo	*Hierococcyx varius*	Migratory
Common Kingfisher	*Alcedo atthis*	Resident Breeding
Common myna	*Acridotheres tristis*	Resident Breeding
Common Redshank	*Tringa totanus*	Migratory
Common sandpiper	*Actitis hypoleucos*	Migratory
Common tailor bird	*Orthotomus sutorius*	Resident Breeding
Common Woodshrike	*Tephrodornis pondicerianus*	Resident Breeding
Coppersmith Barbet	*Megalaima haemacephala*	Resident Breeding
Desert Wheatear	*Oenanthe deserti*	Migratory
Eurasian collared dove	*Streptopelia decaocto*	Resident Breeding
Great egret	*Casmerodius albus*	Resident Breeding
Greater couckal	*Centropus sinensis*	Resident Breeding
Green bee eater	*Merops orientalis*	Resident Breeding
Green sandpiper	*Tringa ochropus*	Migratory
Grey francolin	*Francolinus pondicerianus*	Resident Breeding
Grey heron	*Ardea cinerea*	Resident Breeding
Grey Wagtail	*Motacilla cinerea*	Migratory
House crow	*Corvus splendens*	Resident Breeding
House sparrow	*Passer domesticus*	Resident Breeding
Indian pond heron	*Ardeola grayii*	Resident Breeding

Common Name	Scientific Name	Status
Indian robin	*Saxicoloides fulicata*	Resident Breeding
Indian silverbill	*Lonchura malabarica*	Resident Breeding
Jungle babbler	*Turdoides striatus*	Resident Breeding
Laughing dove	*Streptopelia senegalensis*	Resident Breeding
Little cormorant	*Phalacrocorax niger*	Resident Breeding
Little egret	*Egretta garzetta*	Resident Breeding
Little grebe	*Tachybaptus ruficollis*	Resident Breeding
Long tailed shrike	*Lanius schach*	Resident Breeding
Oriental magpie robin	*Copsychus saularis*	Resident Breeding
Orphean Warbler	*Sylvia hortensis*	Migratory
Pied kingfisher	*Ceryle rudis*	Resident Breeding
Plain prinia	*Prinia inornata*	Migratory
Purple sunbird	*Nectarinia asiatica*	Resident Breeding
Red Collared Dove	*Streptopelia tranquebarica*	Resident Breeding
Red vented bulbul	*Pycnonotus cafer*	Resident Breeding
Red wattled lapwing	*Vanellus indicus*	Resident Breeding
Rose ringed parakeet	*Psittacula krameri*	Resident Breeding
Rufous treepie	*Dendrocitta vagabunda*	Resident Breeding
Rufus tailed lark	*Ammomanes phoenicurus*	Resident Breeding
Spotted owlet	*Athere brama*	Resident Breeding
Variable Wheatear	*Oenanthe picata*	Migratory
White throated kingfisher	*Halcyon smyrnensis*	Resident Breeding
White-eared Bulbul	*Pycnonotus leucotis*	Resident Breeding
Wire tailed swallow	*Hirundo smithii*	Resident Breeding
Yellow Wagtail	*Motacilla flava*	Migratory
Yellow wattled lapwing	*Vanellus malarbaricus*	Resident Breeding

Source: JICA survey team

Reptiles: The majority of the reptile species are fossorial in habit therefore; the assessment of reptiles and their diversity etc. holds special significance for any construction projects. The study included interviews, reviewing secondary literature as well as direct observations on road killed reptiles. In the present study a total of 11 species of reptiles were identified. All the reported species are common and are abundant throughout Gujarat state even in non-forested areas.

Mammals: Mammals being members of higher trophic level in the ecosystem, their presence is an indicator of the health of the eco-systems. It is also important to understand their presence, whereabouts, habitats and behaviours where any development projects are planned in and around their habitats. In the present study we observed a total of 12 mammal species on the proposed track alignment and in nearby areas (Table 7.2.15). The common mammal species that were directly observed included Nilgai, Hanuman langur, Wild Pig, Grey Mongoose, Indian Hare and the Five Stripped Squirrel. The majority of the mammal species recorded during the survey in and around the proposed alignment are present throughout semi-arid, non-forested and non-protected landscapes from North, Central and South Gujarat regions.

The mammal species found in the forest area of Thane and Raigadh are blue bull, langur, Indian hare, jackal and wild boar etc. More details on fauna species are provided in Appendix-7c.

Table 7.2.15 Mammal Species Recorded during the Survey near the Proposed Alignment in JNPT-Vadodara Section

Name	Scientific name	Local status*	Conservation status
Blue bull	*Boselaphus tragocamelus*	Abundant	Sch III
Hanuman langur	*Presbytis entellus*	Common	Sch II
Common mongoose	*Herpestes edwardsi*	Common	Sch II
Fruit Bat	*Cyanopterus sphynx*	Common	Sch IV

Name	Scientific name	Local status*	Conservation status
House rat	*Rattus rattus*	Common	unscheduled
Indian hare	*Lepus migricollis*	Common	Sch IV
Indian pipistrelle	*Pipistrellus coromandra*	Common	unscheduled
Indian porcupine	*Hystrix indica*	Common	Sch IV
Jackal	*Canis aureus*	Common	Sch II
Jungle cat	*Felis chaus*	Uncommon	Sch II
Palm squirrel	*Funambulus pennanti*	Common	Sch IV
Wild Boar	*Sus scrofa*	Abundant	Sch III

Note: *Local status is based on intensive Field data:
Status category Criteria: Abundant: Many direct and indirect evidences, Common: Few direct but many indirect evidences, Uncommon: Few or no direct evidences but good indirect evidences, Rare: No direct evidences and very few indirect evidences

Source: JICA survey team

(i) Protected Areas

i) Sanjay Gandhi National Park

In the Diva - Vasai Section, the alignment of the proposed corridor has been planned parallel to the existing central railway track with a view to utilise the available railway land to the fullest extent and minimize acquisition of additional land. Near the villages listed below, all efforts to ensure that the track runs outside the Sanjay Gandhi National Park have been taken. However, the existing track safety and geological considerations require the proposed line to be near the existing line. Nagale, Shillotar, Sarjamori and Mori village forest areas will have minor additional impacts due to the proposed corridor. A total of 1.823 ha from the village forest area (Reserved forest) is expected to be affected.

Table 7.2.16 Result of Field Survey in Fauna in Sanjay Gandhi National Park Area

Village	Area (ha)	Lengths	Winter	Summer
Nagale	0.1871	95	N/A	6 mammal species, 24 bird species, 3 reptile species were found at the survey. Mammal species are; 1.Blue bull 2.Common mongoose 3.Indian porcupine 4.Jungle cat 5.Palm squirrel 6.Wild Boar
Shilottar	0.3569	108	11 mammal species, 48 bird species, 10 reptile species were found at the survey in winter. Mammal species are; 1.Blue bull 2.Common langur 3.Rhesis Macaque 4.Fruit Bat 5.House rat 6.Indian hare 7.Indian porcupine 8.Jackal 9.Jungle cat 10.Palm squirrel 11.Wild Boar	6 mammal species, 27 bird species, 5 reptile species were found at the survey. Mammal species are; 1.Blue bull 2.Indian porcupine 3.Jackal 4.Jungle cat 5.Palm squirrel 6.Wild Boar
Sarjamori	0.6100	410	12mammal species, 48 bird species, 10 reptile species were found during the winter survey.	7mammal species, 25 bird species, 8 reptile species were found at the survey. Mammal species are;

Village	Area (ha)	Lengths	Winter	Summer
			Mammal species are; 1.Blue bull 2.Common langur 3.Rhesis Macaque 4.Common mongoose 5.Fruit Bat 6.House rat 7.Indian hare 8.Indian porcupine 9.Jackal 10.Jungle cat 11.Palm squirrel 12.Wild Boar	1.Blue bull 2.Common mongoose 3.Indian porcupine 4.Jackal 5.Jungle cat 6.Palm squirrel 7.Wild Boar

Source: JICA survey team

Details of the fauna survey in the project area are provided in Appendix-7c. As the proposed corridor is moving through the outskirts of the SGNP, no major additional impact is expected.

(ii) Forest Areas

During the field survey, movement of some mammal species was confirmed in the forest areas even near the existing railway.

The fauna species recorded in the forest areas of Thane and Raigad are provided in Appendix-7c and a summary is shown below Table.

Table 7.2.17 Total Number of Species in Major Fauna Classes along the Proposed Corridor in Forest of Thane and Raigad

No.	Forest Village	Winter				Summer			
		Reptiles	Birds	Mammals	Total	Reptiles	Birds	Mammals	Total
1	Ovali	7	30	6	43	3	26	3	32
2	Nagala (SGNP)	-	-	-	-	3	24	6	33
3	Sarjamori (SGNP)	10	48	12	70	8	25	7	40
4	Shilottar(SGNP)	10	48	11	69	5	27	6	38
5	Dhaniv	7	27	4	38	5	26	2	33
6	Bhatpada Dandipada	7	29	6	42	7	20	4	31
7	Bilalpada	7	29	6	42	8	24	6	38
8	Kasarali	7	28	7	42	5	26	6	11
9	Kelve road	7	32	5	44	3	18	3	24
10	Kasbe Mahim	8	23	5	36	4	24	1	29
11	Dandipada	7	36	4	47	3	27	3	33
12	Boisar	7	23	5	35	7	19	2	28
13	Rani Shirgaon	7	21	5	33	7	24	1	32
14	Kolavali	7	20	5	32	8	20	8	36
15	Vangaon	7	42	4	53	3	19	4	26
16	Pade	7	20	4	31	3	19	2	24
17	Ambevadi (Protected Area)	7	40	5	52	3	23	4	30
18	Gholvad	6	35	5	46	8	20	4	32
19	Bordee	8	34	7	49	7	23	11	41

Source: JICA survey team

2) Rewari-Dadri Section

(i) Overall situation

In the Rewari-Dadri section, the proposed track is a detour where the alignment mainly goes through agricultural areas. Spotted Deer, Sambar, Blue Bull, Leopard, Caracal, Rusty Spotted Cat, Jungle Cat, Four-horned Antelope, Wild Boar, Jackal, Striped Hyena are some of the larger mammal species found in the forests of Alwar. Among bird species, Peafowl, Grey Partridge, Bush Quail, Sand Grouse, Tree Pie, Golden backed Woodpecker, crested Serpent Eagle and The Great Indian horned Owl are common.

(ii) Forest Areas

The Gulistanpur Reserved Forest falls under the semi arid climatic zone. The forest habitat comprises tolerant plant species which can survive in adverse conditions.

The wide range of hardy vegetation species in the reserve despite being surrounded by an area of heavy industry is surprising but it is this biodiversity that enables resilience. The plantation forest of Gulistanpur is thorny and bushy. The major fauna of the reserved forest is listed in Tables 7.2.18 to 7.2.20. Gulistanpur is the only area in Gautam Buddha Nagar. Tourism infrastructure has been developed in the area.

Table 7.2.18 Checklist of Herpetological Fauna Recorded along the Proposed Corridor in Gulistanpur

Common Name	Scientific Name
Saw scaled Viper	*Echis carinatus*
Indian Cobra	*Naja naja*
Rat Snake	*Ptyas mucosus*
Cheakered Keelback	*Natrix piscator*
Indian Chameleon	*Champacuon zeylanicus*
Garden Lizard	*Calotes versicolor*
Flap shell Turtle	*Lissemus punctatea*
Common Skink	*Mubuya carinata*

Table 7.2.19 Checklist of Birds Recorded along Proposed Corridor in Gulistanpur

Common Name	Status
Black drongo	Resident Breeding
Black winged stilt	Resident Breeding
Blue rock pigeon	Resident Breeding
Cattle egret	Resident Breeding
Citrine Wagtail	Migratory
Common hawk cuckoo	Migratory
Common Kingfisher	Resident Breeding
Common myna	Resident Breeding
Common Redshank	Migratory
Common sandpiper	Migratory
Common tailor bird	Resident Breeding
Common Woodshrike	Resident Breeding
Coppersmith Barbet	Resident Breeding
Desert Wheatear	Migratory
Eurasian collared dove	Resident Breeding
Great egret	Resident Breeding
Green bee eater	Resident Breeding
Green sandpiper	Migratory
Grey Wagtail	Migratory
House crow	Resident Breeding

Common Name	Status
House sparrow	Resident Breeding
Indian pond heron	Resident Breeding
Indian robin	Resident Breeding
Laughing dove	Resident Breeding
Little cormorant	Resident Breeding
Little egret	Resident Breeding
Little grebe	Resident Breeding
Oriental magpie robin	Resident Breeding
Orphean Warbler	Migratory
Plain prinia	Migratory
Purple sunbird	Resident Breeding
Red Collared Dove	Resident Breeding
Red vented bulbul	Resident Breeding
Red wattled lapwing	Resident Breeding
Rose ringed parakeet	Resident Breeding
Rufous treepie	Resident Breeding
Spotted owlet	Resident Breeding
Variable Wheatear	Migratory
White throated kingfisher	Resident Breeding
White-eared Bulbul	Resident Breeding
Wire tailed swallow	Resident Breeding
Yellow Wagtail	Migratory
Yellow wattled lapwing	Resident Breeding

Table 7.2.20 Mammalian Diversity Recorded in Gulistanpur along the Proposed Corridor

Name	Scientific name	Local status	Conservation status[4]
Blue bull	*Boselaphus tragocamelus*	Abundant	Sch III
Rhesus Macaque	*Presbytis entellus*	Common	Sch II
Fruit Bat	*Cyanopterus sphynx*	Common	Sch IV
House rat	*Rattus rattus*	Common	unscheduled
Indian hare	*Lepus capensis*	Common	Sch IV
Jackal	*Canis aureus*	Common	Sch II
Palm squirrel	*Funambulus pennanti*	Common	Sch IV

4) Interview Results

Interviews with experts in the field of forestry and biodiversity and villagers were conducted in order to triangulate and verify survey findings as well as provide additional information on the biodiversity status and occurrence of particular species of fauna and flora in the proposed corridor area. Key comments and opinions from these interviews are reflected in Table 7.2.21.

Table 7.2.21 Key Expert Opinions on Fauna status for the Phase 2 of the Western Corridor

Name and Designation	Important Fauna
Shri N.A Sheikh, DY.Conservator of Forest (Retd.) Bharuch	**Mammal**: Bluebull, Hare(Sasla), Jackal, Wild cat (Rani biladi) **Bird**: Bagla, Crow, Parrot, Samdi (kite), Kabar, Sparrow, Peacock
Shri B.J.Solanki, Range Forest officer, Kamerej SF Range, Kamerej	**Mammal**: Panther, Indian here, Fox, Jackal, Jungle cat **Reptiles**: Snakes (Cobra, Viper, Krait, Python) **Birds**: Flamingo, Saras, Ibis, Wagtail, cranes, Copts, Cormorant,

[4] No person shall hunt any wild animal specified in Schedules I, II, III and IV (Wildlife Protection Act,1972) Captive animal" means any animal, specified in Schedule I, Schedule II, Schedule II or Schedule IV, which is captured, kept, or bred in captivity.

Name and Designation	Important Fauna
	Bhrami duck
Shri N.D. Patel Dy.Conservator of Forests, SF Navasari Division	**Mammal**: Panther, Hyena, Indian Here, Fox, Jackal, Jungle Cat **Reptile**: Snakes (Cobra, Viper, Krait, Python) **Birds**: Cranes Flamingo, Saras, Ibis, Wegtail, **Endangered fauna:** Toddy Cat
V.C.Sharma Asstt.Conservator of Forests Flying Squad Panipech Jhotwara Rd, Jaipur	**Mammal:** Neelgai, Hare, ,Porcupine, five stripped squirrel, jackal, rat spotted **Birds**: pigeon, Myna, parakeet babbler, bulbul, blackdrango, egrets, munias, partridges, quail, weaver bird, woodpeckers
Madhusan Tiwari, IFS, Director Cum Dy.Secretary to the Govt. of Rajasthan,	**Mammal:** Neelgai, Hare, spotted, five stripped squirrel, jackal, **Birds:** Pigeon, Myna, parakeet, heron, bulbul, blackdrango, egrets, munias, partridges, quail, weaver bird, woodpeckers
Shakti Mohan Singh , R.F.S , Ex. Dy Conservator of Forests and Director Forestry Training Institute, JLN Marg, Jaipur	**Mammal:** Neelgai, Hare, five stripped squirrel,jackal, **Birds:** Myna, parakeet, heron, porcupine, Blackdrango, egrets, munia, partridges, quail, weaver
Dr Asad R Rahmani, Director, Bombay Natural History Society, Mumbai	**Mammal:** Porcupine jackal panther **Birds:** Quail, Partridge, kite vulture owl **Endangered**: Leopard, Black buck, WPA-Sch1-Cobra,Python, monitoring lizard
Mr PN Munde, Director, SGNP, Borivalli	**Mammal**: Leopard Chital, Jackal, Panther Hynae, Jungle cat **Bird**: Kite ,vulture, owl **Snakes**: viper, cobra, python
Dr Dilip Gujjar, DCF ,WL, Thane	**Mammal**: Neelgai, Hare, Squirrel Jackal Black buck, Leopard
Mr Ashok Kumar,Forest Range Officer, Gautam Buddha Nagar	**Mammal:** Rabbit, wild boar, blue bull, jackal, **Bird:** Myna, black partridge, bater, wood pecker, crow
Mr Suneel Pandey, IFS, Chief Conservator of Forest, Meerut	**Mammal:** Rabbit, wild boar, blue bull, jackal, **Bird:** Myna, black partridge, Bater, wood pecker, crow
Mr R.G. Soni, Retd PCCF, IFS Avifauna Expert Rajasthan	**Birds:** Jungle babbler, bulbul, black drango, egrets, munias, partridges, quail, weaver bird, woodpeckers are found in entire Rewari-dadri stretch of DFC. **Threatened bird species**: 1. Greater spotted eagle, 2. Red-headed vulture, 3. Cinereus vulture, 4. Longbilled vulture, 5. White-rumped vulture, 6. Pallid harrier, 7. Red-headed falcon, 8. White-bellied minivet, 9. Stoliczka's bushchat, 10. White-naped tit, 11. Green avadavat Out of above birds, Vultures have more chances of being found near the rail tracks, that too on dead animals. Other birds Sr 8 to 10 may occur within the corridor if it passes through fairly good and large forest area. Sr 1. 3, 6 and 7 may only occasionally be available in corridor.
Mr M.S. Mallik, DCF, Gurgaon	**Mammal**: Jackal. Neelgai, **Bird:** Pigeon, Baya, owl, Dove, parrot, woodpecker
Mr KC Meena, Conservator of Forest, Gurgaon	**Mammal**: Jackal. Neelgai, **Bird:** Pigeon, Baya, owl, Dove, parrot, woodpecker
Dr Dilip Jadeja, Agriculture University, Navsari	**Mammal:** Squirrel, Hare, Jackal, Fox **Bird:** Pigeon, Kite, owl, Woodpecker, Myna Egret partridge, quail, parakeet flamingos **Endangered fauna**: Leopard, Black buck WPA-Sch1-Python
Mr GK Anarse, DCF,Vig. Thane	**Mammal:** Leopard, Barking deer, Jackal, Hare, Squirrel **Bird: Pigeon,** Kite Vulture, Owl, Egret, Cranes Parakeet, Flamingos, Pelican **WPA,1972-Schedule:** Blackbuck, Leopard, Hynae, Python
Mr Satyajit Gujjar, DCF Planning CCF Office, Thane	**Mammal:** Leopard, Barking deer, Jackal, Hare, Squirrel **Bird: Pigeon,** Kite Vulture, Owl, Egret, Cranes Parakeet, Flamingos, Pelican **WPA,1972-Schedule:** Blackbuck, Leopard, Hynae, Python

Source: JICA survey team

(3) Impact Assessment

1) Impacts

- Disturbance of occasional animal movement: During the field survey, movements of some mammal species were confirmed in the forest areas even near the existing railway. This may mean that animals may be hit by passing trains. Adequate measures should be considered to separate fauna from the railway by fencing and the construction of a 783 m underpass in the national park.
- Habitat loss in Raigad mangrove area is expected. Similarly, mangrove vegetation near the Ulhas River and Vaitarna bridge construction sites, Pade and Kasarali Villages in Thane district are also expected to be impacted during the construction phase.
- Minor losses in forest villages of Thane, as the majority of the area does not have dense vegetation.
- At the Gulistanpur Reserve Forest, the proposed corridor passes through the middle of the entire forest area and is likely to affect animal movement in the forest land requiring adequate separation and passage to avoid traffic accidents at the operation.

2) Mitigation Measures

- Fencing and development of safe passages for wildlife and local residents.
- Detailed study of the protected area (SGNP) to ascertain the future development aspects only, so that plans can be prepared in a timely fashion to avoid habitat loss and minimise stress.
- The proposed corridor is likely to affect the Gulishtanpur Reserved Forest areas the alignment route bisects the forest area. Therefore, immediate action should be taken to compensate by new plantation in the open scrub area adjacent to the reserve so that loss of habitat can be minimized.

3) Key Expert Opinions on Impact and Mitigation measure

The Experts who belong to forestry and biodiversity authorities provided comments on the possible impact of the proposed corridor on the forests and biodiversity and possible mitigation measures. Their opinion of expected impact due to DFC and proposed mitigation measures are shown in Table 7.2.13.

7.2.3 Supplemental (Monsoon) Survey

(1) Flora

Flora survey was carried out by adopting nested quadrat method using the same methodology as in the previous two seasons surveys. In this supplemental survey, a total of 183 quadrats for trees, 366 quadrats for shrubs and 732 quadrats for herbs were laid. The main reasons for laying large number of quadrats were to overcome degradedness and non-uniformity in all forest areas. At all sites, there are different types of temporary habitats such as seasonal ponds, plantations, thickets formed due to recent cutting, degraded mangroves. Even herbaceous species are scattered and required to have adequate number of quadrats. All vegetation data has been analysed using same indices for floral diversity as in the previous surveys. Detailed results for all forest patches including site photographs in both Thane and G. B. Nagar Districts are given in Appendix - 7d, while the overall conclusion of the supplemental survey is mentioned below:

1) Thane District

- No RET species has been recorded in the area except *Erinocarpus nimonii* (an endemic deciduous tree), which however is common in Thane district and in North Western Ghats.
- All sites are of least importance and least concerned and do not have forest like habitat.
- The vegetation in both sections of Thane District is highly degraded and the tree cover has been observed only at areas where plantation of species such as Teak has been carried out by the Forest Department in the past.
- Forest area in Bordee, Chikhale, Boisar, Kaseb Mahim and some parts of Kelve Road are either totally devoid or have only a few tree species. All such areas are open grasslands or waste lands used by local communities for grazing.
- The area is largely under the human interference since Mumbai suburban area is growing and expanding rapidly and hardly any original vegetation type could be observed.
- Most of the vegetation observed in monsoon season is that of the common herbs and grasses that are grown on degraded areas. Such degraded areas cannot provide habitat to floral diversity. As a result, only secondary vegetation provides some habitat.
- Though these are recorded forest areas, there is hardly any protection given to the areas.
- There are only two areas near the creek where mangrove vegetation has been observed i.e. Kasarali and part of Kelve road. These are completely degraded with only three mangrove species recorded. These mangroves are degraded due to pressure of fuel wood collection from the local people.
- Urbanization in the area has further reduced the scope to have any good vegetation or forest. The main land use of such recorded forest areas appears to be for urban expansion and grazing of cattle.
- Most vegetation species observed and recorded in the area can be easily seen and are available elsewhere in Thane district and Maharashtra in better sheltered and protected forest areas.

2) G. B. Nagar District

- Gulistanpur Reserved Forest is an isolated mixed plantation tree habitat with grasses and is surrounded by industrial area and urban development from all sides. The grasses are distributed in dense patches intermixed with other herbaceous and shrub species.
- Plantation of species such as *Prosopis, Azadirachta indica, Dalbergi sissoo, Pongamia pinnata, Tamarindus indica, Syzygium cumini* are wide spread in the core area.
- The existing avifauna, herpatofauna and minor herbivores cannot increase and establish connectivity with any other nearby good patch of forests or protected area.
- It is a considerably large area sustaining good moisture and favorable habitat for herpatofauna, avifauna, and minor herbivore species.

(2) Fauna

Fauna survey was carried out by adopting linear trekking survey method using the same methodology as in the previous two seasons surveys. In both sections of Thane District, 28 bird species which are common and protected under Indian Wildlife Protection Act 1972 (IWPA 1972) and also least concern as per IUCN 2011 bird list, 2 amphibian species (common), 2 reptile species (very common) and 2 mammalian species protected under IWPA 1972 and least concern as per IUCN 2011 were identified and recorded individually. In Gulistanpur Reserved Forest area of G. B. Nagar, 20 bird species which are common spread, 3 mammal species and one reptile species protected under IWPA 1972 were

identified and recorded. Only one mammal species i.e. Sambar is vulnerable as per IUCN status and also protected under IWPA 1972 but it is very difficult to say that there is any permanent population of Sambar in the area. Detailed results for all forest patches including site photographs in both Thane and G. B. Nagar Districts are given in Appendix – 7e, while the overall conclusion of the supplemental survey is mentioned below:

1) Thane District

- All forest areas are human dominated landscape with little or no scope for any wildlife.
- No IUCN red list or RET species recorded or any sign observed in the area.
- Most of the species are protected under Indian Wildlife Protection Act 1972(IWPA 1972) and also least concern as per IUCN 2011 bird list.
- Only common birds recorded in and around most of the sites and some of them have already adopted to live near human habitations such as Bulbul, Spotted Dove, and Mynas. No forest birds have been observed.
- Such degraded areas cannot provide habitat to faunal diversity. Urbanization in the area has further reduced the scope to have suitable habitat for wild life.
- Though these are recorded forest areas, there is hardly any protection given to the areas.
- Most faunal species observed and recorded in the area can be easily seen and are available elsewhere in Thane district and Maharashtra in better sheltered and protected forest areas.

2) G. B. Nagar District

- Since this is a small isolated forest patch surrounded by various industries and warehouses, no RET species or IUCN red list species could be observed or found. Only one vulnerable species of mammal was observed but it is difficult to confirm its permanent population in the area.
- Most of the species are protected under Indian Wildlife Protection Act 1972(IWPA 1972) and also least concern as per IUCN 2011 bird list.
- Only common birds recoded in and around most of the sites and some of them have already adopted to live in urban conditions such as Bulbul, Myna, Black Drongo, Babler. No forest birds have been observed.

7.3 Eco-sensitive Areas

7.3.1 Background

Two Eco-sensitive areas, Dahanu Taluka Eco-sensitive area and Aravalli Eco- sensitive area are located on the DFC alignment in the Phase 2 Section. A specific survey was required to assess these areas due to their ecological sensitivity as well as the fact that the construction of tunnels under/through the areas has been proposed in the design.

Dahanu Taluka is a coastal city and a municipal council in Thane District on the western coast of Maharashtra State, located approximately 120 km north of Mumbai. Topographically, Dahanu Taluka can be divided into a 10-12 km wide strip of land comprising 1) bandarpatti i.e a coastal belt of lowlands and flats extending from the coast to foot of the Sahyadari Range (Western Ghats), and 2) junglepatti, the forest belt, to the east of the foothills consists of tropical deciduous forests. A 990 km^2 area of the taluka was classified as an ecological sensitive area in June, 1991. The forest cover in Dahanu is still fairly high at 45%. The Dahanu Taluka Environmental Protection Authority (DTEPA) is responsible for natural resource management, monitoring and protection of the area and permission must be obtained from this agency prior to any development activities.

The Aravalli Eco-sensitive Area forms part of and is located within the Aravalli range which is located in in western India running approximately 800 km from the northeast to southwest between Delhi and Gujarat, the area includes reserved forests, protected forests, as well as other uncultivable forest areas, barren lands and grazing lands in the Gurgaon District of Haryana and Alwar District of Rajasthan. The area was classified as being Ecologically Sensitive in May 1992 and permission for development must be obtained.

Table 7.3.1 below summarises some of the key legislative requirements for development activities in these two eco-sensitive areas.

Table 7.3.1 Summary of Information on the Eco-sensitive Areas Declared as per 3.2.v. of EPA 1986 in Phase 2 Alignment

Area/date of notification	Dahanu Taluka (M) 20.6.91& 24.2.99	Aravalli (H&R), 7 May 1992
Coverage of area	Dahanu Taluka, Thane District (The area of Dahanu Taluka: 990 km^2)	Gurgaon(H), Alwar(R) districts. All Reserve Forests, Protected Forests, other forests, barren and grazing lands, also areas (community lands) covered by the Punjab Land Preservation Act
Restrictions	The Guidelines classify industries into three categories ie Green, Orange and Red for granting/refusing permission. Green (non-polluting) category can be cleared by the State agencies. Orange category (low level of pollution), with Environment Assessment and Pollution Control measures, and below an outlay of Rs 30 million can be approved by the State Environment Department and PCB; above Rs 30 million to be approved by MoEF. *Red category (polluting) - not permitted.* Decisions on the categorisation of an industry, in the event of uncertainty, to be made by the State government for projects within Rs 30 million, and by MoEF for above this amount. State government to produce a Master Plan/Regional Plan for Dahanu Taluka, where only 500 acres will be allowed for industrial areas. Apparently the draft master plan has not been finally approved.	No location/modernisation of new industries, all mining including renewal of leases, No cutting of trees, construction of clusters of dwelling units of any kind, including the construction of roads related thereto, laying new electrical transmission lines, etc Mining ban imposed by the Supreme Court in 448 km^2 area of Faridabad and Gurgaon districts in May 2009
Application requirements	To have Environmental Assessment and mitigation plan (including compensatory pre-afforestation)	Environmental Impact Statement and an Environmental Management Plan. Application form annexed to the notification.
Regulatory authority	Dahanu Taluka Environmental Protection Authority, and thereafter the State Dept of Envt/PCB and MoEF	Expert and Monitoring Committee and the MoEF
Remarks	The notification was issued following the intervention of the Supreme Court, there is a lot of public concern for the local environment. Initial Alignment Review Report says that the Dahanu swampy area may be avoided due to structural problems.	The notification was issued following Supreme Court direction.
DFC alignment	The DFC alignment is passing through the area with the detour alignment avoiding residential areas on the east side of the existing railway. Alignment is located approximately 3 km east from the existing Dahanu Road Railway Station. The detour	The alignment crosses a part of the area of the Aravalli range, which is notified as ecological sensitive area which mainly consists of alluvial plain partly interrupted by sand dunes and quartzite ridges, rocky outcrop. The alignment avoids forest

Area/date of notification	Dahanu Taluka (M) 20.6.91& 24.2.99	Aravalli (H&R), 7 May 1992
	route diverts from approx. 5.5 km south (Mumbai direction) and also 3.5 km north (Delhi direction) from the existing railway station. The swamp area is located at the part between southern diverting point of detour and the existing Vangaon Station at parallel section and the area where the detour alignment is passes a tributary of Dahanu Creeck.	areas.

Source: Meenakshi Kapoor, Kanchi Kohli and Manju Menon (2009), India's Notified Ecologically Sensitive Areas (ESAs), Kalpavriksh, Delhi

7.3.2 Dahanu Taluka Eco-sensitive Area

(1) Study Area

The study area was located in Vasai Taluka of Thane District in Maharashtra State. The area under study and the stretch for the proposed tunnel is shown in Figure 7.3.1. The length of the tunnel is 540 m.

(2) Existing Natural Conditions

1) Geomorphology of the Area

The geomorphological characteristics of the study area are that it is a plateau region. A Survey of India topographic map at 1:50,000-scale was combined with a remote sensing satellite image and is shown in Figure 7.3.2.

2) Hydrology and Drainage

The area is can be described as being an elevated plain occasionally traversed with dissected plateaus. Due to slope variations the area is well drained. From the drainage map of the study area it may be observed that at several places the corridor crosses drainage channels and hence adequate measures need to be taken to preserve the natural drainage.

3) Geology and Hydrogeology

In Geological terms the area's bedrock is comprised of alluvium and Deccan basalt inter-bedded with pyroclastic material. The area is characterized by flat alluvium terrain interspersed with flat topped hills of basalts forming a chain of plateaus. The area is also structurally disturbed and seismically active. The Geological succession is as follows at the Tunnel site:

Table 7.3.2 Monthly Rainfall Data of Thane District (2006-2010)

Layer	Type	Thickness	Property
I Top layer	Weathered Limonite Formation	150 – 200 mm	Mixed with Dust
II Layer	Weathered Laterites with Nodular formation	1000 – 1500 mm	Lateritic Iron
III Layer	Andesites Basalt as bottom Layer	1500 mm onward	Ferromagsium + Silica

Basalts and alluvium constitute the two major aquifers in the area. Each basaltic flow

consists of two distinct units i.e. lower massive unit and an upper vesicular unit. The lower massive layer is generally devoid of primary porosity and interconnected pores and hence the water bearing and transmitting properties of these formations are limited to negligible. However, the fractured and jointed portions in the massive zone and presence of vesicles act as a moderate to good aquifer. The degree of weathering and topographic setting plays an important role in determining the occurrence and distribution of ground water. The top weathered zone however, acts as a fairly good aquifer. The alluvium comprises detritus material, sand, gravel and clay and its admixtures form the major aquifer system in the area.

The groundwater regime condition in the area has been studied through a compilation of water level data collected from various organizations including CGWB. From the depth to water level map for the pre-monsoon period, it may be observed that, in general the ground water level in the area remains within 10 m bgl. The majority of the area falls within the water level of 5 m bgl. The area around Vasai in which the tunnel has been proposed lies within the range of 5 to 10 m bgl.

Groundwater quality has been assessed based on an examination of data compiled on its chemical constituents. The electrical conductivity is the basic parameter which indicates the overall quality of groundwater for various uses. Electrical conductivity in the entire study area is within the permissible limit of 1500 micro mhos/cm. In the tunnel area, the conductivity values lies in the range of 750 to 1500 micro mhos/cm.

4) Hydrological Conditions near the Tunnel Area

The topographic maps and information from the field study indicates that for the area near the tunnel due to the existing slope conditions a sizable quantity of water will flow along the slope and across the proposed DFC route. Specifically, if one delineates the micro watershed / catchment near the proposed tunnel, the total area of the watershed / catchment is approximately 1.61 km².

Rainfall in the area varies spatially as well as over time. The monthly rainfall of Thane District for the period 2006-2010 is given in table below. Assuming the total average rainfall is 3000 mm in the area, and taking a coefficient of runoff as 25%, the runoff for the catchment is calculated to be about 1207 TCM from the delineated area, hence this amount of water will flow through the valley region near tunnel and hence there is a need to take necessary measures for allowing the water to pass downstream.

Furthermore, it is understood that filling (embankment) is proposed in the stretch over which the railway line will be laid down. It is expected that this will reduce the water availability on the down slope side i.e. to the west of the railway line due to obstruction of drainage and hence it is suggested that a viaduct (an elevated rail line) would solve the problem of seepage as well as offering stability to the railway line.

Table 7.3.3 Monthly Rainfall Data of Thane District (2006-2010)

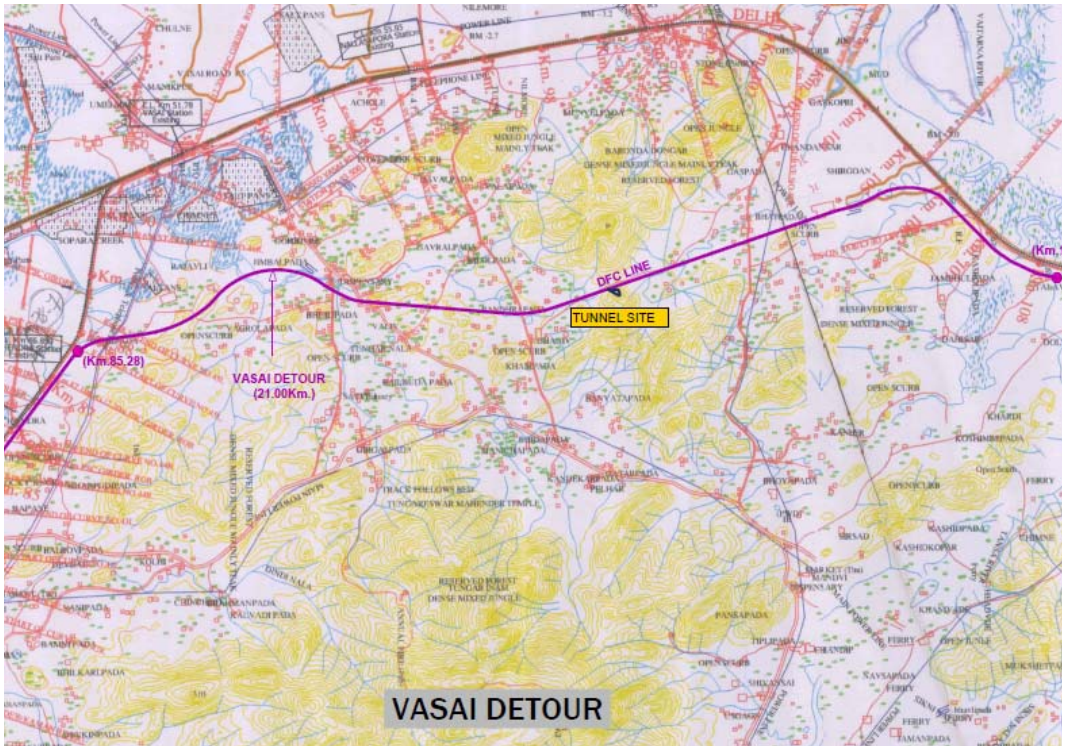
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2006	0.0	0.0	0.3	0.0	32.8	489.7	1153.7	1073.1	284.0	105.7	0.0	0.0
2007	0.0	0.0	0.0	0.0	0.0	512.5	723.7	957.4	401.0	0.0	0.1	0.0
2008	0.0	0.0	0.0	0.0	0.0	528.0	925.1	846.5	443.9	37.7	0.1	0.1
2009	0.0	0.0	0.0	0.0	0.0	131.1	1290.5	176.2	203.2	189.2	62.9	0.0
2010	0.0	0.0	1.4	0.0	0.0	380.4	1007.2	851.1	426.1	94.3	80.2	0..0

Source: Indian Meteorological Department (IMD)

(3) Field Survey Observations

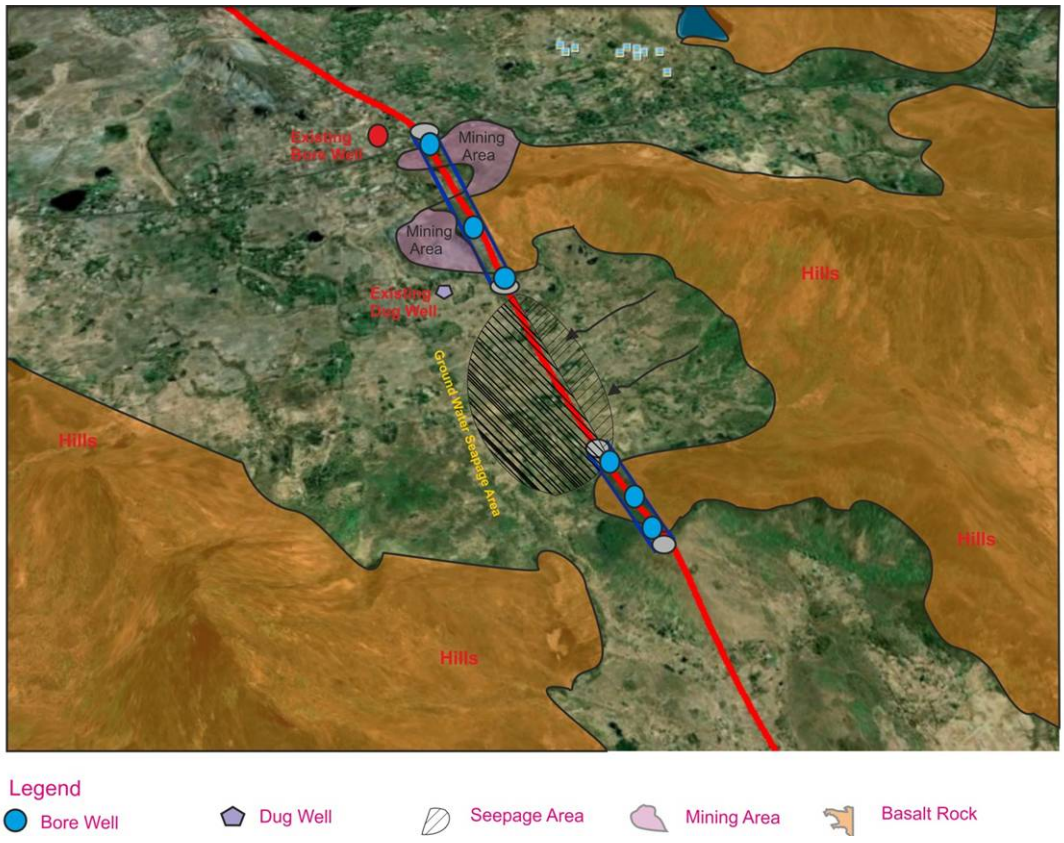
The bedrock around Belapur (19º 26' 17''.5N; 72º 51' 27''E) and Dhaniv (19º 26' 40''N; 72º51'21''E) villages were observed to occur at shallow depths below a soil cover of 2 to 5 m. The ground water level which rests at 2 to 2.5 m below ground level is a perched water table with the main ground water level found in the underlying basaltic rock formation occurs at a greater depth. Water is contained in a narrow band of overburden soil cover formed from hill wash deposit. The soil cover at the tunnel portal face on southern side is lateralised red clay. The hill area on the other hand is comprised of basaltic rock formations and the valley floor is covered with residual soils underlain with basalt rocks. Between the southern face of the tunnel up to Dhaniv Village several spring seepages in the valley floor exist at the intersection between the valley fill deposit and the underlying basalt. The inhabitants of the area use this seepage out-flow for their domestic use. The water is scooped through small holes of 3 to 4 m diameter which extend to about 3 to 4 m depths. The seepage is a shallow ground water flow which enters the rail alignment from eastern part of the watershed.

The intervening area between the closed tunnel and open cut sites is a valley floor area. The low ground area through which the proposed rail alignment is to pass through is also occupied with seepage out-flow of shallow ground water that exists at the contact of thin overlying soil mantle and the underlying basal rocks. The low lying valley floor area between the two sites is mixed lateralised clays and eroded soil deposit washed down the hill slopes.



Source: Index Plan (Prepared by Ministry of Railways)

Figure 7.3.1 Micro Watershed / Catchment Area around the Proposed Tunnel



Source: Based on Reconnaissance Survey

Figure 7.3.2 Schematic Diagram of the Tunnel Section and Location of Exploratory Bore Wells

(4) Summary Observation and Impact Matrix

Table 7.3.4 Summary Observation and Impact Matrix

No	Issues	Observations	Significance of Impact
1	Topography & Drainage	DFC alignment shall pass through a valley surrounded by denudational hills. One closed tunnel of length 540 m and the other open cut have been proposed to cross over two nearby hills. The valley represents the trough of the undulating ridge topography and also acts as a groundwater recharge area. It is expected that natural drainage conditions will be altered during construction phase as well as due to filling (embankments) proposed for elevating the rail line between the hills which in turn may reduce groundwater recharge and obstruct down slope water availability i.e. to the west of the rail line. Therefore, appropriate mitigation measures are required to overcome anticipated impacts on the local natural drainage conditions.	High
2	Geology & Geological hazard	The rock formations in hills are comprised of basalts and in the valley portion, alluvial deposits. Occasionally the basalts are intruded by dykes. Structurally the area is an active tectonic zone and several moderate to high intensity earthquakes have been reported from the area. Though, in the area no major faults or shears zones are reported, the seismic activities are indicative of weak zones and require consideration. The possibility of weak zones such as faults, joints, and shear zones could increase the potential for rock-joint rupture hazards during deep cutting and rock excavation work. Also, the Geological succession of the area along with the topography indicates that the hill is fit for underground tunnel as at least 25 m overburden height is needed for closed loop to provide Arch section of the tunnel.	Medium
3	Hydrogeology	The intervening area between the two hill sites is a valley floor area. The low ground area through which the proposed rail alignment is to pass through is also occupied with seepage out-flows of shallow groundwater that exists at the intersection of thin overlying soil mantle and the underlying basal rocks. The low lying valley floor area between two hill sites is mixed lateralised clay and eroded soil deposit washed down the hill slopes. The inhabitants of the area use this seepage out-flow for their domestic use. The water is scooped through small holes of 3 to 4 m diameter which extend to about 3 to 4 m depths. The seepage is a shallow ground water flow which enters the rail alignment from the eastern part of the watershed. Test exploratory wells may be drilled.	Medium to High
4	Ground Water Conditions	The bedrock around Belapur (19º 26’ 17’’.5N; 72º 51’ 27’’E) and Dhaniv (19º 26’ 40’’N; 72º 51’21’’E) Villages occurs at shallow depths below a soil cover of 2 to 5 m. The groundwater level which rests at 2 to 2.5 m below ground level is a perched water table and the main ground water level in the underlying basaltic rock formation occurs at a greater depth. The excavation work for the rail corridor may result in changed groundwater conditions in the area and may affect groundwater flow. This could affect drinking water sources (open wells, dug wells, hand pumps etc.) in the area.	Low to moderate depending on the results of Site based Permeability tests at identified locations
5	Ground Water Regime	The deep cutting and excavation work may affect the groundwater levels mainly during the construction activities. Some of the existing open wells and borewells in and around the hill area can be identified and used for groundwater level and groundwater quality monitoring. Additional piezometers or observation wells are required to better understand the baseline groundwater levels.	Medium to High

(5) Conclusions and Recommendations

1) Geologically, it is considered possible to construct a railway tunnel in hill sub-surface environment at the proposed site. The understanding of sub-surface ground water situation in vertical direction and its engineering behavior would, however, need exploratory drilling, borehole geophysical logging and geotechnical testing operations to determine the rock strength, rock deformation modulus, in-situ rock stresses, bed rock permeability and internal pressure conditions. The pattern of ground water flow, which is expected to be controlled by secondary rock fractures and joints in the tunnelling area as well as the areas between the two hills, needs detailed study.

2) In the absence of detailed subsurface geological and hydro-geological information at local levels in and around the tunnel section, three boreholes for each hill are recommended to be drilled. Out of three, one on the designated ridge areas and the other two at in-let and outlet tunnel portal points to obtain subsurface geological and hydro-geological information. Tests such as in situ permeability testing should be conducted using these wells and data collected on the variability of rock units and rock permeability along the alignment. A test borehole of 150 m depth should be drilled on the ridge section to obtain the necessary data. The depth of exploratory bores at entry and exit portals shall be of 100 m depth.

3) Depending upon the depth of drilling at portal points, it is recommended to monitor and map the groundwater table of basalt aquifers through proposed bore tests. The groundwater table in basalt aquifer is expected to occur below the tunnel depth however there are chances of seepage in the tunnel during rainy season due to rises in the groundwater levels in the study area. Where there is tunnelling below the groundwater table, it would need to be drained or sealed as appropriate.

4) The area between the two hills for closed tunnel and open cut is the major ground water flow zone recharging from the catchment and feeds the downstream wells. It is recommended that the corridor between the two hills should be elevated so that the existing groundwater flow would not be altered. Alteration of the same may result into reduction of discharge of the wells downstream of the tunnel section.

5) Ground water levels may be monitored on a monthly basis for which stand-pipe bores are recommended to be drilled in valley-fill areas and piezometer bores on ridges and portal areas.

6) The water samples from monitoring boreholes should be collected and analyzed in the first year and prior to the construction phase and at least once in the post-construction phase from installed standpipes and piezometers. The standpipe in the valley-fill area should be monitored for water quality for at least two years after the project completion phase and tunnelling. The water quality data should be analyzed for pH and TDS levels of water in the well bores.

The above mentioned studies shall be taken up by DFCCIL through suitable experts / institutes during the detailed engineering stage, pre-construction stage, construction stage and post construction stage.

7.3.3 Aravalli Eco-sensitive Area

(1) Study Area Location

The project area is physiologically complex being comprised of plain areas occasionally traversed by low flat hills and ridges. In view of the objectives of the project, and based on the reconnaissance survey carried out, the entire study area has been studied and two sub-areas / blocks have been identified. Accordingly, the preliminary investigative study has been carried out in these sub-areas. Sub-area 1 represents the central part of the corridor stretch between Bhiwadi in Alwar and Sohna in Gurgaon. Sub-area 2 represents the eastern section of corridor and falls within Faridabad District bounded by Yamuna River in the east.

The Aravalli area under the study consists of highly undulating topography around Sohna area, shown as the central sub-area and it is proposed to build the corridor by deep cutting of hill rocks.

(2) Existing Natural Conditions

1) Topography

The study area covers the entire stretch of the corridor between Rewari to Dadri and is broadly comprised of two distinct geophysical units, viz. i) the Alluvial plain and ii) the area occupied by Quartzite ridges other than the flood plain areas along the major streams such as Yamuna, Hindon and Sahibi and water bodies including oxbow lakes. The alluvial plain which falls mostly in Haryana and Uttar Pradesh is almost flat but interrupted by sand dunes and quartzite ridges. Sand dunes are most prominent in the south-western part of the area falling within Rewari District of Haryana and Alwar District of Rajasthan. The dunes tend to be formed longitudinally in a NE-SW to E-W direction.

2) Drainage

It has been observed that in the middle of the Gurgaon stretch there is a surface water divide owing to the presence of the Aravalli ridge following a N-S trajectory. Streams originating from the western flank of the ridge flow westerly and join the Sahibi River whereas the east flowing streams finally join the Yamuna River on the eastern boundary of study area.

There are two perennial rivers in the area; the Yamuna and Hindon Rivers. Meanwhile the Sahibi river flow is only ephemeral or transient. It flows in a north-east direction towards Rewari. It carries away water from the western slope of the central range of Aravalli hills. The Yamuna forms the boundary between Haryana and Uttar Pradesh and flows in a southerly direction. The Hindon River also flows in a southerly direction.

3) Geology

The rock formations in the area are comprised of Quartzites, Mica schist and pegmatite intrusions. Structurally the area is an active tectonic zone. The area is dissected by a number of faults, fractures and shears, generally following a NNE-SSW to ENE-WSW direction. The Delhi region forms the northern part of the southerly plunging fold known as the Harchandpur anticline. Since the Aravalli rocky hill ridges between Banban Village and Keherani Village in Tijara Block, Alwar District and from Dhulawat Village to Rojka Village in Mewat District is made up of quartzites which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure profile showing major as well as minor

faults passing through the area.

The hill outcrops near Taoru block (Mewat District), Sohna and Tijara Blocks (Alwar District) were examined. The area is traversed by two parallel ridges bordering the N-S trending Sohna Valley named as Sohna and Harchandpur Ridges. Geologically, the hill outcrops include the Alwar and Ajabgarh series of Delhi super group rock formations that run in a N-S and NNE-SSW direction. Three to four sets of joints in rocky exposures are conspicuous by their presence.

The DFC corridor also passes through the Sohna area of the Gurgaon District. The Gurgaon District is comprised of various geomorphological units including those of fluvial origin, Alluvial Plain, Alluvial Plain with Sand cover, Paleao Channel/Abandoned channel, denudational origin Pediment, Pediplians, Intermontane Valley/Basin, Valley Fill, Residual hills, Structural origin Structural Hills and Linear Ridges. The area is characterized by the quartzites which are geo-morphologically distinct denudational hills meeting with the older alluvial deposits abruptly or in many instances a narrow strip of pediplain can also be observed. The older alluvial plain extends further south and westward.

4) Soil

The section of the DFC corridor passing through the Aravalli Range around Alwar and Mewat Districts consists of thin yellow soils while the remaining section in Rewari-Dadri passes through an area of moderately thick alluvial soil. A major part of the corridor in this section passes through the alluvial plains of the Yamuna River and the flood plains of the Yamuna and Hindon Rivers. The major soil type in the area is of alluvial type of recent age except isolated patches of litho sols and rego-soils around the hillocks. The alluvial soils are deep, well-drained, sandy loam to loam in texture and generally non calcareous.

The soils of the Mewat area are generally sandy loam to loam. In parts of the low-lying areas, they are clay-like and saline. The soils are light and derived from the older and new alluvial layers; the older alluvium is dark-coloured and is generally rich in concretions and nodules of impure calcium carbonate known as “Kankar”. The new alluvium is light coloured and poor in calcareous matter. The soils are generally shallow and low in organic matter.

In the vicinity of the Aravalli hills and in the parts of Gurgaon, Mewat, Faridabad and Rewari in the sub-region, soils are frequently distributed by aeolian activity. These arid areas are dominated by shifting sand dunes. Soils are typically sandy, single grain and are alkaline. They are classified as typic torripsamments. The associated sub-dominant soils are coarse-loamy typic camborethids. They belong to inter-dune areas and are deep, well drained, neutral to slightly alkaline, poor in organic carbon content and fertility.

5) Hydrogeology

The hydro-geological conditions are fast changing due to the continuous development of groundwater resources irrespective of recharge rates and aquifer sustainability. The water table is continuously declining and the ingress of brackish/saline aquifers towards fresh aquifers is increasingly disturbing the hydrodynamics of groundwater in the study area as well as in the surrounding areas under NCR. Groundwater occurs in alluvium and weathered / fractured hard rocks. Sand, gravel and silt-kankar constitute potential aquifer zones in alluvium. Shallow aquifer systems in alluvium are generally under unconfined conditions and deeper aquifer systems are under semi-confined/confined conditions. High potential groundwater structures can be installed in these aquifer systems. Weathered/ fractured hard rocks with secondary

porosity constitute poor to moderate potential aquifer zones which can sustain low capacity groundwater structures locally.

In the majority of the study area, the depth of the water table lies between 10 m and 20 m. In the part of the study area falling in Alwar District, Rajasthan, the water table rests between 10 m and 20 m and in some areas, it is deeper than 20 m. Westwards the water level is even deeper up to 40 m bgl. Similar conditions prevail in Rewari adjoining the Alwar.

Throughout most of the area, the shallow ground water is fresh (EC up to 3000 micro siemens/cm at 25 ºC). Areas with brackish quality of water (EC between 3000-6000 micro siemens/cm at 25 ºC) occur in the north western parts of Sonepat District, northern and north western parts of Rohtak District, north-western and south western parts of NCT of Delhi, north-west and northern parts of Gurgaon District, western parts of Rewari District, and south western parts of Faridabad District.

From the perusal of map it may be observed that in the entire stretch of the corridor the electrical conductivity is below 3000 micro siemens, in pockets it is even less than 1500. However, the higher values of conductivity approaching 3000 micro siemens are very vulnerable, since the underlying aquifers in the majority of the study area contain brackish to saline water and hence any overexploitation or uncontrolled withdrawal may lead to mixing of underlying saline water and freshwater in the shallow groundwater layer.

6) Natural hazards

The entire NCR region including the study area falls in the Seismic Zone IV as per the seismic zone map of India. This makes the area vulnerable to moderate to high intensity earthquakes and is considered as a High Risk Zone. Such intensity may cause severe damage to infrastructure such as buildings, roads, rails etc. Although the active fault zone is some distance from the project area, the impact of any seismic activity could potentially be widespread and needs to be addressed in the project. A detailed geotechnical investigation needs to be undertaken and a hazard zone map should be prepared for the entire stretch of the corridor.

(3) Summary Observation and Impact Matrix

A preliminary hydro-geological study was carried out to identify the potential issues and assess the possible impacts of the various construction activities for the proposed DFC project on the groundwater and geological conditions in and around the tunnelling section. The study involved a site reconnaissance survey by the hydrogeology expert, a review of secondary data, and discussions with key stakeholders which resulted in identifying the existing groundwater regime, existing borehole data of drilled wells, the geology of rock formations in the area, topography and morphology of land facets with a view to assessing the characteristics of the hydrogeology and groundwater situation of the region, the hydrogeology of the project site as well as to assess the groundwater flow pattern in the basaltic bed-rock and the overlying colluvial deposit which consist of weathered rock and hill wash material. Further analysis of site conditions and secondary data has helped to assess ground water recharge and discharge pattern in the valley area around the hills and to assess the possible potential impacts on groundwater system in the area due to tunnelling and embankment activities.

Table 7.3.5 Summary Observation and Impact Matrix

No	Issues	Observations	Significance of Impact
1	Topography	The DFC project site near Aravalli area basically lies in valley fill surrounded by denudation hills from almost three sides. The valley fills represent the trough of the typical undulating ridge topography and also acts as ground water recharge area. Natural conditions may be affected due to the construction activities of the DFC project, thereby affecting the recharge conditions in the area.	Low
2	Drainage	It has been observed that in the middle of Gurgaon stretch there is a surface water divide owing to the presence of nearly N-S trending Aravalli ridges. The streams originating from the western flank of the ridge flows westerly and joins Sahibi River and the east flowing streams finally join the Yamuna River forming the eastern boundary of study area. The DFC intersects both perennial and non-perennial drainage systems at several places between Bhiwadi and Sohna. This has the potential to directly affect the drainage conditions of the area.	Medium
3	Slope Stability	The rock formations in the area are comprised of Quartzites, Mica schist and pegmatite intrusions. Structurally the area represents an active tectonic zone. The area is dissected by a number of faults, fractures and shears, tending to run in a NNE-SSW to ENE-WSW direction. Locally the Delhi region forms the northern part of the southerly plunging fold known as Harchandpur anticline. Since the Aravalli rocky hill ridges from Banban Village to Keherani Village in Tijara Block, Alwar District and from Dhulawat Village to Rojka Village in Mewat District is made up of quartzites which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure map showing major as well as minor faults passing through the area. The deep cutting of rocks up to the depth of 28 m and removal of thick overburden will result in unstable conditions such as slippage of rock blocks, exposing weak joints with increased possibility of collapse of slopes during seismic events.	High
3	Geological Hazard	As deciphered from the Seismic-tectonic profile of the NCR Region, it is established that the active seismic faults do not pass through the proposed DFC alignment route. However, the possibility of weak zones such as faults, joints, shear zones could enhance rock-joint rupture hazards resulting from deep cutting and rock excavation work	Medium to High
4	Soil Liquefaction	In the valley region around Aravalli Hills, the area is dominated by shallow ground water levels (< 4 m), which may result in a reduced load bearing capacity of soil.	Low to Moderate
5	Groundwater Conditions	Since groundwater levels in hard rocky areas are more than 40 to 50 m and the deep cutting for DFC is restricted to 30 m, aquifer characteristics will not be affected. However, for ridge areas near Alwar which is dominated by high permeability sand dune areas, the deep excavation work for DFC project may result in changed ground water conditions in the area and may affect the groundwater flow. This has the potential to affect drinking water sources (open wells, dug wells, hand pumps etc.) in the area due to change in the recharge conditions. The deep cutting and excavation work of DFC Project may affect groundwater levels mainly during the construction activities. Some of the existing open wells, borewells in and around the hill area can be identified and used for groundwater levels and groundwater quality monitoring. Additional piezometers or observation wells are required for better understanding the baseline groundwater levels.	Low to moderate depending on the results of Site based Permeability tests at identified locations

No	Issues	Observations	Significance of Impact
6	Hydrogeology and Natural Aquatic System	The Sohna area was observed to include a number of spring and seepages in quartzite and inter-bedded schistose rocks; Sohna hot spring owes its origin to a deep seated intersection of faults. The directions of linear features are conspicuous by their presence. During construction activities, the existing freshwater spring near the DFC alignment route could be affected resulting in a disturbance to the natural set up, flow and discharge of the existing spring. This water spring acts as a source of drinking water as well as having thearupatic and religious values. If this natural spring is affected, this may affect water sources for some downstream villages.	Medium to High
7	Flora and Fauna	There is no forest area in the Aravalli eco-sensitive area. In Mewat district certain vegetation patches are on panchayat land. No forest area falls within the proposed alignment. - Impact on physical characteristics of the area due to erosion. - The impact on soil will be in terms of top soil erosion and its compaction due to location of labour camps, storage and movement of machineries and disposal of waste on the open ground.	

Source: JICA survey team

(4) Conclusions and Recommendations

Based on the studies and survey carried out in Sections 15 and 16 (Rewari-Dadri) of the DFC Project focusing on villages in the Taoru Block of Mewat District and Tijara Block of Alwar District, the following recommendations are provided to be taken up by DFCCIL during different stages of the project viz. detailed engineering, pre-construction, construction and post-construction.

1) Geotechnical and Slope Stability Study

The steep sloping ridges in the Aravalli area are made up of quartzites which are highly jointed and fractured as well as tectonically disturbed. Due to the blocky nature of the joints in quartzite rock formation, the deep rock cutting and removal of a sufficiently thick overburden to maintain the gradient just above the base of the hill area segments may face problems in terms of rock block slips. It is, therefore, recommendable to have a study made of rock slope stability particularly along the ridge facing Sohna-Rojka area as well as the narrow ridge corridor between the KMP Expressway and the extending rocky ridge between Khor-Guspethi village Section. The said study should be taken up by DFCCIL through suitable experts/institutes like Central Building Research Institute (CBRI) Roorkee, CSMRS, and GSI during the detailed engineering design stage.

2) Standard Penetration Test Borings

In the valley region around the Aravalli Hills, waterlogged or shallow groundwater level conditions exist which have a limited heavy load bearing capacity and over a long period time are susceptible to liquefaction. In order to establish the strength of the soil and its capacity to withstand such load-bearing strength prior to any construction activities in the area, detailed geotechnical investigations are required. Standard penetration test borings, laboratory grain size analysis of soil samples to identify liquefaction potential particularly over shallow ground water table areas (areas with a groundwater table within 4 m of land surface) are to be taken up at pre construction stage. It is also proposed that the detailed study for assessment of liquefaction potential should also be taken up by DFCCIL during pre- construction stage.

3) Hydro-geological Investigation and Permeability Tests

Construction activity on the Aravalli ridge would involve rock excavation which may obstruct groundwater flow at various locations as the nature of fractures and joints in rock formations change. It is recommended that a detailed study be taken up for characterization and assessment of groundwater flow in the underlying aquifers. Although Aravalli quartzites are low permeability rock units, it would still be desirable to establish orders and magnitude of permeability values in localized areas. It is further emphasized that permeability tests at selected intervals are essential to establish groundwater recharge rates and their mechanisms as well as changes if any in the post project scenario. These should be carried out by DFCCIL using hydro-geological expert and drillers by constructing test wells during the detailed engineering or pre-construction stages.

4) Safeguard of Ground Water Dependent Ecosystems

The area adjoining Sohna has natural hot water spring seepages. These springs are connected with deep seated fractures and are tectonically linked with geological structures present at the surface and below the ground. The spring water sources in the area are both sources of drinking water as well as possessing therapeutic and religious values. The hot water spring in Sohna Village is away from the proposed alignment but the freshwater spring seepage located north of Khor Village falls along the proposed alignment. Since the DFC alignment crosses KMP Expressway about 0.5 km north of the spring, utmost care will be required to avoid damage while construction, excavations and blasting so as not to disturb the natural setup and obstruct the spring flow and discharge. In view of this, it is proposed to conduct studies with an objective to work out strategies and technical measures to safeguard the discharge of the springs. Such a study should be taken up during the detailed engineering stage by DFCCIL in and around Khor and Sohna Villages.

5) Ground Water Use in the Construction Phase

Almost all the administrative units including Gurgaon, Rewari, Faridabad of Haryana and Tijara Block, Alwar District of Rajasthan falling within the study area are currently already overexploiting groundwater sources overexploited. The proposed corridor would exacerbate groundwater withdrawal and hence there is need to take up micro level studies including sample surveys for the assessment of the data with regard to rate and distribution of groundwater withdrawals for the section through which the corridor has been proposed. It is strongly recommended to undertake detailed studies to establish the geochemical profile of the groundwater in the study area as well as the environmental impact of any further groundwater withdrawal on the overall groundwater regime of the area. Additionally, in order to address the sustainability the existing groundwater sources as well as partly meeting the construction requirements it is recommended that a comprehensive plan for rain water harvesting and artificial recharge to groundwater may be formulated by DFCCIL, wherever groundwater is extracted for construction purposes.

6) Hydrological Studies

The rocky hill unit divides the precipitation falling on the hills which flows down the slope through the piedmont zones and recharge the groundwater aquifers. Any development activities taken up in the foothills or in the piedmont zone may in turn adversely impact the hydrodynamics of groundwater recharge. The development work associated with the project, including construction and landscaping of the area around the proposed line of the corridor would alter the slope which will disturb the natural drainage system of the area.

A detailed hydrological study including morphometric analysis may be taken up in the area at micro- watershed level to plan the diversions and the drainage system, as deemed necessary. There is a need to observe and channelize run-off from excavated areas or the water may be suitably used for recharging the aquifer. The details of the study may be considered at the detailed engineering or pre- construction stage.

7) Groundwater Monitoring

In order to undertake further studies related to groundwater, a minimum requirement is the availability of basic data on hydrogeology, aquifer disposition, hydraulic parameters, groundwater levels and quality in time and space. The data available from various agencies are currently not sufficient and there are several data gaps. In view of this it is recommended that an optimum number of purpose built ground water observation wells are constructed and a baseline dataset may be established for regular monitoring. It is a requirement that groundwater levels are monitored along the proposed alignment in pre-construction and during construction stages. It would be advisable to ensure groundwater level monitoring through the construction period via specially built piezometer wells at designated sites. An optimal monitoring network would continue to monitor impacts on groundwater sources at a specified frequency by the DFCCIL throughout the pre- construction, construction and post-project periods.

8) Flora and Fauna

There is no forest area in the Aravalli eco-sensitive area. In Mewat district certain vegetation patches are on panchayat land. No forest area falls within the proposed alignment.

Tree cutting and vegetation clearing is expected to be an essential part of the construction of the corridor. Therefore, compensatory plantation in nearby areas will be initiated. Planning for the regular watering, nourishing and protection of the planted trees will ensure their effective restoration as part of the compensatory afforestation programme. In addition, an integrated management plan for mangrove areas will be developed.

7.4 Impact Assessment on Other Concerns

The other concerned items of Natural Environment; Topography and geographical features, Soil erosion, Groundwater, Hydrology Situation, Costal Zone and Global warming is implemented through supplemental studies of secondary data and interview surveys.

7.4.1 Topography and geographical features

The detail impact analysis of the item for Eco-sensitive area is shown in Section 7.3.

(1) Impact Analysis

The project has been planned to minimize the impacts on topography by avoiding sensitive topographic features wherever possible such as tunnels, rivers/hills etc. Topography and geographic features will not experience any major impact except in Bhatpada and Dhaniv forest area where tunnel construction has been proposed. In addition, certain impacts resulting from high embankments are expected as a result of the project. Since the alignment runs on a high embankment, there are local community access issues and anticipated storm water drainage problems during the operation phase of the project. These impacts will be minimized by providing adequate ROBs, RUBs, etc.

During construction phase changes in topography are envisaged due to the clearing of land, felling of trees, cutting and filling, and due to construction. Filling and cutting of land will be required in the stretches where the track traverses through undulating topography. However, changes will be limited within RoW of the track hence overall impacts will be localized.

7.4.2 Soil erosion

(1) Impact Analysis

The clearing of land, cutting of trees, excavation of borrow areas are likely to trigger soil erosion. The Movement of vehicles/machinery/equipment and work forces is also likely to cause soil erosion. Borrow areas will be required for the project. Most sections of the DFC are on embankments. The borrow areas are likely to cause soil erosion and affect agricultural areas. Appropriate measures for borrow area management should be taken.

Pits can be formed by borrowing, which may cause harm to local residents in the vicinity. Debris may also be generated due to dismantling of structures. Oil spills from the operation of the diesel pumps and diesel storage, during transportation and transfer, parking places and diesel generator sets may also have potential negative environmental impacts. The operation of the emulsion sprayer and laying of hot mix on service roads could also have negative environmental impacts.

Due to changes in land use, impact is envisaged on soil during the operation phase. However, the impacts are within the RoW.

7.4.3 Groundwater

The detail impact analysis of the item for Eco-sensitive area is shown in Section 7.3.

(1) Impact Analysis

Associated with the tunnel construction at the Vasai Detour, hydrological conditions in the watershed area are likely to be affected with groundwater shifting. In Vasai Detour in Thane district in Section 1, an underground tunnel with a length of 780 m is planned to be constructed at the hill crossing the watershed. The planned railway formation level on the Mumbai side is higher than it is at the Delhi side and as a result groundwater levels are anticipated to be affected. Detailed analysis is shown in Section 7.3

Due to the alteration of groundwater flow, present flow to out-flow from the tunnel after construction, the water quality of groundwater is likely to be affected especially dissolved metal contents such as iron (Fe) in the water.

(2) Mitigation Measures

The formation level in the tunnel section will be considered by DFCCIL to minimize the impact on the hydrological conditions in each watershed resulting from seepage on both sides of the tunnel.

- Hydrological analysis in the area covering at least 500 m from the tunnel is required and will be conducted by DFCCIL prior to the design.

- Correlation between rainfall and groundwater level (water discharge from the area) should be adequately analyzed based on monitoring over a longer period to clearly assess the impact.

- Geological structure investigation through field reconnaissance of surface condition and aerial photo analysis should be conducted prior to implementation.

- Water recharge to the local community should be considered to replace the groundwater used during construction. The water will be adequately treated and of the same or better quality as at present based on the water quality analysis which will be conducted prior to implementation.

7.4.4 Hydrological Situation

The detail impact analysis of the item for Eco-sensitive area is shown in Section 7.3.

(1) Impact Analysis

- Disturbance to water recharge and surface/sub-surface water flows in the watershed (correspond to 1 and 3 in impact matrix) in Vasai detour in Thane district, Maharashtra.

- Embankment construction between two (2) tunnels in the valley-like condition at the undulating topographic feature in the hilly area is likely affect surface water flow and drainage in the area resulting in potential flooding upstream and water shortages downstream.

(2) Mitigation Measures

Adequate drainage systems to allow surface water flow in the watershed upstream of the railway construction area should be considered based on hydrological analysis of the area.

7.4.5 Coastal Zone

(1) Major Findings

In the Coastal Zone, Mangrove forests are mainly found in lowland areas near creeks in the JNPT area. Among the forest area surveyed Pade and Kasarali village forests have mangrove vegetation. Mangrove vegetation was also noted near the Ulhas River and Vaitarna bridge construction sites. These are sensitive habitats and any development activity is likely to have negative impacts. The flora and fauna survey results revealed minor expected impacts on habitat loss in the mangrove area due to the proposed corridor during construction phase. Mangrove vegetation along the alignment will be cleared for the corridor construction. Mangroves protect coastal areas from erosion and storm surge as the mangroves' massive root systems are efficient at dissipating wave energy. And they also play an important role in maintaining ecological balance too (eg. regulating saline gradients, water flow, etc.).

Mangroves have been categorised as forests in Thane district and are likely to follow suit in Raigad. This follows the High Court, Bombay order dated 27.1.10 in Bombay Environment Action group and others versus State of Maharashtra and others directing the state to declare all these areas covered with mangroves in the entire state as forests. Prior permission of the Honourable High Court should be obtained in cases of any construction in mangroves or within a 50 m buffer zone of mangroves, as per the order of the Honourable High Court in WP (Lodg.) No. 3246 /2004, PIL No. 87/2006, and Honourable High Court order 27.1.10 Government of Maharashtra. Forests in Maharashtra and in the

Western Ghats region as a whole predominantly fall into the following categories as per the Champion and Seth [5]classification.

(2) Impacts Assessment

- The DFC Corridor will have a negative impact on the general habitat and erosion in the area.
- During construction phase at bridge construction sites, mangrove clearing will be carried out.
- Forest areas in Pade and Kasarali Villages of Thane were found to possess mangrove vegetation.
- In Raigad District near JNPT and in areas beyond Panvel, mangrove forests are likely to be affected.

(3) Mitigation Measures

- Protection alone is insufficient to reverse the trends in mangrove forest destruction. Even when disturbance is reduced, the altered soil conditions and limited natural dispersal mean that natural recovery can be very slow. More scientific means of restoring the mangrove vegetation need to be implemented.
- Mangrove restoration efforts should be made to return an area to a condition more closely resembling its original state, including restoring the full range of biological diversity and all the essential ecological processes.
- Developing a monitoring programme to measure the success of restoration is important for effective implementation of the restoration programme.

7.4.6 Landscape

The detail impact analyses on Eco-sensitive areas are shown in Section 7.3.

(1) Impact Analysis

The construction of a railway embankment is likely to cause aesthetic changes to the landscape.

(2) Mitigation measure

Suitable landscaping and plantation activities, slope protection activities are envisaged to minimize the aesthetic impacts.

Source: JICA survey team

Figure 7.4.1 Image of DFC Railway Embankment

[5] Champion and Seth classified forest into five major groups based on climatic factors. These major groups have been further divided into 16 type groups based on temperature and moisture content.

7.4.7 Global Warming

(1) Background

India's economic growth has placed considerable pressure on the rail freight transportation network, one of the most affordable modes of transport in the country. It will be difficult for Indian Railways, even under the ambitious growth plan, to achieve the required freight transportation capacity. On the other hand, global endeavour for a low carbon economy has placed emphasis on low carbon infrastructure and public transport systems such as energy efficient railways to streamline their operations in future years. Considering the huge freight traffic movement between the metropolitan areas, Indian Railways is considering whether to introduce the Eastern and Western Dedicated Freight Corridors (DFC).

The implementation of the DFC is expected to generate two major impacts on the freight movement: the shift of freight from road to rail as a low carbon intensive mode of transport and inherent improvement in the energy efficiency of rail transport. The scope of this study primarily consists of two parts:

- Forecasting of the greenhouse gas (GHG) emission trend under the DFC scenario and the No-DFC scenario over a period of 30 years. The trend analysis has been performed in five year bands, with the reference year of each band coinciding with the terminal year of successive five year plans of the Government of India.
- Identification of possible interventions or levers of GHG abatement (over and above the measures proposed for the DFC) and their techno-economic assessment to suggest a low carbon path for DFC's operation.

DFCCIL implemented the study of 'Green House Gas Emission Reduction Analysis for the Dedicated Freight Corridor' (hereinafter referred to as 'the GHG report'), which aimed to forecast GHG emissions for a 30 year period with and without the DFC. The GHG report summary related to the project is outlined below.

(2) Major Findings

1) Analytical Approach

In the report, DFC suggested two scenarios as DFC scenario and No-DFC scenario as follows.

DFC scenario: Implementation and operation of dedicated freight railway and associated infrastructure in Eastern and Western India called the Eastern DFC and Western DFC respectively and catering for 5216 billion tonne-km of freight. While the Eastern DFC will mainly cater for coal, iron & steel and empties, the Western DFC will cater for container, fertilizer and POL. GHG emissions under DFC scenario will include CO^2 emissions due to:

- Electricity consumption in locomotives during freight movement through DFC with axle load 25 T.
- Fossil fuel and electricity usage for the support infrastructure of DFC

No-DFC scenario: The most plausible alternative mode of transport in absence of DFC would be the growth of current transport infrastructure available i.e. primarily freight trains operated by the Indian Railways and freight carrying road transport (i.e. commodity carriage heavy duty trucks).

This is termed as No-DFC scenario. GHG emissions under No-DFC scenario will constitute of CO_2 emissions from:

- Diesel and electricity consumptions in locomotives during freight movement through rail with axle load 22.9 T, catering to the equivalent volume of freight.
- Diesel and electricity consumptions in locomotives during unplanned halting of freight trains due to congestion on rail routes.
- Diesel consumption in heavy duty trucks during freight movement through roads where modal shifts occur from rail to road due to inadequate freight carrying capacity of the railway
- Fossil fuel and electricity usage of the support infrastructure.

2) Methodology

All the freight projections were provided by the IL&FS Report[6] (based on GDP, capacity expansion plans, industrial growth etc). The saturation capacity of each rail section (commodity wise) is estimated and the year of attaining the saturation capacity. Based on the freight projections and saturation capacity/year, the shift to road is estimated for the No-DFC scenario.

The GHG emission quantification, monitoring and reporting was performed following internationally accepted guidelines such as the GHG Accounting Protocol of the World Business Council for Sustainable Development/World Resources Institute and ISO 14064. The boundary for the study has been selected in accordance with the 'Control Approach' as per the guidelines of the GHG Accounting Protocol.

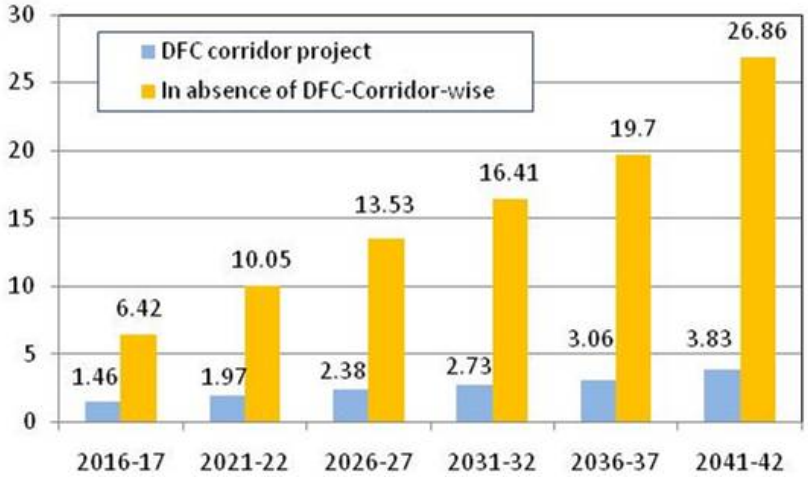
For details on the methodology adopted for the study please refer to the GHG report.

(3) Impact Assessment

1) Major Outcomes of the study on GHG report

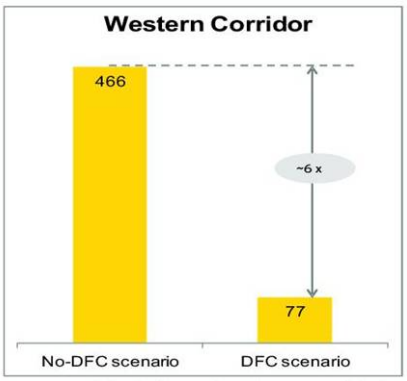
- In 2016-17, GHG emissions under 'No-DFC scenario' would be 8.7 million ton CO_2 while those in case of DFC would be 2.59 million ton CO_2.
- According to the projection, in 2041-42, GHG emissions under 'No-DFC scenario' would have been 33.2 million ton CO_2 while those in case of DFC scenario would be 5.97 million ton CO_2.
- The GHG emission GAP between No-DFC scenario and DFC scenario increases from 6.11 million ton CO_2 in 2016-17 to 27.23 million ton CO_2 in 2041-42 i.e. almost by 4.5 times.
- Cumulative GHG emissions over the 30 year period in the No-DFC scenario would be 582 million ton CO_2 while in the DFC scenario it would be 124.5 million ton CO_2. This demonstrates that without DFC implementation approximately 4.5 times more GHG would be emitted in the 30 year period for freight transportation in the Eastern and Western Corridor.
- In both No-DFC scenario and DFC scenario, the Eastern Corridor produces less GHG emissions than the Western since the latter caters to a higher volume of freight.
- In the Eastern DFC, coal transportation is the highest contributor of GHG emissions followed by transportation of iron & steel. However in the Western DFC, transportation of container and RO-RO are the major contributors of GHG emissions.

[6] IL&FS Final report-"Project Development Consultancy for preparation for Preparation of Business Plan for DFC" August 2009



Note: 'Total' indicates that the emission figures are a summation of Eastern Corridor and Western Corridor
Source: The GHG Report by DFCCIL

Figure 7.4.2 Trend of Projected Annual GHG Emissions due to Freight Transportation in DFC and Absence of DFC-Mode-wise (million ton CO_2)



The graphs illustrate that under 'No-DFC scenario' GHG emissions from rail become almost constant from 2026-27 onwards as the saturation sets in railway sections and more and more freight shifts to road. This leads to increased GHG emissions from road based freight transport since road transport is more GHG-intensive than rail transport. On a cumulative basis (over 30 years), in the Western Corridor, the No-DFC scenario produces 6 times more GHG emissions than the DFC scenario. The right figure indicated Cumulative GHG emissions over 30 years (2016-17 to 2041-42): No-DFC scenario vs. DFC scenario (in million ton CO_2) of Western corridor

GDP values, freight volume and GHG emissions due to freight transportation in the DFC scenario as well as the No-DFC scenario increases almost linearly over the 30 year period. The growth of GHG emissions in the No-DFC scenario show a steeper slope in the second half of the 30 year period due to the fact that almost all rail sections in both corridors become saturated and a modal shift from rail to road takes place. Road transport is a more carbon intensive form of freight transport as compared to the railway system.

2) Outcome of the phase 2 project for global warming on the GHG report

The Phase 2 Section is a part of the Western Corridor. As noted above, the DFC scenario is expected to emit less GHGs than the No-DFC scenario. Cumulative GHG emissions for 30 years (in million ton CO_2) for the Western corridors under the DFC and No-DFC scenarios are presented in the table below. Container and RO-RO are the two major commodities carried by the Western DFC, accounting for about 85% of total freight GHG emissions of this Corridor. Therefore, the phase 2 section plays a significant role in reducing global carbon emissions.

Table 7.4.1 Cumulative GHG Emissions for 30 years (in million ton CO_2)

Contents	Calculated Result
Freight to be transported under DFC scenario	3,241
GHG emissions under No-DFC scenario	465
GHG emissions under DFC scenario	77
GAP of corridor wise GHG emissions between No-DFC scenario and the DFC	388

Source: Prepared by JICA survey team from the GHG report

CHAPTER 8
SOCIAL ENVIRONMENT

CHAPTER 8 SOCIAL ENVIRONMENT

Social impacts are the impacts of developmental interventions on human environment. The impacts of development interventions take different forms. While significant benefits flow in from different development actions, there is also a need to identify and evaluate the negative externalities associated with them. Such impacts not only need to be identified and measured but also need to be managed in such a way that the positive externalities are maximized and the negative externalities are minimized.

Social impact assessment includes the processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment. For large projects where rehabilitation and resettlement is required social consideration becomes most important.

The development projects provide economic benefits and better living environment, but they also affect local people adversely. Social impact assessments help in understanding such impacts. In the phase II of western corridor approximately 374 villages are coming in the alignment. This chapter describes the scale of the land acquisition according to the notification 20E/draft notification 20E and the social status of the affected villages based on the existing socio-economic statistics of Census of India. As for the affected families due to land acquisition and resettlement, it has been currently surveyed in another survey, namely the Baseline Survey and Census, and the results will be separately described in the Baseline Survey and Census and the Rehabilitation and Resettlement Plan (RRP).

8.1 Scope of Land Acquisition and Resettlement

Feature of Land Acquisition: Based on the detailed design of the project corridor, the land acquisition requirement has been assessed through preparation of the Land Plans. As per the Land Plans for 14 districts, the Competent Authority (CA) has been notifying for land acquisition under Railway (Amendment) Act 2008 in the Phase 2 area. Based on the 20E notification or draft 20E (including Joint Measurement List or PAP List) published/to be published under the Act, the land acquisition is required in 374 villages of these 14 districts, which is approximately 2,252 ha, as summarized in the Table 8.1.1.

Table 8.1.1 Scale of Land Acquisition and Resettlement (Provisional)

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
1	1	Mumbai	Maharashtra	Raigad	Mumbai-Uran	***Jaskhar***	0	0
2			Maharashtra	Raigad	Mumbai-Uran	***Sonari***	0	0
3			Maharashtra	Raigad	Mumbai-Uran	***Karal***	0	0
4			Maharashtra	Raigad	Mumbai-Uran	***Pagote***	0	0
5			Maharashtra	Raigad	Mumbai-Uran	***Sawarkhar***	0	0
6			Maharashtra	Raigad	Mumbai-Uran	***Shemtekhar***	0	0
7			Maharashtra	Raigad	Mumbai-Uran	***Jasai***	0	0
8			Maharashtra	Raigad	Mumbai-Uran	***Chirle***	0	0
9			Maharashtra	Raigad	Mumbai-Uran	***Paundkhar***	0	0
10			Maharashtra	Raigad	Mumbai-Uran	***Khatkhar***	0	0
11			Maharashtra	Raigad	Mumbai-Uran	***Bandkhar***	0	0
12			Maharashtra	Raigad	Panvel	***Vahal***	0	0
13			Maharashtra	Raigad	Panvel	***Pandeghar***	0	0

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
14			Maharashtra	Raigad	Panvel	***Bambavi***	0	0
15			Maharashtra	Raigad	Panvel	Kunde Vahal	1	7
16			Maharashtra	Raigad	Panvel	Ovale	6	146
17			Maharashtra	Raigad	Panvel	Dapoli	6	36
18			Maharashtra	Raigad	Panvel	***Pargaon Inam***	0	0
19			Maharashtra	Raigad	Panvel	***Kopar***	0	0
20			Maharashtra	Raigad	Panvel	***Vadghar***	0	0
21			Maharashtra	Raigad	Panvel	Karanjade	5	22
22			Maharashtra	Raigad	Panvel	***Kalundre***	0	0
23			Maharashtra	Raigad	Panvel	Vichumbe	4	11
24			Maharashtra	Raigad	Panvel	Panvel	4	8
25			Maharashtra	Raigad	Panvel	Asudgaon	22	25
26			Maharashtra	Raigad	Panvel	Tembhode	11	4
27			Maharashtra	Raigad	Panvel	Valavali	8	1
28			Maharashtra	Raigad	Panvel	***Ambetkhar***	0	0
29			Maharashtra	Raigad	Panvel	***Rodpali***	0	0
30			Maharashtra	Raigad	Panvel	***Navadhe***	0	0
31			Maharashtra	Raigad	Panvel	***Pendhar***	0	0
32			Maharashtra	Raigad	Panvel	***Taloja***	0	0
33			Maharashtra	Raigad	Panvel	Pisarve	20	109
34			Maharashtra	Raigad	Panvel	Rohinjan	7	22
35			Maharashtra	Raigad	Panvel	Dhansar	15	162
36			Maharashtra	Raigad	Panvel	***Vaklan***	0	0
37			Maharashtra	Raigad	Panvel	***Nighu***	0	0
38			Maharashtra	Raigad	Panvel	Usroli	62	176
39			Maharashtra	Raigad	Panvel	Kolkhe	1	4
40			Maharashtra	Raigad	Panvel	Kone	33	121
41			Maharashtra	Raigad	Panvel	Chikhale	43	122
Raigad District / Maharashtra Affected Villages, Sub-Total						**41**	**248**	**976**
42	1	Mumbai	Maharashtra	Thane	Thane	***Narivali***	0	0
43			Maharashtra	Thane	Thane	***Wadavali***	0	0
44			Maharashtra	Thane	Kalyan	***Ghesar***	0	0
45			Maharashtra	Thane	Kalyan	Nilaje	8	273
46			Maharashtra	Thane	Kalyan	Katai	1	64
47			Maharashtra	Thane	Kalyan	Usarghar	35	73
48			Maharashtra	Thane	Kalyan	Betavade	20	572
49			Maharashtra	Thane	Kalyan	Bhopar	28	121
50			Maharashtra	Thane	Kalyan	Nandivali	27	68
51			Maharashtra	Thane	Kalyan	Aayre	22	42
52			Maharashtra	Thane	Kalyan	***Kopar***	0	0
53			Maharashtra	Thane	Kalyan	Juni-Dombivli	12	1247
54			Maharashtra	Thane	Kalyan	Thakurli	4	14
55			Maharashtra	Thane	Kalyan	Navagaon	1	1
56			Maharashtra	Thane	Kalyan	Gaodevi	22	120
57			Maharashtra	Thane	Bhiwandi	***Pimpalner***	0	0
58			Maharashtra	Thane	Bhiwandi	Pimplas	6	268
59			Maharashtra	Thane	Bhiwandi	Ovali	1	9
60			Maharashtra	Thane	Bhiwandi	Kamatghar	1	5
61			Maharashtra	Thane	Bhiwandi	Rahanal	99	355
62			Maharashtra	Thane	Bhiwandi	Kalwar	50	345
63			Maharashtra	Thane	Bhiwandi	Wadghar	15	77
64			Maharashtra	Thane	Bhiwandi	Dunge	7	312
65			Maharashtra	Thane	Bhiwandi	Vadunavghar	56	148

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
66			Maharashtra	Thane	Bhiwandi	Kharbao	8	545
67			Maharashtra	Thane	Bhiwandi	Malodhi	12	168
68			Maharashtra	Thane	Bhiwandi	Payegaon	8	141
69			Maharashtra	Thane	Bhiwandi	Paye	19	271
70			Maharashtra	Thane	Vasai	Nagle	22	134
71			Maharashtra	Thane	Vasai	Shilottar	4	3
72			Maharashtra	Thane	Vasai	Sasunavghar	9	51
73			Maharashtra	Thane	Vasai	Sarjamori	16	45
74			Maharashtra	Thane	Vasai	Mori	27	27
75			Maharashtra	Thane	Vasai	***Kaman***	0	0
76			Maharashtra	Thane	Vasai	***Bapane***	0	0
77			Maharashtra	Thane	Vasai	Juchandra	22	685
78			Maharashtra	Thane	Vasai	Chandrapada	40	188
79			Maharashtra	Thane	Vasai	Tivri	29	416
80			Maharashtra	Thane	Vasai	Rajavalli	15	652
81			Maharashtra	Thane	Vasai	Gokhivare	33	702
82			Maharashtra	Thane	Vasai	Bilalpada	18	264
83			Maharashtra	Thane	Vasai	Dhaniv	20	277
84			Maharashtra	Thane	Vasai	***Bhatpadi***	0	0
85			Maharashtra	Thane	Vasai	***Chandansar***	0	0
86			Maharashtra	Thane	Vasai	Shirgaon	56	1,771
87			Maharashtra	Thane	Vasai	***Dahisar***	0	0
88			Maharashtra	Thane	Vasai	Kasrali	10	168
89	2	Mumbai	Maharashtra	Thane	Palghar	Wadi Saravali	6	15
90			Maharashtra	Thane	Palghar	***Kandanvan***	0	0
91			Maharashtra	Thane	Palghar	Karvale	5	4
92			Maharashtra	Thane	Palghar	Sartodi	9	22
93			Maharashtra	Thane	Palghar	Saphale	6	31
94			Maharashtra	Thane	Palghar	***Umbarpada Nandade***	0	0
95			Maharashtra	Thane	Palghar	Kardal (Old Makan Kapase)	42	50
96			Maharashtra	Thane	Palghar	Kapase	12	16
97			Maharashtra	Thane	Palghar	Makunsar	33	52
98			Maharashtra	Thane	Palghar	Rothe	24	64
99			Maharashtra	Thane	Palghar	Kelve Road	28	91
100			Maharashtra	Thane	Palghar	Kasbe Mahim	62	81
101			Maharashtra	Thane	Palghar	Navli	11	18
102			Maharashtra	Thane	Palghar	Palghar	17	279
103			Maharashtra	Thane	Palghar	Gothanpur	8	89
104			Maharashtra	Thane	Palghar	***Kolgaon***	0	0
105			Maharashtra	Thane	Palghar	Umroli	19	36
106			Maharashtra	Thane	Palghar	Birwadi	14	92
107			Maharashtra	Thane	Palghar	Panchali	7	14
108			Maharashtra	Thane	Palghar	***Kambalgaon***	0	0
109			Maharashtra	Thane	Palghar	Khairapada (Old Saravali)	57	122
110			Maharashtra	Thane	Palghar	Dandipada	100	95
111			Maharashtra	Thane	Palghar	Boisar	4	79
112			Maharashtra	Thane	Palghar	***Katkar***	0	0
113			Maharashtra	Thane	Palghar	Rani Shingaon	20	22
114			Maharashtra	Thane	Palghar	Navale	11	101
115			Maharashtra	Thane	Dahanu	***Kolavali***	0	0
116			Maharashtra	Thane	Dahanu	Vangaon	17	45

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
117			Maharashtra	Thane	Dahanu	Kapshi	9	26
118			Maharashtra	Thane	Dahanu	Asangaon	25	124
119			Maharashtra	Thane	Dahanu	***Dehane***	0	0
120			Maharashtra	Thane	Dahanu	Pale	1	1
121			Maharashtra	Thane	Dahanu	Aagwan	28	106
122			Maharashtra	Thane	Dahanu	Saravali	80	109
123			Maharashtra	Thane	Dahanu	Patilpada	26	36
124			Maharashtra	Thane	Dahanu	Manfod	2	10
125			Maharashtra	Thane	Dahanu	Junnarpada	25	45
126			Maharashtra	Thane	Dahanu	Nandore	21	32
127			Maharashtra	Thane	Dahanu	Dahanu	2	2
128			Maharashtra	Thane	Dahanu	Kasara	70	273
129			Maharashtra	Thane	Dahanu	Waki	30	107
130			Maharashtra	Thane	Dahanu	Ambewadi	25	28
131			Maharashtra	Thane	Dahanu	Chikhale	36	44
132			Maharashtra	Thane	Dahanu	Gholwad	30	30
133			Maharashtra	Thane	Dahanu	Bordee	16	41
134			Maharashtra	Thane	Talasari	Brahmanpada	9	38
135			Maharashtra	Thane	Talasari	Borigaon	13	10
136			Maharashtra	Thane	Talasari	Vevaji	2	10
Thane District / Maharashtra Affected Villages, Sub-Total						**95**	**1,745**	**13,112**
137	2	Mumbai	Gujarat	Valsad	Umargaon	Govada	5	48
138			Gujarat	Valsad	Umargaon	Dahad	2	47
139			Gujarat	Valsad	Umargaon	Solsumba	13	241
140			Gujarat	Valsad	Umargaon	Humbran	1	1
141			Gujarat	Valsad	Umargaon	Sanjan	12	100
142			Gujarat	Valsad	Umargaon	Gumse Kankaria	5	22
143			Gujarat	Valsad	Umargaon	Tumb	7	74
144			Gujarat	Valsad	Umargaon	Malav	8	88
145			Gujarat	Valsad	Umargaon	Deheli	19	119
146			Gujarat	Valsad	Umargaon	***Vankash***	2	119
147	3	Surat	Gujarat	Valsad	Umargaon	Bhilad	13	365
148			Gujarat	Valsad	Umargaon	Karamveli	26	142
149			Gujarat	Valsad	Umargaon	Valvada	22	135
150			Gujarat	Valsad	Pardi	Vapi / Vapi-2	11	28
151			Gujarat	Valsad	Pardi	Orvad	12	71
152			Gujarat	Valsad	Pardi	Rentlav	3	9
153			Gujarat	Valsad	Pardi	Motiwada	17	140
154			Gujarat	Valsad	Pardi	Umersadi	3	3
155			Gujarat	Valsad	Valsad	Haria	14	63
156			Gujarat	Valsad	Valsad	Atul	10	30
157			Gujarat	Valsad	Valsad	Dived	5	36
158			Gujarat	Valsad	Valsad	Maghod	9	38
159			Gujarat	Valsad	Valsad	Pari Parnera	43	135
160			Gujarat	Valsad	Valsad	Vasiyer	9	44
161			Gujarat	Valsad	Valsad	Abrama	5	9
162			Gujarat	Valsad	Valsad	Mograwadi	2	2
163			Gujarat	Valsad	Valsad	Pardi Sadpur	11	74
164			Gujarat	Valsad	Valsad	Vejalpur	3	8
165			Gujarat	Valsad	Valsad	Lilapur	12	55
166			Gujarat	Valsad	Valsad	Sarodhi	23	77
167			Gujarat	Valsad	Valsad	Chikhala	12	51
168			Gujarat	Valsad	Valsad	Sankar talav	7	38

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
169			Gujarat	Valsad	Valsad	Dungri	36	198
170			Gujarat	Valsad	Valsad	Rolla	31	89
171			Gujarat	Valsad	Valsad	Jespore	3	32
172			Gujarat	Valsad	Valsad	Olgaon	16	111
173			Gujarat	Valsad	Valsad	Jora Vasan	11	161
Valsad District / Gujarat Affected Villages, Sub-Total						**37**	**443**	**3,003**
174	3	Surat	Gujarat	Navsari	Gandevi	Desra	10	44
175			Gujarat	Navsari	Gandevi	Billimora	19	80
176			Gujarat	Navsari	Gandevi	Bhatha	26	91
177			Gujarat	Navsari	Gandevi	Devdha	32	73
178			Gujarat	Navsari	Gandevi	Sarikhurad	8	28
179			Gujarat	Navsari	Gandevi	Saribujrang	17	79
180			Gujarat	Navsari	Gandevi	Amalsad	24	63
181			Gujarat	Navsari	Gandevi	Ancheli	11	20
182			Gujarat	Navsari	Gandevi	Mohanpur	15	32
183			Gujarat	Navsari	Gandevi	Khaparwada	11	39
184			Gujarat	Navsari	Jalalpore	Vedchha	40	117
185			Gujarat	Navsari	Jalalpore	Mandir	26	104
186			Gujarat	Navsari	Jalalpore	Hansapore	55	217
187			Gujarat	Navsari	Navsari (Rural)	Vejalpore	12	36
188			Gujarat	Navsari	Navsari (Rural)	Veravan	2	0
189			Gujarat	Navsari	Jalalpore	Tavdi	26	55
190			Gujarat	Navsari	Jalalpore	Sagra	31	132
191			Gujarat	Navsari	Jalalpore	Chhinam	2	13
192			Gujarat	Navsari	Jalalpore	Kadoli	37	123
193			Gujarat	Navsari	Jalalpore	Mahuwar	32	54
194			Gujarat	Navsari	Jalalpore	Ponsra	15	33
195			Gujarat	Navsari	Jalalpore	Maroli	10	35
Navsari District / Gujarat Affected Villages, Sub-Total						**22**	**461**	**1,468**
196	4	Surat	Gujarat	Surat	Choryasi	Kansad	32	46
197			Gujarat	Surat	Choryasi	Sachin	29	79
198			Gujarat	Surat	Surat City	Unn	24	76
199			Gujarat	Surat	Surat City	Bhestan	16	73
200			Gujarat	Surat	Surat City	Bhedwad	5	11
201			Gujarat	Surat	Choryasi	Dindoli	5	12
202			Gujarat	Surat	Choryasi	Godadra	6	17
203			Gujarat	Surat	Choryasi	Devach	9	27
204			Gujarat	Surat	Choryasi	Dakhanwada	20	73
205			Gujarat	Surat	Palsana	Sedhav	13	29
206			Gujarat	Surat	Palsana	Niyol	17	38
207			Gujarat	Surat	Kamrej	Vedchha	24	50
208			Gujarat	Surat	Kamrej	Chhedchha	13	40
209			Gujarat	Surat	Kamrej	Kosmada	33	96
210			Gujarat	Surat	Kamrej	Khadsad	12	51
211			Gujarat	Surat	Kamrej	Pasodra	18	51
212			Gujarat	Surat	Kamrej	Laskana	12	118
213			Gujarat	Surat	Kamrej	Valak	14	172
214			Gujarat	Surat	Kamrej	Bhada	15	64
215	4	Vadodara	Gujarat	Surat	Choryasi	Bharthana Kosad	39	120
216			Gujarat	Surat	Surat City	Variyav	18	72
217			Gujarat	Surat	Surat City	Kosad	16	74
218			Gujarat	Surat	Kamrej	Abrama	44	116

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
219			Gujarat	Surat	Kamrej	Shekhpur	6	19
220			Gujarat	Surat	Kamrej	Kathodara	3	26
221			Gujarat	Surat	Olpad	Gothan	48	145
222			Gujarat	Surat	Olpad	Umara	11	33
223			Gujarat	Surat	Olpad	Sayan	27	263
224			Gujarat	Surat	Olpad	Kareli	5	8
225			Gujarat	Surat	Olpad	Kudsad	36	373
226			Gujarat	Surat	Olpad	***Kim***	0	0
227			Gujarat	Surat	Mangrol	Siyalaj	7	33
228			Gujarat	Surat	Mangrol	Kunwarda	8	24
229			Gujarat	Surat	Mangrol	Kosamba	31	146
230			Gujarat	Surat	Mangrol	Hathuran	39	198
Surat District / Gujarat Affected Villages, Sub-Total						**35**	**655**	**2773**
231	5	Vadodara	Gujarat	Bharuch	Amod	Ochhan	22	66
232			Gujarat	Bharuch	Amod	Telod	35	71
233			Gujarat	Bharuch	Amod	Ikhar	31	101
234			Gujarat	Bharuch	Amod	Dhora	25	61
235			Gujarat	Bharuch	Amod	Wantarsa	39	116
236			Gujarat	Bharuch	Amod	Tankariya	19	99
237			Gujarat	Bharuch	Amod	Pardriya	4	20
238			Gujarat	Bharuch	Bharuch	Parkhet	42	192
239			Gujarat	Bharuch	Bharuch	Pipaliya	1	2
240			Gujarat	Bharuch	Bharuch	Pariyej	66	277
241			Gujarat	Bharuch	Bharuch	Tralsa	71	204
242			Gujarat	Bharuch	Bharuch	Tralsi	21	72
243			Gujarat	Bharuch	Bharuch	Derol	13	69
244			Gujarat	Bharuch	Bharuch	Mahudhala	18	95
245			Gujarat	Bharuch	Bharuch	Tham	22	110
246			Gujarat	Bharuch	Bharuch	Kanthariya	21	212
247			Gujarat	Bharuch	Bharuch	Manubar	63	227
248			Gujarat	Bharuch	Bharuch	Dahegam	22	49
249			Gujarat	Bharuch	Bharuch	Kukarwada	16	39
250			Gujarat	Bharuch	Ankleshwar	Sarfudin	15	73
251			Gujarat	Bharuch	Ankleshwar	Deeva	60	289
252			Gujarat	Bharuch	Ankleshwar	Ankleswar	34	224
253			Gujarat	Bharuch	Ankleshwar	Piraman	13	112
254			Gujarat	Bharuch	Ankleshwar	Umarwada	11	78
255			Gujarat	Bharuch	Ankleshwar	Bhatkodra	3	7
256			Gujarat	Bharuch	Ankleshwar	Kapodra	8	21
257			Gujarat	Bharuch	Ankleshwar	Sakkarpor	8	12
258			Gujarat	Bharuch	Ankleshwar	***Sanjali***	0	0
259			Gujarat	Bharuch	Ankleshwar	Panoli	2	20
Bharuch District / Gujarat Affected Villages, Sub-Total						**29**	**705**	**2,918**
260	5	Vadodara	Gujarat	Vadodara	Karjan	Mesrad	40	85
261			Gujarat	Vadodara	Karjan	Mangrol	22	24
262			Gujarat	Vadodara	Karjan	Kambola	34	52
263			Gujarat	Vadodara	Karjan	Bodka	46	125
264			Gujarat	Vadodara	Karjan	Handod	21	52
265			Gujarat	Vadodara	Karjan	Khanda	28	81
266			Gujarat	Vadodara	Karjan	Kurai	24	88
267			Gujarat	Vadodara	Karjan	Pingalwada	53	127
268			Gujarat	Vadodara	Vadodara	Unitya Medad	29	129
269			Gujarat	Vadodara	Vadodara	Gosindra	18	52

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
Vadodara District / Gujarat Affected Villages, Sub-Total						**10**	**315**	**815**
270	15 & 16	Rewari-Dadri	Haryana	Rewari	Rewari	Daliaki	12	41
271			Haryana	Rewari	Rewari	Jatuwas	49	395
272			Haryana	Rewari	Rewari	Bhadawas	19	164
273			Haryana	Rewari	Rewari	Bithwana	22	68
274			Haryana	Rewari	Rewari	Bhiwari	46	194
275			Haryana	Rewari	Rewari	Kamalpur	34	193
276			Haryana	Rewari	Rewari	Devlawas	54	256
277			Haryana	Rewari	Rewari	Dhamlaka	47	572
278			Haryana	Rewari	Rewari	Dawana	60	543
279			Haryana	Rewari	Rewari	Lalpur	26	434
280			Haryana	Rewari	Rewari	Kasola	48	472
281			Haryana	Rewari	Rewari	Lodhana	69	362
282			Haryana	Rewari	Rewari	Pithanwas	25	573
283			Haryana	Rewari	Rewari	Mukandpur Basi	24	603
284			Haryana	Rewari	Rewari	Asiaki Tappa Jarthal	34	199
285			Haryana	Rewari	Rewari	Jarthal	103	455
286			Haryana	Rewari	Rewari	Nandrampur bas	31	227
Rewari District / Haryana Affected Villages, Sub-Total						**17**	**703**	**5,751**
287	15 & 16	Rewari-Dadri	Rajasthan	Alwar	Tijara	Rabarka	14	5
288			Rajasthan	Alwar	Tijara	Salarpur	121	492
289			Rajasthan	Alwar	Tijara	Shahpur	53	315
290			Rajasthan	Alwar	Tijara	Kalaka	23	64
291			Rajasthan	Alwar	Tijara	Tatarpur	11	175
292			Rajasthan	Alwar	Tijara	Thara	6	11
293			Rajasthan	Alwar	Tijara	Khajooriwas	22	211
294			Rajasthan	Alwar	Tijara	Jiwana	12	233
295			Rajasthan	Alwar	Tijara	Banban	57	446
296			Rajasthan	Alwar	Tijara	Kehrani	92	429
297			Rajasthan	Alwar	Tijara	Mundana Meo	56	720
298			Rajasthan	Alwar	Tijara	Amlaki	25	481
299			Rajasthan	Alwar	Tijara	Shahdod	20	128
Alwar District / Rajasthan Affected Villages, Sub-Total						**13**	**512**	**3,710**
300	15 & 16	Rewari-Dadri	Haryana	Mewat	Taoru	Sewaka	24	110
301			Haryana	Mewat	Taoru	Raniyaki	32	46
302			Haryana	Mewat	Taoru	Gunawat	66	164
303			Haryana	Mewat	Taoru	Dhidara	37	174
304			Haryana	Mewat	Taoru	Bharangpur	41	101
305			Haryana	Mewat	Taoru	Taoru	51	177
306			Haryana	Mewat	Taoru	Gaurka	118	354
307			Haryana	Mewat	Taoru	Buraka	14	16
308			Haryana	Mewat	Taoru	Rahedi	55	247
309			Haryana	Mewat	Taoru	Malaka	55	197
310			Haryana	Mewat	Taoru	Dalaka	76	446
311			Haryana	Mewat	Taoru	Dhulawat	121	345
312			Haryana	Mewat	Taoru	Sashol Patuka	118	381
313			Haryana	Mewat	Taoru	Khor	2	0
314			Haryana	Mewat	Taoru	Marola	1	0
315			Haryana	Mewat	Taoru	Rojka	2	4
316			Haryana	Mewat	Taoru	Nuh	12	25

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
317			Haryana	Mewat	Nuh	Rampur	24	160
318			Haryana	Mewat	Nuh	Uddaka	42	103
Mewat District / Haryana Affected Villages, Sub-Total						**19**	**891**	**3,050**
319	15 & 16	Rewari-Dadri	Haryana	Gurgaon	Sohna	Raipur	0	0
320			Haryana	Gurgaon	Sohna	Sohna	48	428
321			Haryana	Gurgaon	Sohna	Lakhuwas	74	423
322			Haryana	Gurgaon	Sohna	Sancholi	60	225
323			Haryana	Gurgaon	Sohna	Bhirawati	2	3
324			Haryana	Gurgaon	Sohna	Karanki	41	270
325			Haryana	Gurgaon	Sohna	Silani	15	6
326			Haryana	Gurgaon	Sohna	Khuntpuri	25	71
327			Haryana	Gurgaon	Sohna	Barkhera (Rati Ka Nawad)	29	204
Gurgaon District / Haryana Affected Villages, Sub-Total						**9**	**294**	**1630**
328	15 & 16	Rewari-Dadri	Haryana	Gurgaon	Palwal	Parauli	73	234
329			Haryana	Gurgaon	Palwal	Dahlaka	14	141
330			Haryana	Gurgaon	Palwal	Kalwaka	0	0
331			Haryana	Gurgaon	Palwal	Chhapraula	94	26
332			Haryana	Gurgaon	Palwal	Pirthala	211	1,526
333			Haryana	Gurgaon	Palwal	Jataula	28	178
334			Haryana	Gurgaon	Palwal	Asawati	231	667
335			Haryana	Gurgaon	Palwal	Laadpur	55	369
Palwal District / Haryana Affected Villages, Sub-Total						**8**	**706**	**3,141**
336	15 & 16	Rewari-Dadri	Haryana	Faridabad	Ballabgarh	Pahaladpur	53	210
337			Haryana	Faridabad	Ballabgarh	Fatehpur Billoch	139	1,037
338			Haryana	Faridabad	Ballabgarh	Ladauli	44	378
339			Haryana	Faridabad	Ballabgarh	Bahbalpur	35	414
340			Haryana	Faridabad	Ballabgarh	Fafunda	37	76
341			Haryana	Faridabad	Ballabgarh	Dayalpur	61	341
342			Haryana	Faridabad	Ballabgarh	Machgar	18	82
343			Haryana	Faridabad	Ballabgarh	Bukharpur	61	212
344			Haryana	Faridabad	Ballabgarh	Nawada Tigaon	69	498
345			Haryana	Faridabad	Faridabad	Tigaon	32	128
346			Haryana	Faridabad	Faridabad	Nimka	29	162
347			Haryana	Faridabad	Faridabad	Saidpur	47	283
348			Haryana	Faridabad	Faridabad	Faridpur	30	175
349			Haryana	Faridabad	Faridabad	Kheri Kala	70	430
350			Haryana	Faridabad	Faridabad	Nachauli	37	178
351			Haryana	Faridabad	Faridabad	Bhopani	69	210
352			Haryana	Faridabad	Faridabad	Dhandhar	60	253
353			Haryana	Faridabad	Faridabad	Mahawatpur	30	117
354			Haryana	Faridabad	Faridabad	Laalpur	46	93
355			Haryana	Faridabad	Faridabad	Riwazpur	34	320
356			Haryana	Faridabad	Faridabad	Tikawali	24	68
357			Haryana	Faridabad	Faridabad	Baadshahpur	18	100
358			Haryana	Faridabad	Faridabad	Palwali	45	165
359			Haryana	Faridabad	Faridabad	Wazipur	26	85
360			Haryana	Faridabad	Faridabad	Mawai	60	170
361			Haryana	Faridabad	Faridabad	Mewala Maharajpur	131	538
362			Haryana	Faridabad	Faridabad	Sarai Khawaza	116	188
363			Haryana	Faridabad	Faridabad	***Pul pahladpur***	0	0
Faridabad District / Haryana Affected Villages, Sub-Total						**28**	**1,421**	**6,911**

Sl. No.	Section	CPM	State	District	Taluk / Tahsil	Name of Village	No. of Plots as per 20E / JM / PAP List	No. of T-holders as per 20E / JM / PAP List
364	15 & 16	Rewari-Dadri	Uttar Pradesh	G B Nagar	Sadar	Dalelpur	30	152
365			Uttar Pradesh	G B Nagar	Sadar	Gulaoli	52	137
366			Uttar Pradesh	G B Nagar	Sadar	Jhatta	6	22
367			Uttar Pradesh	G B Nagar	Sadar	***Badoli Bangar***	0	0
368			Uttar Pradesh	G B Nagar	Sadar	***Mubarakpur***	0	0
369			Uttar Pradesh	G B Nagar	Sadar	Guijarpur	22	50
370			Uttar Pradesh	G B Nagar	Sadar	***Namoli***	0	0
371			Uttar Pradesh	G B Nagar	Sadar	***Gulistanpur***	0	0
372			Uttar Pradesh	G B Nagar	Sadar	***Saquipur***	0	0
373			Uttar Pradesh	G B Nagar	Sadar	***Pali***	0	0
374			Uttar Pradesh	G B Nagar	Sadar	***Tilpata Karanbas***	0	0
Gautam Buddha Nagar District / Uttar Pradesh Affected Villages, Sub-Total						**11**	**110**	**361**
Total						**374**	**9,209**	**49,619**

Note: The name of village in Italic shows that only the governmental land in the village is required for the project; the number of plots and titleholders are provisional. In many cases, titleholders residing over multiple plots are listed multiple times in 20E/draft 20E, causing double counting of the same titleholders. Titleholders who have already deceased may be listed in 20E/draft 20E due to the outdated land records based on which these notifications are prepared. Also, the way plots are counted varies across different measurement system and as such, there may be some differences in the number of plots in this table and the figure in the baseline survey and census depending on the type of documents available when the survey was carried out.

Source: Notification 20E and Draft Notification 20E

8.2 Socio-economic Features of the Affected Districts

8.2.1 Demographic features

The Baseline Survey and Census has been carried out from November 2010 onwards and is still in progress in 17 villages in Thane district and 6 villages in Fairdabad district as of early November 2011 as shown in the following table. Additionally, there are 6 villages in Thane district and 1 village in G.B. Nagar district where the Baseline Survey and Census was conducted recently and the survey data is not yet included in this chapter as specified in the following table.

Table 8.2.1 Survey Coverage of the Socio-economic Features

Sl. No.	District	Villages where the survey is in progress/not surveyed as of early Nov. 2011	Villages surveyed but its data is not incorporated in this chapter
1	Thane	Usarghar*, Dhaniv, Shirgaon, Kardal*, Kharbao, Malodhi, Payegaon, Paye, Tivri, Rajavali, Gokhivare, Bilalpada, Katai, Nandivali, Nagle, Kasrali*, and Bhopar* (17 villages)	Nilaje, Betvade, Bhopar, Kopar, Dombivali, and Pimplas (6 villages)
2	Faridabad	Pahaladpur, Fatehpur Billoch, Ladauli, Bahbalpur, Tigaon, and Mewala Maharajpur (6 villages)	-
3	G.B. Nagar	-	Nawoli (1 village)
Total	3 districts	23 villages	7 villages

Note: *particially surveyed.
Source: Baseline Survey and Census, 2011

In this section, socio-economic features of the affected households will be described with

available results of the Baseline Survey and Census up to the end of September 2011 and exclude that of 30 villages. The final socio-economic features of the affected households in the project area will be available in the final report of the Baseline Survey and Census to be prepared by early March 2012 (planned).

The Baseline Survey and Census has identified and surveyed 4,652 households in 13 districts (i.e. excluding the survey data of Raigard district). The total population of these households is 38,310. The district-wise distribution of surveyed households and population (both titleholders and non-titleholders) is presented in Table 8.2.2. The village-wise details are available in the report for the Baseline Survey and Census.

Table 8.2.2 District-wise Distribution of Affected Households (Provisional)

Distrcit	Titleholders (Non-resettlers)		Titleholders (Resettlers)		Non-titleholders[1] (Non-resettlers)		Non-titleholders[1] (Resettlers)	
	HH	Population	HH	Population	HH	Population	HH	Population
Raigad[2]	-	-	-	-	-	-	-	-
Thane	455	3,282	415	2,133	131	896	84	502
Valsad	354	2,377	67	476	51	327	4	37
Navsari	386	2,011	30	216	71	437	34	205
Surat	317	2,452	55	373	3	23	0	0
Bharuch	444	3,352	1	4	1	3	0	0
Vadodara	206	1,598	1	5	6	36	0	0
Rewari	210	1,820	39	447	9	53	1	6
Alwar	275	3,032	15	198	16	197	1	15
Mewat	221	3,140	29	485	38	579	4	47
Gurgaon	118	922	13	96	1	10	1	14
Palwal	182	1,849	15	214	9	101	3	22
Faridabad	203	2,913	18	247	25	384	1	12
G. B. Nagar	64	577	6	41	19	144	0	0
Total	**3,435**	**29,325**	**704**	**4,935**	**380**	**3,190**	**133**	**860**

Note: 1. Non-titleholder includes natural descendants not registered in the land record or listed in the Notification 20E, squatters and encroachers.
2. The number of the affected households for Raigad district is under review as of early Nov. 2011.
Source: Baseline Survey and Census, 2011

Based on the number of family members, the surveyed households have been categorized in 4 categories and presented in Table 8.2.3. Over 70% of the total households belong to either small (1-5 members) or mid-sized (6-10 members) family. Meanwhile, 4.1% of the affected households can be classified as large family with more than 20 members.

Table 8.2.3 Family Sie of the Affected Households (Provisional)

District	Household Size				
	Small	Mid-Sized	Big	Large	Total Households
Raigad	-	-	-	-	-
Thane	559	409	113	4	1,085
Valsad	222	181	70	3	476
Navsari	309	159	50	3	521
Surat	124	177	67	7	375
Bharuch	160	187	93	6	446
Vadodara	80	85	46	2	213
Rewari	66	120	65	8	259
Alwar	56	108	113	30	307
Mewat	12	86	136	58	292
Gurgaon	51	49	30	3	133
Palwal	50	49	97	13	209
Faridabad	24	64	111	48	247
Gautam Budh Nagar	39	26	18	6	89

District	Household Size				
	Small	Mid-Sized	Big	Large	Total Households
Total	**1,752**	**1,700**	**1,009**	**191**	**4,652**
Percentage	**37.7%**	**36.5%**	**21.7%**	**4.1%**	**100%**

Note: Small family: 1-5 members; Mid-Sized Family: 6-10 members; Big Family: 11-20 members; Large Family: more than 20 members
Source: Baseline Survey and Census, 2011

8.2.2 Social Category

General Castes (41.7%) is the most common social categories among the affected households, closely followed by Other Backward Castes (39.1%). The district-wise social category of the surveyed households is presented in Table 8.2.4.

Table 8.2.4 Social Categories of the Surveyed Households (Provisional)

District	General	OBC	SC	ST	Total
Raigad	-	-	-	-	-
Thane	186	421	62	416	1,085
Valsad	82	255	30	109	476
Navsari	168	283	36	34	521
Surat	302	34	16	23	375
Bharuch	344	83	11	8	446
Vadodara[1]	157	27	22	5	211
Rewari	112	142	5	0	259
Alwar	23	241	43	0	307
Mewat	71	182	30	9	292
Gurgaon	66	64	3	0	133
Palwal	174	19	13	3	209
Faridabad	195	46	6	0	247
Gautam Budh Nagar	59	22	8	0	89
Total	**1,939**	**1,819**	**285**	**607**	**4,650**

Note: 1. 2 households in Vadodara district did not respond this question.
Source: Baseline Survey and Census, 2011

8.2.3 Religious Belief

Overwhelming majority (84.5%) of the surveyed households are Hindu while over half of the households are Muslim in Bharuch and Mewat Districts. The district-wise religion of surveyed households is presented in Table 8.2.5.

Table 8.2.5 Religious Belief of the Affected Households (Provisional)

District	Hindu	Muslim	Christian	Jain	Sikh	Other	Total
Raigad	-	-	-	-	-	-	-
Thane	1,062	16	0	0	0	7	1,085
Valsad	460	13	0	0	0	3	476
Navsari	490	27	0	4	0	0	521
Surat	337	37	0	0	0	1	375
Bharuch	172	274	0	0	0	0	446
Vadodara[1]	186	25	0	0	0	0	211
Rewari	259	0	0	0	0	0	259
Alwar	266	36	0	0	5	0	307
Mewat	58	234	0	0	0	0	292
Gurgaon	129	4	0	0	0	0	133
Palwal	188	20	0	0	0	1	209
Faridabad	247	0	0	0	0	0	247
G. B. Nagar	74	4	0	0	11	0	89
Total	**3,928**	**690**	**0**	**4**	**16**	**12**	**4,650**
Percentage	**84.5%**	**14.8%**	**0%**	**0.1%**	**0.3%**	**0.3%**	**100.0%**

Note: 1. 2 households in Vadodara district did not respond this question.
Source: Baseline Survey and Census, 2011

8.2.4 Educational Status

Education level of the affected population is presented in Table 8.2.6. In both gender groups, the most common category of educational attainment is highschool education (12th grade). On average, however, male populations have achieved greater educational attainment than their female counterparts. The number of illietarate females is more than double that of male despite the fact that there are fewmer females than males in the project affected area.

Table 8.2.6 Gender-wise Educational Status of the Affected Populations (Provisional)

Educational Status	Male	%	Female	%
Illiterate	2,106	10.2%	4,560	25.7%
Can read	806	3.9%	692	3.9%
Can write	1,718	8.3%	1,479	8.3%
Below 6 years	1,512	7.3%	1,263	7.1%
Up to Class 5	3,833	18.6%	3,122	17.6%
Up to Class 12	7,853	38.1%	5,020	28.3%
Graduate	1,833	8.9%	1,274	7.2%
Professional Education	924	4.5%	315	1.8%
Total	**20,585**	**100%**	**17,725**	**100%**

Source: Baseline Survey and Census, 2011

8.2.5 Sectors Engaged

Sector-wise engagement of the affected households and members thereof in economic sectors is presented in Table 8.2.7. Over half of the affected households are primarily engaged in agriculture.

Table 8.2.7 Engagement of Affected Households and Members in Economic Sector (Provisional)

Sectors	No of Households	%	No of Members	%
Agriculture	2,420	52.0%	23,625	61.7%
Manufacturing	47	1.0%	129	0.3%
Government Service	245	5.3%	1,214	3.2%
Private Service	583	12.5%	3,536	9.2%
Misceraneous	1,357	29.2%	9,806	25.6%
Total	**4,652**	**100%**	**38,310**	**100%**

Note: The table presents the primary sector for each household although members of the same households can be engaged in different sectors

Source: Baseline Survey and Census, 2011

8.2.6 Vulnerability

NRRP 2007 defines Vulnerable Persons as disabled, destitute, orphans, widows, unmarried girls, abandoned women or persons above 50 years of age; who are not provided or cannot immediately be provided with alternative livelihood, and who are not otherwise covered as part of a family (para 6.4 (v) NRRP 2007). 1,903 families are with a person of age more than 50 years and 818 families are headed by a widow. The district-wise total number of vulnerable families likely to be adversely affected due to the project has been summarized in Table 8.2.8.

Table 8.2.8 Number of Vulunarable Households in Affected Districts (Provisional)

District	Total	Disabled	BPL	Women Headed	Elderly over 50	Widow Headed	Unmarried Girl	Abandoned Women	Orphans
Raigad	-	-	-	-	-	-	-	-	-
Thane	1085	9	198	0	363	217	214	12	0
Valsad	476	5	94	2	208	100	75	0	0
Navsari	521	8	68	3	141	33	28	0	0
Surat	375	7	16	0	209	59	35	0	0
Bharuch	446	9	22	0	203	79	88	1	0
Vadodara	213	4	8	0	94	45	28	0	0
Rewari	259	1	1	4	143	49	4	2	0
Alwar	307	3	8	0	176	79	11	0	1
Mewat	292	8	2	0	175	5	43	0	0
Gurgaon	133	0	7	0	49	18	13	0	0
Palwal	209	0	8	1	81	29	35	2	0
Faridabad	247	0	0	1	38	95	105	1	0
G. B. Nagar	89	1	2	0	23	10	3	1	0
Total	**4,652**	**55**	**434**	**11**	**1,903**	**818**	**682**	**19**	**1**

Note: Below Poverty Line (BPL) Family is calculated by comparing annual household income and the latest BPL threshold income figure determined by Planning Commission, Government of India (which is INR30240 for urban households and INR19872 for rural households). Since some households did not provide information about their income, this is the minimum number of the BPL households in the affected area.

Source: Baseline Survey and Census, 2011

8.2.7 Socio-economic Status of Non-titleholders

(1) Educational Status

Although the trend of educational attainment of non-titleholders is similar to that of the overall population, the gender disparity appears to be greater among non-titleholder populations. Over 30% of female non-titleholders are illiterate, the figure much higher than their male counterparts. The level of education attainement of the affected non-titleholders is presented in Table 8.2.9.

Table 8.2.9 Educational Status of Non-titleholders (Provisional)

Educational Status	Male	%	Female	%
Illiterate	287	13.0	588	31.7
Can read	115	5.2	87	4.7
Can write	221	10	142	7.7
Below 6 years	180	8.2	171	9.2
Up to Class 5	441	20.0	271	14.6
Up to Class 12	723	32.8	467	25.2
Graduate	168	7.6	103	5.6
Professional Education	66	3.0	25	1.3
Total	**2,201**	**100**	**1,854**	**100**

Source: Baseline Survey and Census, 2011

(2) Occupation

Occupation categories of the affected non-titleholders are presented in Table 8.2.10.

Table 8.2.10 Occupation of Non-titleholders Populations (Provisional)

Category	Agriculture	Govt. Service	Manufacturing	Private Service	Misceraneous
Permanent Employee	0	81	0	112	
Retired	0	1	0	0	
Rural Artisan	0	0	2	0	4
Self Employed	732	0	3	4	58
Small Trader	0	0	0	2	16
Wage Employee	45	0	0	215	95
Total	**777**	**82**	**5**	**333**	**173**

Source: Baseline Survey and Census, 2011

(3) Income Level

Income level of the non-titleholder household is summarized in Table 8.2.11.

Table 8.2.11 Monthly Income of Non-titleholder Households (Provisional)

Monthly Income (INR)	Household	
	Number	%
< =2500	47	9.2%
2501 - 5000	123	24.1%
5001 - 10000	100	19.6%
10001 - 20000	69	13.5%
20001 - 50000	48	9.4%
No Answer	124	24.3%
Total	**511**	**100%**

Source: Baseline Survey and Census, 2011

8.3 Social Impact Assessment Results

The most significant impact on social environment is land acquisition and involuntary resettlement, though it is expected that impact on resettlement is relatively smaller considering the scale of land acquisition since the majority of affected area is agricultural land and the urban areas are avoided as much as possible by detours in the panning stage. However, the adverse impacts of land acquisition and Rehabilitation & Resettlement (R&R) need to be minimised by adequate mitigations, and they will be further discussed in the RRP separately.

Other than land acquisition & R&R-related issues (e.g invloluntary resettlement, and local economy such as employment and livelihood), there are some more social concerns in the survey area, such as access to social infrastructures and services (e.g. access to work place or school) raised by interactions during the Baseline Survey and Census and Public Consultation Meetings (PCMs). These impacts will be further studied in the RRP and the next round of PCMs on draft RRP planned in November 2011.

The results of the Social Impact Assessment (SIA) are summarized in the following table.

Table 8.3.1 Impact Assessment of Social Environment

No	Likely Impacts	Rating			Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"<>".)
		Planning/ Design Phase	Construction Phase	Operation phase	
Social Environment					
1	Involuntary Resettlement	A-	-	-	**Planning/ Design Phase** *<Land acquisition>* It is expected that a large scale of involuntary resettlement (more than 200 persons to be displaced) will be caused by the Project, even though the railway alignment is planned to minimize the scale of the involuntary resettlement as much as possible by applying the following policy: (1) The detour is planned to avoid the populated areas to minimize the involuntary resettlement as much as possible. (2) However, involuntary resettlement will be caused by the project due to limitations such as a feature of the railway alignment which makes design sharp curb unable, and topographic condition in the project area. Additionally, it is expected a larger number of the land owners will affected by partical land acquisiotn due to a feature of the linear project. According to DFCCIL's monthly land acquisition report as of October 2011, the area to be acquired is 2,252 ha. The number of the affected households including the titleholders and non-titleholders is approx. 4,652 and the affected population is approx. 38,310 according to the field data of the Baseline Survey and Census collected by the end of Sept. 2011.

No	Likely Impacts	Rating			Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"<>".)
		Planning/ Design Phase	Construction Phase	Operation phase	
2	Local economy such as employment and livelihood	A-	B-/B+	A+	**Planning/ Design Phase** *<Land acquisition>* Since the detour route is adopted to minimize the involuntary resettlement in the built-up area, the detour route passes through agricultural land in the most project area. Acquisition of the agricultural area for the Project would affect livelihood for a large number of farmers whose farmland will be acquired.
					Construction Phase *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Overall construction activities and traffic restriction would affect local economy activities to some extent due to disturbance in smooth operation of commercial/public transportation during construction. On the other hand, construction activities also bring positive impacts on local economy such as shops and casual workers.
					Operation Phase *<Operation of trains>* Overall, the construction of the Project will make more employment and business opportunities for local residents during construction.
3	(Surrounding) Land use and utilization of local resources	B-	-	B-	**Planning/ Design Phase** *<Land acquisition>* *<Change of land use plan, control of various activities by regulations for the construction>* Land use could be worsened due to the acceleration of unplanned development along the proposed route and around new stations unless the land use is property planned by the local government. Agricultural land will be affected by the project, and irrigation facilities need to be restored for the remaining agricultural land, if necessary.
					Operation Phase *<Operation of trains>* - ditto -
4	Social institutions (including regional severance)	-	B-	B-	**Planning/Design Phase** No impact is expected.
					Construction Phase *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* During construction, if access to the rest of the community is disturbed, social institution would be temporarily disturbed. People's movements will be restricted and they will face inconvenience.
					Operation Phase *<Appearance of the tracks and related facilities>* *<Operation of trains>* Accessibility and connection among communities would be affected due to the new freight tracks and other related facilities especially people concerns how to cross the proposed railway during operation.

No	Likely Impacts	Rating			Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"<>".)
		Planning/ Design Phase	Construction Phase	Operation phase	
5	Social infrastructures and services	B-	B-	B-	**Planning/ Design Phase** *<Land acquisition>* Land acquisition for the project, involving relocation of public and/or community facilities, would affect local communities to some extent.
					Construction Phase *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction works and traffic restriction would disturb access to the existing social infrastructures and services.
					Operation Phase *<Appearance of the tracks and related facilities>* *<Operation of trains>* Unless affected existing social infrastructure is replaced in a proper manner, nearby residents' access to existing social infrastructure will be negatively affected. The affected strctures would include schools, community centres, wells, places of worship, a road, pump houses, burial sites, irrigation channel & drainage, electric poles according to the Baseline Survey and Census results as of the end of Sept. 2011. More detailed impacts will be studied in the RRP.
6	Socially vulnerable groups such as the poor, indigenous and ethnic people	B-	B-	B-	**Planning/ Design Phase** *<Land acquisition>* The proposed alignment passes through the areas socially vulnerable groups live. For instance, 416 Schedule Tribe (ST) households are identified as affected households in Thane distirct, 109 in Valsad district, 34 in Navsari district, and 23 in Surat district according the results of the Baseline Survey and Census upto the end of Sept. 2011. More detailed impacts will be studied in the RRP.
					Construction Phase *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Construction works and traffic restriction would cause inconvenience especially to the disables, children, the elderly and women in near the construction sites.
					Operation Phase *<Appearance of the tracks and related facilities>* *<Operation of trains>* The project would cause inconvenience to the physically disabled, children, the elderly and women in both the parallel and detour areas unless the alternative passage to the other side of the proposed railway is secured.
7	Misdistribution of benefit and damage	C-	-	C-	**Planning/Design Phases** *<Land acquisition>* Inequality among the stakeholders might be expected, since some would receive a benefit from the project (industrial and commercial sectors) and others would be affected negatively by the project (individual affected land titleholders and users). More detailed impacts will be studied in the RRP and PCMs.
					Operation Phase

No	Likely Impacts	Rating			Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"<>".)
		Planning/ Design Phase	Construction Phase	Operation phase	
					<Operation of trains> - ditto -
8	Historical and cultural heritage (including religious matters)	B-	B-	B-	**Planning/Design Phase** *<Land acquisition>* There is no distinctive historical and cultural site identified in the proposed ROW; however, religious and historical places will be affected. Several community assets such as places of worship, temples and community centres will be affected according to the Baseline Survey and Census results up to the end of Sept. 2011. More detailed impacts will be studied in the RRP.
					Construction Phase *<Operation of construction equipment and vehicles>* *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Religious places which usually require silence might be affected by noise from operation of construction equipments and vehicles in some areas. In addition, access to religious places might be disturbed by construction works and traffic restriction.
					Operation Phase *<Operation of trains>* Religious places near the DFC proposed alignment and relevant facilities might be affected by noise due to operation of the trains.
9	Local conflict of interests	C-	-	C-	**Planning/Design Phase** *<Land acquisition>* Conflicts of interests related to the Project could occur among beneficiaries and the PAPs unless the adequate RRP and public consultation are not arranged.
					Construction Phase No impact is expected.
					Operation Phase *<Operation of trains>* Conflicts of interests related to the Project could occur among beneficiaries (industrial & commercial sectors) and the individual PAPs affected by pollution such as noise and vibration unless the adequate mitigation measures are adopted and public consultation are arranged.
10	Sanitation	-	B-	-	**Planning/Design Phase** No impact is expected.
					Construction Phase *<Construction of track, station, viaduct/bridges & other related facilities>* Sanitary issues such as hygiene, health and environmental sanitation in and around labor camps and construction areas would be occurred in the case where sanitary facility is not adequately installed such as toilet and septic tank.
					Operation Phase No impact is expected.
11	Hazardous (risk) infectious diseases such as HIV/AIDS	-	B-	-	**Planning/Design Phase** No impact is expected.
					Construction Phase *<Construction of track, station, viaduct/bridges & other related facilities>*

No	Likely Impacts	Rating			Explanation on Potential Impacts (Project-related activity is shown in the parenthesis"<>".)
		Planning/ Design Phase	Construction Phase	Operation phase	
					Risk of infectious diseases by labors would be expected during construction due to the inflow of the construction workers from outside.
					Operation Phase No impact is expected.
12	Occupational health and safety (OHS)	-	B-	B-	**Planning/Design Phase** No impact is expected.
					Construction Phase *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, viaduct/bridges & other related facilities>* *<Traffic restriction in construction area>* Minor negative impacts on occupational safety are inevitable during construction; however, it will be secured in accordance with the domestic laws and regulations during construction.
					Operation Phase *<Operation of trains>* Minor negative impacts on occupational safety would be expected during operation; however, it will be secured in accordance with the domestic laws and regulations during operation.
13	Accident	-	B-	B+/ B-	**Planning/Design Phase** No impact is expected.
					Construction Phase *<Alteration to ground by cut land, filling, drilling, tunnel, etc.>* *<Operation of construction equipment and vehicles>* *<Construction of track, station, viaduct/bridges & other related facilities>* Increased risk of accidents is expected due to the operation of heavy equipment and heavy vehicles during the construction.
					Operation Stage *<Operation of trains>* Increased risk of accidents is expected due to the trains. On the other hand, in the long run, with change of transport mode from freight trucks to railway system, reduction of accidents would be expected.

<Rating>
A-: Serious impact is expected, if any measure is not implemented to the impact.
B-: Some impact is expected, if any measure is not implemented to the impact.
C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)
-: No impact is expected. Therefore, ESIA is not required.
A+: Remarkable effect is expected due to the project implementation itself and environmental improvement caused by the project.
B+: Some effect is expected due to the project implementation itself and environmental improvement caused by the project.
<Project phase> P: Planning and design phase, C: Construction phase, O: Operation phase

Reference: Japan Transport Cooperation Association (JTCA) and Japan Railway Technical Service (JARTS) (1996) "Manual for Environmental Considerations in International Cooperation for Transportation Technology (Railway Project) (provisional translation)", Tokyo, Japan.

CHAPTER 9
PUBLIC CONSULTATION MEETINGS

CHAPTER 9 PUBLIC CONSULTATION AND INFORMATION DISSEMINATION PROCESS

9.1 Public Consultation Meeting

Public consultation meetings offer an opportunity to people to participate in the decision making process leading to project design, development and its implementation. It provides a platform for the project affected persons and different stakeholders to express their views on possible impact of the proposed intervention on environmental and social parameters.

Public consultation meetings (PCMs) for ESIA were planned at 2 different stages to collect opinions and feedback of the public and to disseminate information on the Project and ESIA Study.

(1) First Stage of the PCM for ESIA (PCM for ESIA Scoping Stage)

The first stage of the PCM for ESIA was conducted at the time of environmental scoping in the initial stage of the ESIA Study. Information on the Project and scope of the ESIA Study was disseminated to the public, and then comments and opinions were collected to incorporate in the ESIA Study.

(2) Second Stage of the PCM for ESIA (PCM for Draft Final ESIA Report Stage)

The second stage of the PCM for ESIA was conducted at the time of preparations of draft final report of the ESIA Study. Information about findings of draft environmental and social impact assessment study and mitigation measures were disseminated to the general public that are directly or indirectly affected by the DFC Project and obtained their feedback and opinions which are reflected in the final ESIA Report together with their comments and request on the environmental and social mitigation measures and Environmental and Social Management and Monitoring Plan (EMP and EMoP).

9.1.1 Approach of PCMs

PCMs are a critical component of a comprehensive ESIA. DFCCIL has conducted extensive consultations with PAPs, communities and other stakeholders potentially affected by the proposed DFC project and associated infrastructure.

Public consultation is a process of the ESIA. In this context, the meetings as part of the public consultation process help to initiate discussion among the participants so that their opinions and comments could be incorporated and analyzed in the ESIA report. With this objective in mind, stakeholders were identified and invited to attend the meetings. These meetings were held at venues convenient to PAPs for the concerned and timings were arranged to suit their preferences. It was kept in mind to invite stakeholders from all villages of affected area so that opinions from all concerned could be addressed.

The objectives of the PCMs were to incorporate the opinion and suggestions of the public and all other stakeholders at the project planning stage to ensure wider acceptability of the project. The key objectives were to:

- Provide information on the economic, environmental and social benefits as well as potential negative impacts from the project.

- Ensure that the potential PAPs, stakeholders and local communities were engaged in a meaningful dialogue and were well informed prior to the decision of the DFCCIL, as to the nature and extent of social and environmental impacts attributable to the proposed project in respect to the alignment, schedules and plans.
- Ensure that the concerns of, and issues raised by the PAPs, stakeholders and local communities were incorporated and adequately addressed in the study.
- Engage in a participative exercise with PAPs, stakeholders and local communities and obtain expertise and local, traditional wisdom and knowledge from them in order to plan mitigation measures.
- Facilitate periodic opportunities to the principal stakeholders to offer their inputs on all key components of the project.

9.1.2 Methodology

(1) Target Area

District-wise PCMs were scheduled to organize at 1 time (1 venue)/district in the 14 affected districts.

(2) Stakeholder Identification

Target invitees to the PCMs were the general public along the alignments of the DFC or boundaries of the relevant facilities. Different categories of stakeholders ranging from PAPs to government officials to different civil society actors were identified in order to seek opinions on the project and to discuss social and environmental impacts. The various categories of stakeholders who were invited to attend both the stages of the PCMs were as follows;

- Project Affected Persons (PAPs)
- Government Officials from the local administration, revenue department, land acquisition officer, forest officers, police officers, and railway officials
- Representatives from Gram Sabha and Gram Panchayat, such as Sarpanch (Village head), other elected members of Gram Panchayat, and Numberdar (Village Headman)[1]
- Local municipal bodies, members of parliament and the legislative assembly of the area, and elected members of the Zila Parishad[2]
- Local industry owners
- Residents, merchants/businessmen, advocates, farmers, senior citizens

(3) Facilitators

Suitable agencies were identified to carry out the stakeholder/public consultation meetings. It was deemed preferable to appoint a local organization with a good track record and experience in social work. Their acquaintance with different sections of society and the ability to mobilize the stakeholders to attend the meeting were the advantages to their selection. The ability to facilitate the following activities was taken into consideration;

[1] Numberdar (Village Headman) is a traditionally social position in a village and a nominated person work for a longer period whereas Sarpanch (Village Head) is a political and democratically elected head of a village level statutory institution of local self-government called the gram panchayat (Village government) and is for a fixed tenure.
[2] Zila Parishad (District Council) is a local government body at the district level.

- Identification of a suitable venue for the meetings
- Preparation of logistical arrangements such as food, stationary distribution and public address system
- Assisting in publicity in local languages (Gujarati, Marathi and Hindi)
- Sending of Invitations to stakeholders and motivating them to participate in the meeting
- Maintenance and compilation of meeting records
- Other arrangements such as transport, security and smooth conduct of the meeting proceedings

(4) Method of Information Dissemination

The facilitator team visited all the affected villages and distributed handout highlighting DFC project information and Draft ESIA Results. The team informed the purpose of the meeting and invited stakeholders to attend the meeting.

The following methods were used for notifying participants;

- Invitation letters were translated in local languages (Marathi for the villages in Maharashtra State, Gujarati for the villages in Gujarat State and Hindi for the villages in Rewari to Dadri Section) as appropriate and were sent to the Gram Panchayats, Legislators, NGOs and Government Officers.
- A handout containing information about the project and Draft ESIA Study in local languages (Hindi, Gujarati and Marathi) was distributed in potential affected villages. It was also stuck /pasted on the notice board of Panchayat office.

The invitation letters, handouts and presentation materials in English as well as in local languages (Hindi, Gujarati and Marathi) are attached in Appendix-9a for scoping stage PCM and Appendix-9c for Draft ESIA stage PCM.

(5) Record of the Meeting

In order to duly incorporate the result into the report, information on participants and content of the meeting was recorded in each PCM. Besides, feedback form was distributed to collect further comments and suggestions from the participants.

- Record of the Participants: Name, gender, occupation, village to which the participants belong and other appropriate features was recorded at the entrance.
- Record of the content of meeting: The contents of the discussion of the PCM were recorded by electronically recordable device and reproduced by transcribing the contents in the report.
- Feedback Form: Feedback forms were distributed to collect further comments and suggestions from participants, especially targeting comments and suggestions from vulnerable groups. Assistant(s) who helped participants to fill out the form were arranged when assistance in writing is required. The result was analyzed and incorporated into the report.

9.1.3 Schedule of PCM

(1) ESIA Scoping Stage

After having the 14 PCMs in 14 districts, necessity of holding additional PCMs in Thane and Raigad Districts were found to respond appropriately to the questions from the participants on social issues, especially on land acquisition and compensation. Therefore, it was decided to re-hold the meeting in Thane and Raigad. At the time, the area of affected villages in Thane was divided into two areas and had two PCMs separately to make the PCMs more effective since stretch of the DFC Phase 2 alignment passes through Thane District is much longer than that in other districts. In addition, in Faridabad, an additional PCM was held to cover 9 additional villages due to new alignment route for Faridabad-Tuglakabad DFC line. Thus, 18 PCMs in total were organized for the ESIA scoping stage.

Table 9.1.1 Information of 18 PCMs for ESIA Scoping Stage

District		Venue	Date
JNPT-Vadodara Section			
1	Bharuch District	Sevasharam Rajput Chhatralay	Nov. 18, 2010
2	Surat District	Manibhai Marrigat Hall	Nov. 19, 2010
3	Navsari District	Shri Maharaja Agrasen Sanskritik Hall	Nov. 20, 2010
4	Valsad District	Shri Ganesh Hall	Nov. 22, 2010
5	Vadodara District	Kheri Wadi Utpan Samiti Meeting Hall	Nov. 24, 2010
6	Thane District	K.T Wadi Hall	Nov. 25, 2010
7	Thane (Kalyan, Bhiwandi, Vasai): re-holding	Geeta Hall	Feb. 24, 2011
8	Thane (Palghar): re-holding	Lions Club of Palghar	Feb. 28, 2011
9	Raigad District	Asirvad Mangaal Karyalaya	Nov. 25, 2010
10	Raigad: re-holding	Agri Samai Hall	Feb. 25, 2011
Rewari-Dadri Section			
11	Rewari District	Yadav Samaroh Sthal	Nov. 10, 2010
12	Alwar District	Hotel Rajasthan Heritage	Nov. 11, 2010
13	Mewat District	Agarwal Dharamshala	Nov. 13, 2010
14	Palwal District	Abhinandan Banquet Hall	Nov. 16, 2010
15	Faridabad District	Jaat Bhawan	Nov. 18, 2010
16	Faridabad District (9 additional villages)	Primary School, Badshahpur Village, Faridabad Tehsil	Feb. 17, 2011
17	Gautam Budh Nagar	Sheree Vatika	Nov. 19, 2010
18	Gurgaon District	Punjabi Dharamshala	Nov. 20, 2010

Source: JICA survey team

(2) Draft Final ESIA Stage

District-wise PCMs were organized at 1 time (1 venue)/district basically in the 13 affected districts except Thane District. The DFC alignment traverses the land so long that the PCM was held at two places in Thane. After having the PCMs, necessity of holding additional PCMs in Valsad were found in order to respond appropriately as it was low participation rate in previous meeting due to the short notice to the participants. Therefore, it was decided to re-hold the meeting in Valsad.

Table 9.1.2 Information of 16 PCMs for Draft ESIA Stage

District		Venue	Date
JNPT-Vadodara Section			
1	Navsari District	Shri Maharaj Agrasen Sanskratik Bhawan	Sep. 9, 2011
2	Valsad District	Shri Ganesh Hall	Sep. 10, 2011
3	Valsad: re-holding	Shri Ganesh Hall	Sep. 26, 2011
4	Surat District	Sri Kutch Kadva Patidar Samaj Bhawan	Sep. 12, 2011
5	Bharuch District	Panchbati Rajput Chhatralaya	Sep. 13, 2011
6	Vadodara District	Khetivadi Utpann Bazar	Sep. 14, 2011
7	Thane (Palgar, Dahanu)	Lions Club Community Hall	Sep. 20, 2011
8	Thane (Kalyan, Bhiwandi, Vasai)	Geeta Hall	Sep. 21, 2011
9	Raigad District	Gokhale Sabhagrih & Mangal Karyalaya	Sep. 22, 2011
Rewari-Dadri Section			
10	Rewari District	Yadav Samaroh Sthal	Sep. 9, 2011
11	Alwar District	Hotel Rajasthan Heritage	Sep. 10, 2011
12	Mewat District	Agarwal Dharamshala	Sep. 12, 2011
13	Palwal District	Abhinandan Banquet Hall	Sep. 14, 2011
14	Faridabad District	Jaat Bhawan	Sep. 15, 2011
15	Gurgaon District	Punjabi Dharamshala	Sep. 16, 2011
16	Gautam Budh Nagar	Primary School, Gulaoli	Sep. 17, 2011

Source: JICA survey team

9.1.4 PCM for ESIA Scoping Stage

(1) Participants Analysis

Participants of the PCM for ESIA Scoping stage included the PAPs, other villagers, Gram Pradhan, Village Patwari, Administrative officers, Forest officers and Railway officers. All castes, creeds and classes participated in the PCM; however, the participation of women was poor. Detailing of the PCM meeting including minutes, number of participants, photographs and feedback analysis in each PCM are shown in Appendix-9b.

(2) Opinion and Issues Raised in the PCMs and Actions Taken

During the discussion in the PCMs, the main issues raised were compensation and employment. Other important issues were displacement and land acquisition, environment, health, drainage, and socio-cultural aspects. These issues were discussed and answered by the railway officials and experts. Main issues discussed are described as follows. Also, a summary of PCMs include information of venue, language, number and type of participants, major comments made by participants are shown in Table 9.1.3.

a) Compensation and employment opportunities

- Discontent on the compensation rate: Compensation proposed to be paid by DFCCIL is 160% of the circle rate (official rate). There was a very high resentment as the rates being paid as compensation does not correspond with the actual market rates.
- Demand on realizing guidelines on providing jobs to one member of every land losing household
- Demand on land-for-land and building-for-building were addressed

- Demands for female and young people to have access to equal opportunities of employments as well as individuals to provide training opportunities to develop their skills

b) Displacement and land acquisition

- Concern on the severe effected resulted from land acquisition: In some cases there may even be loss of homestead land of the people leading to subsequent displacement.
- Concern on loss of income due to land acquisition and concomitant livelihood impacts
- Concern on perceived loss due to the changes in land value along the alignment
- Concerns not only on compensation of land values but also for assets on that land – especially trees and wells.
- Concerns on how to manage the transition between an agricultural livelihood to something else – alternative livelihood or employment options associated with loss of productive land
- Location and quality of land replacement: PAPs do not want to be allocated remote land plots as compensation
- Devaluation of the agricultural land: Farmers do not want to be left with small useless plots of land
- Displacement of squatters and their treatment

c) Environment and Health

- Concerns on communities affected by loss of ecologically valued environment, culturally significant sites, and risks on their health (due to increasing noise and air pollution)
- Concerns on traffic accidents: Pedestrians (particularly children) and domesticated livestock living along the alignment may face risks caused by traffic accidents.
- Concerns on negative effect on natural habitats and landscapes be it forests, pasture land or specific habitats or landscapes with distinct characteristics: Specifically in Gurgaon, Navsari, Valsad, Thane and Raigad, they have an important cultural or spiritual meaning to communities or offer important resources to the local population, or are of economic importance.
- Noise and air pollution impacts: It might call for specific mitigation measures (like noise protection walls or a green belt as proposed by many stakeholders) or even for additional resettlement (moving people out of areas with intolerable noise levels).

d) Agriculture, Irrigation and Drainage

- Concerns on the negative impact on cultivated land.
- Concerns on the negative impact on social communication, petty trade, losing access to irrigation systems etc. where the project might constitute an obstacle to efficient use of or access to resources
- Concerns on famers' productive land divided in two and how this will be accommodated by design
- Concerns on shifting of existing water supply pipelines, electrical lines and sewerage lines: There are surface water bodies such as drains and canals joining the river bodies. Therefore, cross drainage works such as bridges, culverts etc. were required.

e) Access to resources and community facilities

- Concerns on situation in which residential areas find themselves separated from agricultural fields or other community assets like temples, mosques, cremation grounds, community centers etc., areas which were easily accessible before, or access to certain categories of land (e.g. pastures, sources of firewood or water)
- Concerns on potential interference with local infrastructure, such as markets, transport, electricity, communication and water, and public services such as medical service and education

f) Socio-cultural

- Concerns on physical impacts on culturally meaningful sites or objects (occupation of land), or by influx of people with a different ethno-cultural background into an area inhabited by a minority population
- Demand on constantly updating the status of the project and related social and environmental implications
- Demand on providing public consultation on gender, cultural, social, ecological and above all compensation related financial issues throughout project phases.

Table 9.1.3(1) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
JNPT - Vadodara Section					
1	[Date] 18 Nov. 2010 [Venue] Sevashram Rajput Chhatralay, Bharuch Gujarat [Participants] (1) 80 (2) Farmer, Sarpanch, Student, Service (3) 0/80 [Language] Gujarati	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Compensation: request to provide details on compensation and decision of land value	It was suggested that the issue regarding the land value is better to discuss with the "arbitrator" of the area.	Deputy Project Manager and Assistant Project Manager from CPM Surat Office
2	[Date] 19 Nov. 2010 [Venue] Manibhai Marriage Hall, Surat Gujarat [Participants] (1) 104 (2) Farmer, Housewife (3) 4/100 [Language] Gujarati		Compensation: request to provide compensation on affected trees	The experts will evaluate value of tree and calculate their monitory benefits to you for next 10 -20 years. This will help to give appropriate estimation of affected trees.	Deputy Project Manager and Assistant Project Manager from CPM Vadodara Office
			Accessibility disturbed by the alignment: request to provide information on the accessibility of water supply of their agricultural land and reaching their own agricultural land	No response made	
			Permission of the construction near alignment: request to provide information on the authority to give permission of construction near the DFCC track.	Presently permission for construction is given on the land located near railway line in big cities. The Government will think about similar process in villages too.	
			Change of water way: concern on the change of water way will cause inundation	Prior to construction, hydraulic study will be carried out to avoid such situation.	
			[Suggestions from collected feedback form] -Request for proper planning of water drainage		

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(2) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
3	[Date] 20 Nov. 2010 [Venue] Shri Maharaja Agrasen Sanskritik Hall, Navsari Gujarat [Participants] (1) 73 (2) Farmer, Government Official, Businessman, (3) 7/66 [Language] Gujarati	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Compensation: "Sangharsh Committee" established to deal and negotiate for all the issues related to DFC project, request appropriate compensation (be provided annuity for 32 years and job for one person per family)	The suggestion will send to higher authorities for consideration.	Assistant Project Manager from CPM Surat Office
			Compensation: request on Land-for-land, building-for-building	(No response made.)	
			Impact on the infrastructure: request to provide information on the affected infrastructures such as water source and drainage line	It will be ensured that drinking water, drainage, gas pipeline and phone cable do not get affected.	
			Change of water way: concern on the change of water way will cause inundation	Proper drainage system will be developed.	
			Socio-cultural: concern on the impact on the Dargah and Cremation ground	It will be ensured that no religious and cremation place under acquisition.	
			Accessibility disturbed by the alignment: request to provide provision for securing accessibility of the land which is to be divided by the alignment	The queries will be sent to the higher authorities for consideration.	
			[Suggestions from collected feedback form] -Request for compensatory afforestation -Request to minimise noise pollution	(No response made.)	
4	[Date] 22 Nov. 2010 [Venue] Shri Ganesh Hall, Valsad Gujarat [Participants] (1) 167 (2) Farmer, Others (Housewife etc), Government Official, Self Employed, Wage Worker, Village Head (3) 41/126 [Language] Gujarati		Compensation: request to revise the rate based on market rate	It is in the process an valuation will be done as per the government rules. It is suggested to inquire the value of your land with the "arbitrator".	Project Manager and Assistant Project Manager from CPM Surat Office
			Land acquisition: request to provide details of affected land	At the time of joint measurement survey, affected land will be clearly informed.	
			Employment: request to provide at least one member of the project affected family a job	The request will send to the higher authorities.	
			Compensation: request to evaluated the value of affected trees based on the market price	Valuation of the trees will be done by the experts and compensation will be given accordingly. The request will be sent to the higher authorities.	
			Accessibility disturbed by the alignment: request to provide provision for securing accessibility of passing rail way	The request will send to the higher authorities.	
			[Suggestions from collected feedback form] -Request for compensatory afforestation -Request for land-for-land and building-for-building compensation		

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(3) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
5	[Date] 24 Nov. 2010 [Venue] Kheti Wadi Utpann Samiti Meeting Hall, Vadodara Gujarat [Participants] (1) 105 (2) Farmer, Village Head, Government Official (3) 1/104 [Language] Gujarati	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	-Compensation: request to revise the rate based on market rate -Special consideration to vulnerable: request to provide any provision prepared for the woman land owner -Accessibility disturbed by the alignment: request to provide provision for securing accessibility of passing rail way -Compensation: request to provide information of tree compensation -Change of water way: concern on the change of water way will cause inundation -Residual land after the acquisition: Concern on the residual land which become too small to cultivate [Suggestions from collected feedback form] -Request for compensatory afforestation	All the request in the meeting will sent to the higher authorities and try to accommodate into the planning and implementation.	Assistant Project Manager from CPM Vadodara Office
6	[Date] 26 Nov. 2010 [Venue] K. T. Wadi Hall, Thane, Maharashtra [Participants] (1) 170 (2) N.A. (3) 5/165 [Language] Marathi		N.A	N.A	Assistant Project Manager from CPM Mumbai Office
7	[Date] 24, Feb 2011 (Re-holding meeting for Thane District) [Venue] Geeta Hall, Thane, Maharashtra [Participants] (1) 56 (2) Farmer, Social Worker, Government Official, Village Head (3) 2/54 [Language] Marathi		-Land acquisition: provide details on the affected land -Employment: request to provide job for affected farmers -Compensation: request to rise the compensation rate based on the market price -Special consideration to vulnerable: request to provide any provision prepared for affected elders -Noise pollution: request to provide details of noise pollution from the project and the counter-measure -Rehabilitation: request to provide appropriate rehabilitation measures for rentees	All the request in the meeting will sent to the higher authorities and try to accommodate into the planning and implementation.	Deputy Chief Project Manager and Assistant Project Manager from CPM Mumbai Office

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(4) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
8	[Date] 28, Feb 2011 (Re-holding meeting for Thane District) [Venue] Lions Club Community Hall, Palghar, Maharashtra [Participants] (1) 201 (2) Farmer, Businessman, Housewife, Village Head (3) 68/133 [Language] Marathi	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. Of the Project Proponent; and 7. Q & A	-Compensation: request to rise the compensation rate based on the market price -Afforestation: request for compensatory afforestation of trees cut during construction of the project -Accessibility disturbed by the alignment: request to provide provision for securing accessibility of passing rail way -Pollution: request to provide details of any potential pollution from the project and the counter-measure -Land record: request to assist the land to be registered before starting any procedure of compensation -Land acquisition: provide details on the affected land -Employment: request to provide job for affected farmers -Compensation: request to provide land-for-land and building-for-building compensation -Special consideration to vulnerable: request to provide any provision prepared for affected schedule tribes and poor -Accessibility disturbed by the alignment: request to provide provision for securing accessibility of passing rail way	All the request in the meeting will sent to the higher authorities and try to accommodate into the planning and implementation..	Deputy Chief Project Manager and Assistant Project Manager from CPM Mumbai Office
9	[Date] 25 Nov. 2010 [Venue] Asirvad Mangal Karyalaya, Raigad Maharashtra [Participants] (1) 133 (2) N.A. (3) 26/107 [Language] Marathi		N.A.	N.A.	Assistant Project Manager from CPM Office Mumbai Office
10	[Date] 25, Feb 2011 (Re-holding meeting for Raigad District) [Venue] Agri Samaj Hall, Raigad, Maharashtra [Participants] (1) 64 (2) Farmer, Village Head, M.L.A, P.A, Reporter (3) 3/61 [Language] Marathi		-Socio-Cultural: request to provide provision for securing the place of worship -Compensation: request to revise the compensation rate base on the market price -Land acquisition: provide details on the affected land -Employment: request to provide job for affected farmers -Afforestation: request for compensatory afforestation of trees cut during construction of the project -Compensation: request to adapt similar policy of CIDCO, which was agreed to give airport land shares to the farmers, to this project	All the request in the meeting will sent to the higher authorities and try to accommodate into the planning and implementation.	Deputy Chief Project Manager and Assistant Project Manager from CPM Office Mumbai Office

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(5) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
Rewari - Dadri Section					
11	[Date] 10 Nov. 2010 [Venue] Yadav Samaroh Sthal, Rewari, Haryana [Participants] (1) 174 (2) Farmer, Village Head (3) 2/172 [Language] Hindi	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Compensation: request to revise the rate based on market rate.	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Employment: request to provide at least one member of the project affected family a job.	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate.	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities.	
			Accessibility disturbed by the alignment.	DFC will see that there is minimum disruption in the ordinary live of people wherever the railway corridor is coming up. Existing roads if closed due to compulsions of project, alternate roads will be drawn up. Depending on the need railway crossing or underpass or railway overrides will be constructed.	
			[Suggestions from collected feedback form] -Afforestation should be encouraged along the rail corridor. -Request to minimize the noise and vibration pollution.		
12	[Date] 11 Nov. 2010 [Venue] Hotel Rajasthan Heritage, Alwar, Rajasthan [Participants] (1) 154 (2) Farmer, Wage Worker, Businessman, Driver, Village Head, Forest Officer, Counsellor (3) 0/154 [Language] Hindi		Compensation: request to revise the rate in terms of involving the villagers at the time of decision making.	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Alignment: request to reconsider the alignment not to affect the company called EMCO, which has 300 employees.	Please mention the details with plot number in the feedback forms. (Later, there was no feedback forms indicating this matter)	
			Alignment: request to reconsider the alignment to traverse the industrial area instead of going through centre of the village.	Please provide all details in the feedback form. (Later, there was no feedback forms indicating this matter)	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate.	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities.	
			[Suggestions from collected feedback form] -Request to minimize the noise and vibration pollution. -Afforestation should be encouraged along the rail corridor.		

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(6) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
13	[Date] 13 Nov. 2010 [Venue] Agarwal Dharamshala, Mewat, Haryana [Participants] (1) 195 (2) Farmer, Businessman, Village Head, Reporter, Forest Officer (3) 0/195 [Language] Hindi	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Compensation: request to revise the rate	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Employment: request to provide at least one member of the project affected family a job	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities	
			Afforestation: request for compensatory afforestation of trees cut during construction of the project	(No response made.)	
			[Suggestions from collected feedback form] -Request to minimize the noise and vibration pollution -Request to adapt NCR rate for the compensation estimation		
14	[Date] 16 Nov. 2010 [Venue] Abhinandan Banquest Hall, Palwal Haryana [Participants] (1) 86 (2) Farmer, Village Head, Forest Officer (3) 0/86 [Language] Hindi		Compensation: request to revise the rate based on market rate	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Employment: request to provide at least one member of the project affected family a job	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities	
			Accessibility disturbed by the alignment	DFC will see that there is minimum disruption in the ordinary live of people wherever the railway corridor is coming up. Existing roads if closed due to compulsions of project, alternate roads will be drawn up. Depending on the need railway crossing or underpass or railway overrides will be constructed.	
			[Suggestions from collected feedback form] -Request to minimize the noise and vibration pollution -Request for prepare the provision of land-for-land -Request to prepare the provision of avoid accident (both villagers and cattle)		

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(7) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
15	[Date] 18 Nov. 2010 [Venue] Jaat Bhawan, Faridabad Haryana [Participants] (1) 119 (2) Farmer, Service, Shop Owner, Village Head (3) 3/116 [Language] Hindi	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Accessibility disturbed by the alignment	DFC will see that there is minimum disruption in the ordinary live of people wherever the railway corridor is coming up. Existing roads if closed due to compulsions of project, alternate roads will be drawn up. Depending on the need railway crossing or underpass or railway overrides will be constructed.	APM from CPM R-D Office
			Compensation: request to provide details	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities	
			Employment: request to provide at least one member of the project affected family a job	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			[Suggestions from collected feedback form] -Request for compensatory afforestation -Request to minimize the noise and vibration pollution -Request to prepare the provision of avoid accident (both villagers and cattle)		
16	[Date] 17 Nov. 2010 [Venue] Faridabad Tehsil, [Participants] (1) 86 (2) Farmer (3) 0/86 [Language] Gujarati		Request to provide project details and alignment	DFC will provide it very soon.	Consultant from DFCCIL
			Compensation: request to provide details on compensation and decision of land value	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	
			Negative impact to existing water resource by the alignment passing through the village	Alternative arrangements will be made wherever such dislocation of water resources will occur.	

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.3(8) Summary of Public Consultation Meeting for ESIA Scoping Stage

No	Date / Venue / Participants / Language	Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
17	[Date] 19 Nov. 2010 [Venue] Shree Shyam Vatika, Gautam Butabudh Nagar Uttar Pradesh [Participants] (1) 39 (2) Farmer, Businessman, Reporter (3) 0/39 [Language] Hindi	1. Introduction 2. Project Objectives & Components; 3. Expected Env. & Social Impacts under EIA; 4. Proposed ESIA Study Scope; 5. Further Information Disclosure; 6. Contact Info. of the Project Proponent; and 7. Q & A	Compensation: request to adapt the project to similar policy of Greater Noida Authority, which allots plots in lieu of land acquired	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Employment: request to provide at least one member of the project affected family a job	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			Residual land after the acquisition: Concern on the residual land which become too small to cultivate	Such residual land will be acquired by DFC. The interests of small farmers will be kept in mind while designing appropriated policy and guidelines. The concern will be taken to the higher authorities	
			Afforestation: request for compensatory afforestation of trees cut during construction of the project	(No response made.)	
18	[Date] 20 Nov. 2010 [Venue] Punjabi Dharamshala, Gurgaon Haryana [Participants] (1) 125 (2) Farmer, Forest Village Head, Businessman, Forest Officer, (3) 0/125 [Language] Hindi		Compensation: request to revise the rate based on market rate	Compensation will be 160% of the circle rate of respective villages. Land is being acquired as per Railway Amendment Act 2008.	Consultant from DFCCIL
			Employment: request to provide at least one member of the project affected family a job	The guideline are being drawn and a written notification has also been issued in this regard, detailed guidelines and other such policy matters will be informed in the next meeting.	
			[Suggestions from collected feedback form] -Request for compensatory afforestation -Request to minimise noise and dust pollution -Request for prepare the provision of land-for-land -Request to construct bridge over the rail track to secure the accessibility -Request to prepare the provision of avoid accident (both villagers and cattle)		

Note: Participants; (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

9.1.5 PCM for Draft Final ESIA Report Stage

(1) Participants Analysis

Participants of the PCM for Draft ESIA Reporting stage were almost composed of same concerned people as the participants of PCMs for Scoping stage i.e. PAPs, other villagers, Village Sarpanches, Village Patwari, Administrative officers, Competent Authority, Forest officers and Railway officers. Detailing of the PCM meeting including minutes, number of participants, photographs and feedback analysis in each PCM are shown in Appendix-9d.

(2) Opinion and Issues Raised in the PCMs and Actions Taken

During the discussions in the PCMs for Draft ESIA Reporting stage, people raised many issues apart from higher compensation rate and employment. Most of these issues related to clarification on published 20A or 20E Notifications, discrepancy in land records, clarification on width of ROW, provision of accessibility of service roads to farmers, displacement and land acquisition, environment and health, drainage conditions, and socio-cultural aspects. These issues were discussed and answered by the railway officials, Competent Authority and experts. Main issues discussed along with suggestions provided by the people are described as follows. In addition, a summary of PCMs including information of venue, language, number and type of participants, major comments made by participants and responses by DFCCIL officials are shown in Table 9.1.4.

a) Displacement and land acquisition

- Concern on removal of existing overhead electric cable lines in alignment route, underground water pipelines for irrigation, gas pipelines, sewerage lines etc.,
- Concern on loss of income due to land acquisition and concomitant livelihood impacts,
- Concern on perceived loss due to reduced land value along the alignment,
- Concerns not only on compensation of land values but also for assets on that land – especially trees and wells,
- Concerns on how to manage the transition between an agricultural livelihood to something else – alternative livelihood or employment options associated with loss of productive land,
- Devaluation of the agricultural land: Farmers do not want to be left with small useless plots of land, and
- Displacement of squatters and their treatment.

b) Clarification on aspects related to alignment

- Width of land in ROW to be acquired by DFC Project,
- Confusion on published 20A or 20E Notifications due to different plot numbers, missing titleholder names, different village names due to alignment change and mismatch with revenue land records,
- Concern on non-availability of alignment drawings for DFC Project to the PAPs,
- Suggestions on shifting of alignment from main village habitation to at least 200 m or beyond and keeping safe distance from the houses,

- Provision of service roads on both sides of the alignment route and adequate ROBs/RUBs/FOBs to reduce hardships to farmers, and
- Clarification on time period for completion of project and compensation payment to PAPs, District-wise project costs.

c) Compensation and employment opportunities

- Discontent on the compensation rate: Compensation proposed to be paid by DFCCIL is 160% of the circle rate (official rate). There was a very high resentment as the rates being paid as compensation does not correspond with the market rates. Some area is more developed, has high fertile land, and has high quality of other environmental attributes, so the land valuation is not uniform as compared to other areas in the same district,
- Demand for consideration of compensation rate as per the proposed New Land Acquisition Bill which is due to be passed within next six months. Moreover, long term benefits to be passed on to the farmers since Railways will continue to have profit for a longer period,
- Demand on acquisition of residual portion of land at the same compensation rate,
- Demand on realizing guidelines on providing jobs to one member of every land losing household. Employment should be given before land acquisition and not after construction of the project,
- Uniform rate for adjoining lands irrespective of they fall in different administrative boundaries,
- Demand on land-for-land, building-for-building, compensation for damaged crops (if any) or loss of productivity in nearby fields, and compensation for common lands to be addressed, and
- Demands for female and young people to have access to equal opportunities of employments as well as individuals to provide training opportunities to develop their skills.

d) Environment and health

- Suggestion on no use of top fertile soil from the nearby agricultural lands for DFC Project,
- Suggestion on implementation of afforestation work on both sides of the DFC line using local trees only. Not only afforestation should be done on both sides of railway line but all tress planted should be protected from illegal felling,
- Concern on deterioration of local water resources in terms of quality and quantity due to the DFC Project. Since many project area has high ground water table and surface rivers, no wastewater should enter surface and ground water sources,
- Concern on creation of unhygienic environment in and around the villages due to poor sanitation and stagnation of water along the rail line,
- Use of fertile agricultural lands for construction of yards or stockpiling of construction materials to be avoided,
- Concerns on communities affected by loss of ecologically valued environment, culturally significant sites, and risks on their health due to increasing noise and air pollution, and

- Noise and air pollution impacts: It might call for specific mitigation measures (like noise protection walls or a green belt as proposed by many stakeholders) or even for additional resettlement (moving people out of areas with intolerable noise levels).

e) Drainage conditions

- Suggestion of appropriate drainage along the rail line so that land along the alignment does not get affected due to water logging, and
- Concerns on shifting of existing water supply pipelines, electrical lines and sewerage lines: There are surface water bodies such as drains and canals joining the river bodies. Therefore cross drainage works such as bridges, culverts etc. were required.

f) Access to resources and community facilities

- Concerns on situation in which residential areas find themselves separated from agriculture fields or other community assets like temples, mosques, cremation grounds, community centers etc., areas which were easily accessible before, or access to certain categories of land (e.g. pastures, sources of firewood or water), and
- Concerns on potential interference with local infrastructure, such as markets, transport, electricity, communication and water, and public services such as medical service and education.

g) Socio-cultural

- Concerns on physical impacts on culturally meaningful sites or objects (occupation of land), or by influx of people with a different ethno-cultural background into an area inhabited by a minority population,
- Demand on constantly updating the status of the project and related social and environmental implications, and
- Demand on providing public consultation on gender, cultural, social, ecological subjects and above all compensation related financial issues throughout project phases.

Table 9.1.4(1) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
JNPT - Vadodara Section				
1	[Date] 9 Sep. 2011 [Venue] Shri Maharaj Agrasen Sanskratik Bhawan, Navasari, Gujarat [Participants] (1) 86 (2) Farmers, Village Sarpanches, Lawyer, Land Acquisition Officer (3) 6/80 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	-Compensation: Participants wanted to know the kind of compensation which will be awarded to them. -If the Railway is using the land for commercial purpose in the name of DFCC, why does not it give the farmer the commercial rates for land acquisition?	As far as compensation is concerned, that will be declared by the Ministry of Railways during the RRP PCM Meetings.	Project Manager and Assistant Project Manager from CPM Office Surat
		-What will happen to our facilities and utilities? Any repair or alteration in our properties near to the railway tracks requires permission from railways. We have to travel to Mumbai several times to seek such permission. Will it be the same with DFCC?	All the facilities and utilities will remain as it is and if there is any destruction, DFC will reconstruct the same at its own cost.	
		-Participants wanted to know redress of the issues raised during scoping PCM. -Participants demanded minutes of the last PCM meeting.	(No response made.)	
		-Raised concern on confusion about the measurement of the land to be acquired for the project as there are many pillar in their field. -Why railways did not inform or taken along the local people during marking.	(No response made.)	
		-Why the higher officials of the state administration are not present in the meeting? -Why was the notice for organising PCM not published in the newspapers?	(No response made.)	
		[Suggestions from collected feedback forms]: -Committee having members from the local farmers should be formed before conducting any physical survey. -Farmers should be included in the on-going market survey.		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(2) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
2	[Date] 10 Sep. 2011 [Venue] Ganesh Hall, Near Kasturba Hospital , Valsad , Gujarat [Participants] (1) 21 (2) Farmers, Village Sarpanch, Land Acquisition Officer (3) 1/20 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. EMP outline 6. Institutional Framework 7. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports	-Compensation: Kind of compensation which will be awarded to them. -One of participants wanted DFCC to take up government land instead of their land.	(No response made.)	Project Manager and Assistant Project Manager from CPM Office Surat
		Concern about the measurement of the land to be acquired for the project as there are many pillars in their field.	Assistant Project Manager asked them to give their applications and DFCC will forward them to higher officials.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(3) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
3	[Date] 26 Sep. 2011 (Re-holding meeting for Valsad District) [Venue] Ganesh Hall, Near Kasturba Hospital, Valsad, Gujarat [Participants] (1) 210 (2) Farmers, Village Sarpanches, Social Workers, Press Reporters (3) 45/165 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Considerations on deciding Compensation Rate: 1. Land between Mumbai and Surat is highly fertile and cultivated, so this factor should also be assessed while deciding the compensation rate. 2. People reiterated that the compensation rate should be given as per market rate and not as per Circle rate (locally called "Jantri Rate"). If this rate is not given, they will fight for it. They should be given some definite timeline for giving compensation.	As per special Railway Amendment Act, 2008, the highest rate between Jantri rates and Sale deed are considered for payment by adding 60% more. Extra payment is also given for affected structures, wells, trees and any other.	Project Manager and Assistant Project Manager from CPM Office Surat
		Clarification on 20E Notification: Concern on missing names in the 20E Notification. Some had confusion on alignment route due to publication of notification for two times. They enquired if the compensation would be given based on notification or actual ground survey.	Compensation would be given as per actual ground survey as well as according to revenue records.	
		Concern on Acquisition of fertile land: During construction no fertile land should be used either for go downs or for stockpiling of construction materials. Decision should be made by DFC to exclude acquisition of all fertile lands for construction of yards since the land requirement in this case is more. Only barren lands should be used.	Project has already considered all these aspects.	
		-Concern on blockage of approach roads to existing lands by the DFC Project and this issue should be addressed appropriately in the project. -Mechanism under which their comments were going to be addressed by the project. -Status of R&R Report in the project. -Clarity on whether the service roads would be made accessible to them or not.	Within next two to three months, separate meeting would be conducted where results of R&R Report including rate of compensation would be explained to them. Such meetings would be conducted with only PAPs and preferably in smaller groups.	
		More Info on Compensation Rate: 1. When will the compensation rate be given? 2. How much compensation rate will be given? 3. Whether the project will give compensation as per the proposed New Land Acquisition Bill which is due to be passed within next six months? 4. Compensation rate should be informed to each PAP in writing. 5. Process of compensation for common lands such as burial ground etc.	As per RAA, compensation has to be given within one year from the date of publication of 20E Notification, otherwise the notification will lapse.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(4) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
4	[Date] 12 Sep. 2011 [Venue] Sri Kutch Kadva Patidar Samaj Bhawan, Surat, Gujarat [Participants] (1) 72 (2) Farmers, Village Sarpanches, Businessman, (3) 2/70 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	-Compensation: 1 Should be paid keeping into the losses incurred by the farmers. 2 Due to vibration, the productivity of the land adjoining the rail track will be severely affected. How DFCC will compensate that? 3 Farmer's representatives should be included for deciding compensation. - Will provisions of new Land Acquisition Bill introduced in the parliament recently be implemented for the present acquisitions?	(No response made.)	Project Manager and Assistant Project Manager from CPM Office Surat
		-How will the DFCCIL compensate the use of land which has not been acquired but will be used during construction of the tracks (dumping of construction materials)?	Whosoever contractor would be involved for construction, such cases may be dealt by them.	
		What will happen to the part of land which is not being acquired?	There was a provision of 25 percent extra compensation for such issue.	
		20A: Since last four years after declaration of 20A, farmers are still waiting for the compensation. This amounts to mental torture to them.	New 20A has been issued on 12/3/2011 and now the acquisition will be done accordingly	
		Will farmers need NOC from the railways to convert their adjoining land to NA?	There is no need to take permission from the Railways if it was not within ROW.	
		Farmers wanted to know it there was any provision of land for land under the Railways Act.	There is no such provisions in the Railways Act.	
		Pillars measurement: Farmers wanted to know when the railways was doing marking (Pillars) why were they not informed or taken along with.	(No response made.)	
		Project: Farmers wanted to know if it was a Japanese company or Indian Railways company.	(No response made.)	
		Farmers expressed fear that the land being acquired by the Railway might be given to private parties for commercial use.	(No response made.)	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(5) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
5	[Date] 13 Sep. 2011 [Venue] Panchbati Rajput Chhatralaya, Bharuch, Gujarat [Participants] (1) 56 (2) Farmers, Village Sarpanches, other Villagers (3) 1/55 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	What will happen to the part of the land which had not been acquired?	(No response made.)	Deputy Project Manager and Assistant Project Manager from CPM Office Vadodara
		Employment: One person from each affected family should be given a job in the DFCC. There are some families who are losing their settlements, what will be resettlement plan for them.	Till now we are considering the RRP 2007 for deciding the compensation. But the head office is working on new RRP which will be disclosed to you all in the next meeting.	
		The farmers losing the entire land will become landless and will be deprived of their farmer's status.	The competent authority will issue them a certificate in this regard and these farmers will retain their status.	
		There would be loss of productivity in the fields adjoining tracks, how DFCC will compensate that.	DFCC had done a detailed study on the impacts of the vibration along the rail tracks. There will be not much effect on productivity. However, all necessary mitigation measures will be taken to reduce the impact on the productivity of the land.	
		They would need permission of the Railways for any alteration, construction or repairing near the ROW which is not given easily by the Railways.	Since it concerned Railways, only they could comment on this.	
		The compensation given to the PAPs will finish to meet the immediate expenses or needs of the PAPs. For long term livelihood sustenance, there should be provision of pension scheme for the land losers so that they can have a regular income.	This suggestion should have been given earlier so that it could have considered for the RRP. CPM officers will forward the suggestion to higher authorities for consideration.	
		One of the participants suggested that the number of bridges and ROBs should be increased to cut the travel time of the people.	(No response made.)	
		Participants wanted the detailed ESIA report in each village so that they could read it in full text.	The summary will be available with Panchayats. However, participants insisted on detailed report to be made available to the Panchayats.	
		The compensation should be paid directly in the account of the PAPs.	(No response made.)	
		The compensation paid by the GGIL in 2007 was more than what DFCC is giving now. It is injustice to farmers.	The complaints and suggestion such as these should be presented to the competent authority for his consideration.	
		There was unnecessary delay in payment of the compensation.	All those cases appropriate interest will be paid.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(6) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
6	[Date] 14 Sep. 2011 [Venue] Khetivadi Utpann Bazar, Vadodara, Gujarat [Participants] (1) 56 (2) Farmers, Village Sarpanches, Other Villagers (3) 2/54 [Language] Gujarati [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	If environment is a concern for the government, this railway project should not be done?	All necessary steps will be taken to mitigate the impact of the project on environment.	Assistant Project Manager and Station Superintendent from CPM Office Vadodara
		Water logging due to elevated track is one of the most anticipated issues. The productivity of the land will decrease significantly due to water logging.	The design of the alignment will take care of this issue. Villagers were requested to support DFCC technical team in identifying the areas where water logging can happen.	
		The circle rate is very less whereas the fact is that the land is being sold to private companies for Rs 40 lakhs per acre. The DFCC is paying very less. Higher rate as compensation should be considered. We had several rounds of PCMs but do not know what was outcome of it.	They have instituted an agency to confirm the market rate and considerations would be given to its recommendations.	
		Though a lot of land has already been acquired, the farmers have not received the compensation yet. Why there was delay in disbursement of the compensation?	The disbursement of the compensation was going on and if there was any delay in the payment, appropriate interest would be paid.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(7) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
7	[Date] 20 Sep. 2011 [Venue] Lions Club Community Hall, Thane (Palghar, Dahanu, Talasari), Maharashtra [Participants] (1) 115 (2) Farmers, Village Sarpanches, Police Officers, Competent Authority, (3) 20/95 [Language] Marathi [Topics] 1. Project background 2. Information on New Government Resolution (GR) 3. Scope of Project 4. Objectives of PCM 5. Results of ESIA Study on Environmental Impacts and Mitigation Measures 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Concern on new GR: Apart from members from the Government Department and Railways, representatives of the PAPs or people's representatives should also be included in the Committee.	Committee has been formed to negotiate the rates with the farmers/PAPs. This will benefit the PAPs. However, the suggestion of the PAPs regarding inclusion of People's Representatives in GR will be forwarded to the DFCCIL.	Deputy CPM (Fin.), Deputy Project Manager and Assistant Project Managers from CPM Office Mumbai
		People demanded Minutes of last meeting to know what decisions were taken on the issues raised during the meeting.	Issuing of new GR was the result of the last meeting	
		Requested to release their excess land from the purview of notification since the project would not acquire it. It was causing a lot of trouble to them for last three to four years since they could neither rebuilt their houses nor could raise their crops on notified part of land.	Soon this issue will be resolved.	
		Concern on anomalies in the 7/12 forms and should be corrected before any further action on land acquisition.	(No response made.)	
		Concern on Compensation: 1. Why the provisions of the Proposed New Land Acquisition Bill presented in the Parliament recently was not being presented here and why they would not be considered for deciding compensation? 2. Long term benefits to the farmers should be for at least 33 years since Railways will continue to have profit for 33 years through this project. 3. If their land was being acquired under the RAA 2008 only, what is the purpose of these PCM meetings.	No comment can be made on the provisions of proposed New Land Acquisition Bill as no decision has been conveyed to them in this regard.	
		Concern on absence of any responsible officer from the Revenue Department to answer their questions on land related issues.	(No response made.)	
		Demanded confirmation in writing on provisions of POBs, RUBs and FOBs planned in the project.	(No response made.)	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(8) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
8	[Date] 21 Sep. 2011 [Venue] Geeta Hall, Thane (Kalyan, Bhiwandi), Maharashtra [Participants] (1) 94 (2) Farmers, Village Sarpanches, Other Villagers, Competent Authority, Member of Zila Parishad, Press Reporters, (3) 9/85 [Language] Marathi [Topics] 1. Project background 2. Information on New Government Resolution (GR) 3. Scope of Project 4. Objectives of PCM 5. Results of ESIA Study on Environmental Impacts and Mitigation Measures 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Concern on Compensation for Structures: 1. Compensation for destruction of the buildings are too less and should also include location factor while deciding the rate of compensation. 2. PAPs will be compensated at the prevailing rates of 2008 but they would have to buy the property in 2012. How will that be matched?	(No response made.)	Deputy CPM (Fin.), Deputy Project Manager and Assistant Project Managers from CPM Office Mumbai
		Concern on Compensation for Land: 1. The Nagar Sewak said that the people were not against the development of the country or railway but wanted proper compensation so that they can sustain their livelihood. He requested to compensate as per the ready reckoner. 2. There are many cases where people are living on rent. How will they be compensated? 3. People's representatives should be consulted before the land being acquired.	DFCC was aware of the ready reckoner and other existing rates and that was being finalized with the government.	
		Concern on new GR: Apart from members from the Government Department and Railways, representatives of the PAPs or people's representatives should also be included in the Committee.	(No response made.)	
		The Vice-President of the Zila Parishad was highly concerned on low compensation to the PAPs. He also informed that Kopar Village was inundated in 2005 floods and DFCC is taking the track from the same village. It would be dangerous for the project. He also demanded proper connectivity so that people do not have to travel 6 km or more to cross over.	The land will be acquired only after payment of the compensation amount to the PAPs.	
		Concern on 7/12 Records: 1. How the entitlement of those farmers would be decided who did not have the title but are taking crops from the same field for long time? 2. 7/12 Extract has many names and it was not clear whose land was actually being acquired. 3. Concern on exact demarcation of land on ground to be acquired.	Issues related to 7/12 Extract would be over once the Joint Measurement is done. People would know how much land is being acquired and of whom.	
		Concern from those farmers who will become landless after losing all land. If loses all the land, what option for livelihood.	(No response made.)	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(9) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
9	[Date] 22 Sep. 2011 [Venue] Gokhale Hall (Panvel), Raigad, Maharashtra [Participants] (1) 135 (2) Farmers, Vilalge Sarpanches, Other Villagers, Ex-President of Zila Parishad, Competent Authority (3) 9/126 [Language] Marathi [Topics] 1. Project background 2. Information on New Government Resolution (GR) 3. Scope of Project 4. Objectives of PCM 5. Results of ESIA Study on Environmental Impacts and Mitigation Measures 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Concern on Compensation: 1 People demanded minutes of last meeting 2 The issue of compensation should be discussed with a committee of People's Representatives before finalizing the rates.	-DFCCIL has already taken action on the basis of the proceedings of the last meeting to give due consideration to the issues of PAPs and only because of such consultative exercise that a special GR has been issued for deciding the compensation rate. -The minutes of this meeting and last meeting will be presented when the next meeting will be organized to discuss various provisions based on the results of RRP Study.	Deputy CPM (Fin.), Deputy Project Manager and Assistant Project Managers from CPM Office Mumbai
		Concern on new GR: Apart from members from the Government Department and Railways, representatives of the PAPs or people's representatives should also be included in the Committee.	The demand of market rates will be resolved through negations with farmers by the committee.	
		Strong demand on the social considerations such as compensation rates and provision of jobs. A Social Expert should assess the social problems of the PAPs.	(No response made.)	
		It was suggested that the Sarpanches of all the affected villages, councilors, MLAs and MP meet first to discuss various issues faced by the PAPs and then the next PCM meeting of DFFCIL should be conducted.	(No response made.)	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(10) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
Rewari - Dadri Section				
10	[Date] 9 Sep. 2011 [Venue] Yadav Samaroh Sthal, Rewari, Haryana [Participants] (1) 152 (2) Farmers, Village Sarpanches, DRO (3) 0/152 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. EMP outline 6. Institutional Framework 7. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 8. Contact info of the CPM Officers and 9. Q & A	Local Infrastructure: Concern on the removal of existing overhead electric cable lines in alignment route and underground water pipelines for irrigation.	DFC would ensure that all such disturbed facility is restored or alternate arrangement is done without affecting the local villagers/farmers.	Project Manager from CPM Office Noida
		Width of ROW: How much width of land would be acquired by DFC?	In general the total width of land would be 50-60 m but wherever yards, sub-station or any other facility is to be built, additional width of land would be acquired.	
		Clarification on published 20A Notification: Issue – Clarity on newspaper notices published in June 2010 and again published in July 2011 as both were showing different khasara nos and did not match with pegging stones on field. If land belonging to both khasara nos. would be acquired.	All Khasara numbers mentioned in July 2011 notification was correct and final and should forget June 2010 notification. Joint measurement survey would be done only for khasara nos. mentioned in July 2011 notice. 5-6 objections had already come in response to July 2011 notification and would be clarified in DRO Office on 29th September 2011.	
		Residual land after acquisition: Concern on the residual land which become too small to cultivate.	Once again informed that DFCCIL would also acquire any such small residual portion of land which would be left after acquiring main portion of land if any farmer would be so interested.	
		Availability of Drawings: Requested that alignment drawings for DFC Project should be made public.	All relevant alignment drawings were available in the DRO Office and could be accessed.	
		Discrepancy in Land Records: Concern that since notification of land was done about two years ago and from that time many of the landowners have changed, what precaution DFC would take so that compensation amount goes to the right person.	In case of any discrepancy, people should give their application to the DRO Office. In addition, they can also inform the team during Joint Measurement (JM) survey. Although the record was taken from the local District Office, there could be an error. DFC would not solely go by the newspaper notice but verify them during JM exercise.	
		Issue: Concern of people from Village 'Kamalpur' specifically since DFC alignment was going within 100 m from their habitation.	The alignment was already finalized but the project would ensure that no impact is there due to noise and vibration.	
		[Suggestions from collected feedback forms]: -No soil should be taken from the nearby agricultural lands. -Afforestation should be done on both sides of railway line		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(11) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
11	[Date] 10 Sep. 2011 [Venue] Hotel Rajasthan Heritage, Alwar, Rajasthan [Participants] (1) 140 (2) Farmers, Village Sarpanches, SDM, Range Forest Officer (3) 0/140 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. EMP outline 6. Institutional Framework 7. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 8. Contact info of the CPM Officers and 9. Q & A	Local Water Resources: Concern on effect to local water resources in terms of quantity and quality. No wastewater should enter surface and ground water sources. Since the area has high ground water table, no activity of the project should pollute the water sources.	Project would take all care to protect local water sources. No water would be taken from the existing water sources which are used by the local people but the project would explore alternate options in consultation with the local Government Departments.	Project Manager from CPM Office Noida
		Sanitation: Concern on problem of sanitation and stagnation of water along the rail line which create unhygienic environment in and around the villages.	Project is meant for freight trains and hence would not result in any sanitation problem. Proper drainage system would be provided along the alignment to avoid any stagnation of water.	
		Noise and Vibration Pollution: Vibration level should be reduced to a minimum so that local villagers are not affected.	New and modern technology would be used in the project which would reduce noise and vibration pollution to the minimum levels.	
		Compensation Rate: Uniform rate should be provided since there is a wide difference in circle rate of Haryana and Rajasthan and adjoining villages of Haryana would get more compensation due to better circle rate.	This is a special project of Railways and hence they are entitled to receive 60% more rate above the circle rate as decided by the Competent Authority. The State has appointed SDM, Tijara Block as the Competent Authority for deciding the circle rate. The project would ensure that there is no loss to the people. Not only this, compensation rate would also be provided for all affected trees on private land, structure, dug well, tube well or any other.	
		Residual land after acquisition: Concern on the residual land which become too small to cultivate	Once again informed that DFCCIL would also acquire any such small residual portion of land which would be left after acquiring main portion of land if any farmer would be so interested.	
		[Suggestions from collected feedback forms]: -Afforestation should be done on both sides of railway line using local trees -Road should be provided on both sides of the alignment route		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(12) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
12	[Date] 12 Sep. 2011 [Venue] Agarwal Dharamshala, Mewat, Haryana [Participants] (1) 187 (2) Farmers, Village Sarpanches, Businessman, District Revenue Accountant, Land Acquisition Collector (3) 0/187 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Improper Representation from Revenue Department: Concern on absence of key Government Officials from Revenue Department such as SDM, DRO, Tehsildar.	Due to an urgent visit of some Central Government team, these officials could not come. However, CPM office would facilitate a separate meeting with all of these officials at the earliest after discussing with DRO (Competent Authority).	Project Manager and Consultant from CPM Office Noida
		Width of ROW: How much width of land would be acquired by DFC? Is there any provision in the project to provide service road on both sides of the alignment?	In general the total width of land would be 50-60 m but wherever yards, sub-station or any other facility is to be built, additional width of land would be acquired. Mewat will have a crossing station where the land requirement will be more. Nearly 5 m wide service road will be provided on one side of the alignment route.	
		-Compensation Rate and Employment: 1. Land valuation of Taoru area is more as compared to other areas in Mewat District because of high quality of water, air, soil and climate. These factors should also be considered while deciding the circle rate of this area. 2. Most of the farmers in project affected villages are small and marginal and they would become landless after this project. So, they should be provided with some sort of support in terms of employment.	(No response made.)	
		Clarification on published 20A Notification: No information on publication of 20A Notification. No Village Patwari had informed them about their Khasra nos. and area of land which would be acquired.	CPM Office would send official letter to DRO in a day or two and asked each village Patwari to inform each and every affected person. For any confusion, they can also contact directly the CPM Office at Noida.	
		Residual land after acquisition: Concern on the residual land which become too small to cultivate. Wanted a written policy in this regard. What extent the project would acquire additional land and what would be the compensation rate for this additional piece of land?	Project would also acquire any such small residual portion of land which would be left after acquiring main portion of land if any farmer would be so interested.	
		Availability of Drawings: Request for alignment drawings for DFC Project.	All relevant alignment drawings were available in the DRO Office and could be accessed.	
		[Suggestions from collected feedback forms]: -Appropriate drainage should be provided so that lands along the alignment does not get affected due to water logging -Not only afforestation should be done on both sides of railway line but all trees planted should be protected		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(13) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
13	[Date] 14 Sep. 2011 [Venue] Abhinandan Banquet Hall, Palwal, Haryana [Participants] (1) 91 (2) Farmers, Village Sarpanches, SDM, Block Forest Officer (3) 0/91 [Language] Hindi [Topic] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Width of ROW: Concern on width of land in the Project. Is there any provision in the project to provide service road on both sides of the alignment?	In general the total width of land is 60 m but in case of yard, the width is 150 m. Pirthala in Palwal District will have a yard. Nearly 5 m wide metalled road will be provided on one side of the alignment route to cater to not only the need of the railway but also to provide the local farmers the passage for movement.	Assistant Project Manager and Consultant from CPM Office Noida
		-Compensation Rate and Employment: 1 Land Compensation rate should be decided once the Proposed New Land Acquisition Bill has been passed. 2 Since the Government is acquiring this land for Public Project, the registration fee and stamp duty should be waived off. 3 Employment policy should be formulated considering some facts such as more benefits to those families who are losing more land; if land is owned by two or three brothers then one member of each brother's family should be given employment; and position suitable to one's qualification should be provided. 4 Land mutation should be in the name of MoR and not in the name of any corporation.	(No response made.)	
		Crop Damage: Concern on damage of crops in nearby fields due to dust loading during construction of DFC Project.	Project would take all necessary precautions to limit dust emissions from various activities but in case any incidence of crop damage is found, the project would settle all claims for such loss to the farmers after due verification.	
		Possibility for Alignment Change: Request for change of alignment since the DFC alignment was going very close to the habitation in Villages of *Chhapraula* and *Jataula*.	The alignment was fixed after long survey, after assessing all pros and cons and after approval from the MoR. So, at this moment, it was not possible to make any change in the alignment.	
		Clarification on Gazette Notification: Procedure for submitting objections on Gazette Notification.	20A Notification has already been published for Palwal District and 20E Notification is in Press. It was specifically informed that if any titleholder finds any mistake in the Notification in terms of omission or incorrect name or area, the objection should be immediately submitted to the SDM Office. Not only this, whenever team comes for Joint Measurement Survey, they should also be informed so that no wrong person could claim compensation.	
		Residual land after acquisition: Concern on the residual land which become too small to cultivate	People felt satisfied when it was informed that the project would also acquire any such small residual portion of land which would be left on both sides of the alignment after acquiring main portion of land if any farmer would be so interested.	
		Clarification on Passage for the Fields: Concern on the provision of proper passage for their nearby fields after construction of rail line. Some people whose lands are around the proposed yard location were really disturbed.	Suitable underpasses shall be provided after every 600-700 m. The width shall be 22 feet or 12 feet with height of about 4-5 m. There would be no problem for farmers to take their lorries or tractors through it. The issue near proposed yard would be dealt appropriately so that farmers do not suffer.	
		[Suggestions from collected feedback forms]: -In case any tube well or other source of water is affected, it should be restored or alternately provided by the DFC Project. -In case any canal water irrigation channels are affected, it should be restored or alternately provided by the project. -Not only afforestation should be done on both sides of railway line but all trees planted should be protected.		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants, Source: JICA survey team

Table 9.1.4(14) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
14	[Date] 15 Sep. 2011 [Venue] Jaat Bhawan, Faridabad, Haryana [Participants] (1) 108 (2) Farmers, Village Sarpanches, Businessmen, Range Forest Officer, Patwari (3) 0/108 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Provision of Road along alignment: Should be given in writing about the provisions of road along the alignment.	There is a provision in the project to provide 3-5 m wide metalled road on one side and unmetalled road on the other side for smooth passage.	Assistant Project Manager and Consultant from CPM Office Noida
		-Compensation Rate and Employment: 1. Will not give their land unless the land compensation rate is decided on the basis of Proposed New Land Acquisition Bill which is due to be passed within next six months. 2. The DFC Project should have provision of life time royalty as per Haryana Government laws. 3. The DFC Project should have provision of alternate land as per Haryana Government laws. 4. Farmers should be made shareholders in this project. 5. Employment should be assured for one member of each family who owned the land irrespective of taking into account only titleholder. 6. Employment should be given before land acquisition and not after construction of the project. 7. More benefits should be given to those families who are losing more land. 8. Farmers could not reap benefit from their lands for last two years because of notification and this loss should be compensated.	(No response made.)	
		Clarification on Passage for the Fields: Concern on the provision of proper passage for their nearby fields after construction of rail line.	Suitable underpasses shall be provided after every 600-700 m. The width shall be 22 feet or 12 feet with height of about 4-5 m. There would be no problem for farmers to take their lorries or tractors through it. Due to site conditions at any particular location, the height of embankment could be raised.	
		Minimum Distance from the Houses: Minimum distance of DFC line from the houses.	Appropriate distance has been maintained from the houses but in case any structure is getting affected, they shall be suitably compensated.	
		Objection on Alignment: Concern on reference in the newspaper article which appeared the other day that the District Administration has recently raised objection to the alignment and are in the process to submit details to the Chief Minister, how would it affect the project?	Alignment is already finalized and endorsed by the MoR and PMO Office. So, any change would not be possible.	
		Clarification on Gazette Notification: Procedure for submitting objections on Gazette Notification.	20A Notification shall be issued soon. The new notification had to be reissued because of change of Competent Authority from SDM, Ballabgarh to DRO, Faridabad. Any objection can now be submitted to DRO Office in Faridabad.	
		[Suggestions from collected feedback forms]: -In case any tube well or other source of water is affected, it should be restored or alternately provided by the DFC Project. -The project should bear all cost for provide alternate arrangement in case of disruption of electric connection. -Not only afforestation should be done on both sides of railway line but all trees planted should be protected.		

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(15) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
15	[Date] 16 Sep. 2011 [Venue] Punjabi Dharamshala, Gurgaon, Haryana [Participants] (1) 51 (2) Farmers, Village Sarpanches, Forest Range Officer (3) 0/51 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	Clarification on Change in Alignment: Name of villages where change in alignment has taken place.	Some changes took place in the alignment in Villages – *Raipur, Sohna, Lakhuwas and Bhirawati.*	Consultant and Office Assistant from CPM Office Noida
		Clarification on Gazette Notification: Timeframe for issuing of Gazette Notification.	20A Notification would be issued within next 15 days. PAPs would be given one month time to submit any objection to the Competent Authority. In case of any difficulty, they can approach the project manager at the Noida Office.	
		Provision of Road along alignment: Clarification on provision of road along the alignment.	There is a provision in the project to provide 3-5 m wide metalled road on one side and unmetalled road on the other side for smooth passage.	
		-Compensation Rate and Employment: 1 Will not give their land unless the land compensation rate is decided on the basis of Proposed New Land Acquisition Bill which is due to be passed within next six months. 2 Employment should be assured for one member of each family who are dependent on land to be acquired. 3 Employment should be given before land acquisition and not after construction of the project. 4 More benefits should be given to those families who are losing more land. 5 Farmers could not grow any crop on their lands for last two years because of issuing of previous notification and this loss should be compensated.	(No response made.)	
		Residual land after acquisition: Concern on the residual land which become too small to cultivate.	The project has the provision to acquire any such small residual portion of land which would be left on either side of the alignment after acquiring main portion of land in case any farmer would be interested to give it to DFCCIL.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

Table 9.1.4(16) Summary of Public Consultation Meeting for Draft ESIA Stage

No	Date / Venue / Participants / Language / Topics	Participants' Major Comments	DFCCIL's Responses	Attendant from DFCCIL
16	[Date] 17 Sep. 2011 [Venue] Barat Ghar, Gautam Buddh Nagar, Uttar Pradesh [Participants] (1) 70 (2) Farmers, Village Sarpanches, Lawyer, Lekhpal (Land Record Officer) (3) 0/70 [Language] Hindi [Topics] 1. Project background 2. Scope of Project 3. Objectives of PCM 4. Results of ESIA Study on Environmental Impacts and Mitigation Measures 5. Importance of ROB, RUB and Flyovers 6. EMP outline 7. Institutional Framework 8. Information on ESIA Public Disclosure and availability of Draft ESIA Main and Summary Reports 9. Contact info of the CPM Officers and 10. Q & A	-Clarification on DFC Project: 1. Why DFC Project is not included in the Master Plan 2021 of G. B. Nagar? 2. How much time will the project take to complete and what is the project cost? 3. How much will be the compensation paid to people dependent on agricultural land and other non-titleholders?	-It was the responsibility of the State Government to include DFC Project in the Master Plan of G. B. Nagar and if that has not happened, the Railways cannot give answer to this question. -The expected completion target date is 2017 and total cost of the Western Corridor on 2008 basis is about Rupees 42,000 crores. The cost of alignment in G. B. Nagar will be about 150 crores.	CPM and Project Incharge, Project Manager and Consultant from CPM Office Noida
		-Clarification on Gazette Notification: 1. When was the 20E Notification issued and in which Newspapers was it published? 2. When will the Joint measurement survey start? 3. What is the solution if wrong names are given in the 20E Notification?	The 20E Notification was published on May 18, 2011 in the local newspapers. JM will start soon and all mistakes either in missing name or survey no. area will be solved. All PAPs should bring to the notice to avoid compensation to the wrong person. In case of wrong entry, they can submit their objections to SDM.	
		-Compensation Rate and Employment: 1. When will the compensation rate be given? 2. How much compensation rate will be given? 3. Whether the project will give compensation as per the proposed New Land Acquisition Act which is due to be passed within next six months? 4. What is the provision of employment in the Project?	-The compensation will be given between January and March 2012. The compensation rate has to be decided by the Competent Authority and the project will add 60% extra to the cost. It depends on the Competent Authority to make the basis for deciding the rate. -MoR is considering the provision of providing employment to the affected people and is in the process of formulating the policy. -The project has the provision to acquire any such small residual portion of land which would be left on either side of the alignment after acquiring main portion of land in case any farmer would be interested to give it to DFCCIL.	

Note: Participants: (1) No. of the participants; (2) Type of participants; (3) No of female participants/male participants
Source: JICA survey team

9.1.6 Lessons Learned From the PCMs

PCMs are a very effective method for gathering concerns/responses/suggestions from the public for the development project to assess its impact on the society. During the PCMs at scoping stage and Draft ESIA stage, various issues were raised by the participants and answered by the railway and state government officials. Achievements made and various lessons learned from these PCMs are elaborated as follows:

(1) Achievements to fulfill purpose of PCMs

- Fulfills legal requirements of the ESIA.
- Appropriate forum for dissemination of information to PAPs.
- PCM meeting truly gives an opportunity to all project affected persons to interact directly with the government officials in a more transparent and open environment. In normal procedure, affected people do not know even basic parameters of the project and usually develop wrong notions about the project.
- Traditional knowledge and need comes directly from the affected population, which can be used for rehabilitation.

(2) Overall Lessons learned from the PCMs

- Most concerns raised in the PCMs across the 14 districts generally revolved around adequate compensation and provision of jobs in spite of the PCM being rather intended to discuss on environment and social issues and impacts.
- Although PCM meetings for projects where land acquisition is a sensitive issue are normally carried out under stress environment, they still give an opportunity to PAPs to convey their common agenda and concerns to the relevant authority for appropriate action. Without interacting directly with the affected people on a common forum, it is not only difficult to gauge area specific issues but also difficult to distinguish between genuine and non-genuine demands of the people.
- Before starting any new PCM meetings, minutes of previous meetings along with the actions taken should be presented before the participants as it actually builds confidence among people towards the project. People normally expect and wanted to know if whatever they had mentioned in previous meetings were taken into consideration or not.
- There was a feeling amongst the PAPs that the PCMs at scoping stage were happening too late for them to influence the outcome of the project.
- People expect more frequent communication with project managers for clarifying their doubts at individual level since PCMs cannot handle individual queries.
- Sometimes the meetings are dominated by individuals/ interest groups limiting opportunities for other weaker groups or PAPs to participate actively.
- In most of the PCMs, there was poor participation of women.
- The PCM is not an end. The public must be given access to information which must be updated regularly and made accessible to them in an easy to understand format. Information centers or grievance mechanism redressed avenues must be provided for on a continual basis even after winding up the PCM proceedings.

(3) Recommendations for future PCMs (Procedural Aspects)

- For ensuring effective public participation the public/ PAPs must be informed about the meeting well in advance.
- Proper meeting arrangement, careful preparation, positive response to people's queries and more ownership are some of the important elements for successful PCMs.
- Information about PCM meetings should not only be given to Village Sarpanches but also to Numberdar (Village Headman) who would ensure that information reaches to all affected persons in the village.
- It is generally found that whenever any senior Government Official from the local District Administration such as SDM or DRO is present in the meeting, the villagers do not make any unnecessary noise or create unruly scene in the PCM meetings. Moreover, it gives an equal opportunity to all affected persons to raise their concerns and do not let some vocal persons to hijack the objective of the meeting.
- An effective feedback mechanism is required to ensure that public has not only been consulted but their opinions are valued and incorporated in the policy and project documents. This instills some confidence among people that the project is taking them along and valuing to their suggestions.
- In case there is other alternative, PCM meetings should rarely be organized in venues located within any one of the project villages.
- There was some concern raised by PAPs in areas like Valsad and Navsari Districts that formal presentations may be intimidating to and may exclude members of tribal communities who traditionally do not speak in public.
- Although there was poor participation of women and sometime nil but still there must be at least one woman member on the dais to encourage women to come forward and participate and articulate their concerns wherever they come in the meeting.

9.2 Comments from the Public on Draft ESIA Report

The ESIA study findings are disseminated to the project affected persons, stakeholders and the implementation authorities so that preventive measures can be taken for the successful completion of the project. The information dissemination is implemented at two stages for the ESIA.

- The first stage of information dissemination is conducted when the draft ESIA is prepared. The full draft ESIA in English is delivered and placed at each DFCCIL office, major existing railway stations and district authorities along the DFC route. Additionally, the summary of the draft ESIA is prepared in local languages, such as Hindi, Gujarati and Marathi and is delivered to all the project affected villages along the DFC route.
- The second stage of information dissemination is implemented when the ESIA is finalized. The final ESIA report in English is delivered and placed at the same places as in the first stage. Additionally, the summary of the final ESIA is also prepared in local languages and is delivered to all the project affected villages in the similar manner as in the first stage.

9.2.1 Objective of Information Dissemination

The objectives of information dissemination are as follows:

1) Disseminate information on findings of the study on environmental and social considerations of the DFC Project, including environmental and social impacts, mitigation measures, general plan on the management and monitoring of the environment in the study area.

2) Collection of comments and opinions from the public on environment and social issues on the DFC Project so as to reflect in the final ESIA report.

9.2.2 Methodology of Information Dissemination and Collection of Comments

The process of information dissemination was arranged in a systematic, time bound and transparent manner ensuring widest possible public participation of the project. Methodology of the process in the first stage was as follows:

- The distribution of draft ESIA reports including summary in vernacular languages (Hindi, Gujarati and Marathi) and English as shown in Appendix-10b started from 17th September 2011 and completed by 28th September 2011.
- Draft ESIA Report had been distributed to DFCCIL Head Office, 4 Chief Project Manager (CPM) offices of DFCCIL, 14 District Collectorate (DC) Offices and 17 Major Stations including Junction Stations along the proposed DFC alignment. Full Reports (Main and Appendix) were available there for public reviewing. All details are shown in Table 9.2.1.
- Summary of the draft ESIA reports were distributed to Sarpanches of 374 Project Affected villages, 4 CPM offices, 14 DC Offices, and 17 Major Stations including Junction Stations along the proposed DFC alignment. On request of CPM Mumbai Office, copies of summaries in English and Marathi were also distributed to the Competent Authority of Raigad and Thane Districts, Chairman of JNPT in Mumbai, and CIDCO office in Raigad. All details are shown in Table 9.2.2.
- In order to facilitate proper information dissemination of availability of draft ESIA deports as well as summary and call for comments, public notices in vernacular languages (Hindi, Gujarati and Marathi) had been put up on notice boards of Sarpanch offices of respective villages. Letters in vernacular languages were also given to individual Sarpanch. Letters in English language were given to DC and Station Masters of all Major Stations along with the reports and summaries. Additionally, proper announcement of availability of draft ESIA report and submission of comments was made in all PCM meetings at Draft ESIA Report stage which were conducted from 9th to 26th September 2011. The public notices and letters distributed in the information dissemination process are shown in Appendix-10b.
- Last date of sending comments was initially set as 26th September 2011 but since some distribution was made a little late after request from CPM Mumbai office, submission date was later extended to 9th October 2011, considering minimum 10-12 days for review by the public.
- Comments and opinions were accepted on draft ESIA report only in writing through direct delivery, fax, or post and email (dfc.phase2@gmail.com) to the respective CPM offices.
- After collection of all comments from CPM offices, it had been sorted out and summarized.

- Collection of the draft ESIA reports from Major stations and District Collectorate Offices will be done as much as possible at the time of distribution of final ESIA reports.
- Finalization of ESIA report by reflecting comments/opinion.

Table 9.2.1 Distribution of Number of Draft ESIA Reports

Sl No.	Locations	No. of Set of Reports
1	DFCCIL Head Office	3
2	DFCCIL CPM Offices (4)	12 (3 each)
3	District Collectorate Offices (14)	14
4	Major Railway Stations along the Corridor (17)	17
5	Reserved Copies with JST	4
	Total	**50**

Note: A detailed list is shown in Appendix-10c.
Source: JICA survey team

Table 9.2.2 Distribution of Number of Summary of Draft ESIA Report

Sl No.	Location		Number of Vernacular Language			
	State	Number of Villages	Hindi	Gujarati	Marathi	English
1	Haryana, Rajasthan, U.P., Delhi	105	2100			525
2	Maharashtra	136			2,720	680
3	Gujarat	133		2,660		665
4	DFCCIL Head Office	-	5	5	5	5
5	CPM Offices (4)	-	15	30	15	20
6	DC Offices (14)	-	70	50	20	85
7	Railway Stations (17)	-	45	120	90	85
8	CIDCO, JNPT, Competent Authorities of Thane & Raigad	-			20	20
	Sub Total	374	2,235	2,865	2,870	2,085
	Total	-	10,055			

Note: A detailed list is shown in Appendix-10c.
Source: JICA survey team

9.2.3 Collected Comments

All comments and opinions were received only through email and none of the comments or opinions was received either by post or fax or by hand delivery by any of the CPM Offices.

(1) Number of Collected Comments

Total 5 (4 readable and 1 unreadable) comments were received. District wise numbers of comments are given in Table 9.2.3.

Table 9.2.3 District Wise Number of Comments Received Regarding Draft ESIA Report

State	District	No. of Comments Received *
Haryana	Palwal	2
	Faridabad	1
	Gurgaon	1
	Sub-Total	4**
Rajasthan	Alwar	Nil
U. P.	G. B. Nagar	Nil
Gujarat	Vadodara, Bharuch, Surat, Navsari and Valsad	Nil
Maharashtra	Thane and Raigad	Nil
Grand Total		4

Note: Other than this, 5 letters were given directly to JST members during PCM meetings at Draft ESIA Report Stage and 2 letters came by post directly to JST. These are not considered as comments on Draft ESIA Report. However, original and scanned copies of all these letters were sent to DFCCIL Head Office and respective CPM Offices.
*As of 09th October 2011
** One additional comment received but it was unreadable. The sender was immediately informed through return email but no response came.
Source: JICA survey team

(2) Classification of Comments

After scrutinizing these 4 comments, these were categorized in the following category such as Natural Environment, Pollution, Sensitive Receptor, Land Compensation, Compensation for utilities, Employment and others. Summary table of comments is shown in Table 9.2.4. Details of comments in original are shown in Appendix-10d.

Table 9.2.4 Classification of Comments regarding Draft ESIA

State	District	No. of Comments Received	Type of Party	Classification of Comments						
				Natural Environment	Pollution	Sensitive Receptor	Land Compensation	Compensation for utilities	Employment	Others
Haryana	Palwal	2	Individual (2)	1	1	0	7	3	4	2
	Faridabad*	1	Jointly signed by Village Sarpanch (3), Businessman (1) and Numberdar (1)	0	0	0	2	2	1	3
	Gurgaon*	1	Jointly signed by Village Sarpanch (1), Businessman (1) and Numberdar (1)	0	0	0	2	2	1	3
Grand Total		**4**		**1**	**1**	**0**	**11**	**7**	**6**	**8**

Note: As of data available on 09th October 2011
*Comments received from Faridabad and Gurgaon were identical.
Source: JICA survey team

9.2.4 Conclusion

Among these comments, only two comments pertaining to reduction of dust pollution during construction to avoid damage to crops in nearby fields and minimizing impacts on existing drainage channels are incorporated in the final ESIA report. These comments will be taken care of at the time of implementation period through mitigation measures and Environmental Management Plan.

Besides these, there are mainly comments related to higher compensation for land and utilities, employment, and other rehabilitation and resettlement issues. These specific issues will be dealt separately in RRP report and will be taken care of at the time of preparation of Rehabilitation and Resettlement Plan.

Details of public dissemination process such as summaries of the draft ESIA report, public notices, distribution letters, distribution list and comments from the public are shown in Appendices-10a to 10d.

CHAPTER 10
ENVIRONMENTAL MITIGATION MEASURES

CHAPTER 10 ENVIRONMENTAL MITIGATION MEASURES

The present section assesses the potential environmental impacts likely to result from the activities involved in the freight corridor project during different phases of the project and deals with the identification of impacts and presentation of mitigation measures suitable for the project with appropriate cost-effectiveness. Some of the mitigation measures are at the design stage such as detouring and changes in the alignment routes. Meanwhile suggesting suitable mitigation measures for various environmental and social impacts would come at the construction and operation stages of the project.

10.1 POLLUTION CONTROL

10.1.1 Noise and Vibration

The frequent train movements would generate noise and vibration which may disturb the residential areas along the alignment. In the JNPT-Vadodara section, the proposed corridor passes semi urban and urban areas. Although the detour section is considered to have a lower impact as compared to the parallel sections as it is mainly in rural and open areas, some places along the detour would also be affected by noise as there are many residential areas coming up near the proposed corridor. Apart from residential areas, noise and vibration impacts will also be felt by sensitive receptors located near the proposed corridor such as educational institutions, hospitals and religious institutions.

(1) Noise Impacts during Construction/Operation Phase

1) Impacts

The main impacts in terms of noise pollution would be during the operation phase and it is expected that noise levels may exceed the prescribed ones. The operation of construction equipment and machineries will also cause noise pollution but this will be during the construction phase only. Since higher noise level has some possibility to cause sleep disturbance and mental instabilities to the residents living adjacent to the proposed corridor, the following mitigation measures are proposed.

2) Mitigation Measures

- Notify the local people prior to undertake the construction activities associating with higher noise level such as blasting operations.

- Locate the quarry sites away from the residential areas and sensitive receptors.

- Machinery and vehicles should be maintained regularly, with particular attention to silencers and mufflers, to keep construction noise levels to minimum.

- The construction yards should be located away from the settlement areas. Where a construction yard is unavoidably located at the residential areas and sensitive receptors, the time of the construction activities should be limited.

- Protection devices (ear plugs or ear muffs) should be provided to the workers operating in the vicinity of high noise generating machines.

- Expanding the right of way (buffer zone) is recommended method of reducing the noise impact. A vegetative barrier in the buffer zone will be suitable.

- Noise barriers should be erected at appropriate locations such as residential areas and sensitive receptors which are adjacent to the corridor.

(2) Vibration Impacts during Construction/Operation Phase

1) Impacts

- The proposed freight corridor would generate a certain level of vibration as it is designed to accommodate trains traveling at 100 km/hr as well as those with double-decker carriages. Although perceptible ground borne vibration is generally limited to the areas within few hundred feet of the railway system, the following mitigation measures are proposed since higher level of vibration has some possibilities to cause sleep disturbance and mental instability to the residents living adjacent to the proposed corridor.

2) Mitigation Measures

- Notify the local people prior to undertake the construction activities associating with higher vibration level such as activities using vibrating rollers.

- The vibrations should be reduced considerably by ensuring and keeping correct track geometry by advanced measurement.

- Expanding the right of way (buffer zone) is sometimes the easiest method of reducing the vibration impact.

10.1.2 Water Pollution

(1) Construction Phase

1) Impacts

- Water pollution would be generated mainly from the construction activities. Impacts on the surface water quality would be caused not only by the construction activities itself, but also from the workers being temporarily housed for the construction due to the discharge of waste and material into surface water bodies.

- The deterioration of surface and ground water quality is expected near construction site due to wastewater disposal from the office camp as well as sludge generated from the construction activities. If adequate arrangements are not made to ensure proper drainage of wastewater from the construction sites, such water may form stagnant pools and aggravate soil erosion, leaching of pollutants. Stagnant pools of water also promote breeding of mosquitoes and create generally unsanitary conditions.

- Surface and ground water could become polluted if sediment is washed from site roads and other exposed soil by rainfall. Rivers will be polluted by sediment if sand, aggregate etc. is obtained from riverbeds. Soil compaction can also occur as a result of construction activities. Soil compaction causes a reduction in the volume of water permeating into the ground therefore increasing run-off. The run-off would normally contain suspended silt as the compacted ground would be susceptible to erosion in the absence of vegetation cover.

- Discharge of untreated sewage from office camp or labor camp could pollute both surface and ground water.

- Increase of sediment load in the runoff from construction sites would increase in turbidity in receiving streams/water bodies.

- Slight change in hydrology and geomorphology of the stretch of water course directly affected by the temporary works at the site of new crossing.

- Water quality of nearby water bodies to the construction sites could be affected due to spillage and uncontrolled release of construction and toxic materials such as cement, concrete, oil, fuel and paints.

2) Mitigation Measures

- All relevant water quality laws should be complied with at all construction sites along the proposed alignment route during the entire period of construction activity.

- It should be ensured that no liquid is discharged from any construction site/activity without treatment.

- Site drainage should be retained in purpose-built lagoons for enough time to allow most sediment to settle out before discharge to natural or urban drains.

- Stockpiled soil and other loose material should be covered with secure tarpaulins and drainage should be passes from stockpile areas into settlement lagoons.

- Since most of the important rivers in DFC Phase 2 already have high turbidity levels, construction work when conducted in such rivers/streams should adopt suitable precautions to minimize and contain sediment disturbance.

- In order to prevent materials leaking from static plant, such as pumps and generators, contaminating the ground and being washed into the drainage system, static plant should be placed on drip trays.

- All parking, repair and fuel storage areas should be located more than 100 m from any water body.

- Lagoons or other silt retention measures should be provided at the base of embankments built near water bodies.

- Effective storm water drainage system should be provided in every bridge to eliminate / reduce the chance of discharge of untreated storm water directly into the river.

- Measures should be adopted to avoid contact between water and machinery when construction work is conducted in rivers, streams and canals.

- All hazardous materials on-site should be stored in areas with concrete floors enclosed by concrete bunds.

- Oil catch pit/ oil trap may be erected along drain channel from construction site to prevent oily water to flow into any water body.

- As temporary/emergency mitigation, a floating oil boom should be placed on the water surface near construction site to prevent discharge of any trace oil or fuel

that may have entered the drainage system. This would serve as a contingency measure for the surface water body.

- Used oil may be sold to CPCB/ SPCB approved authorized recycler/ re-processor

- Waste oil should be collected and stored in sealed damage-proof containers and disposed-off at legally approved common landfill site which can be approached for disposal of waste oil according to local laws.

10.1.3 Air Pollution

(1) Construction Phase

1) Impacts

- The earthmoving and construction activities are likely to generate dust. The impacts associated with generated dust will only be significant where work is taking place close to residential areas. In the majority of cases dust generation would only be a temporary impact. In the event that dust from the construction activities is being deposited on the nearby settlement then the mitigation measures are to be adopted as early as possible. Emissions from vehicles and machinery could also impact quality of air in and around construction sites.

- There are some locations which fall within DFC Phase 2 project area such as Faridabad in Haryana, Noida in Gautum Buddh Nagar, Dombivali in Thane, Navi Mumbai/Panvel in Raigad and Ankalehwar in Bharuch which are identified as critically polluted areas by the Central Pollution Control Board based on Comprehensive Environmental Pollution Index (CEPI).

2) Mitigation Measures

- Consult the local pollution authorities, comply with relevant air quality laws and obtain necessary permissions at least for critically polluted areas before start of any construction related activities. Comply with all conditions when permission is granted.

- Maintain all construction vehicles to minimize vehicle emissions.

- Payload area of the trucks or dumpers should be covered by tarpaulin when transporting soil and crush in order to prevent fall out of fines and emissions as dust. The material carrying trucks or dumpers will carry on the haulage corridors provided for the transport.

- Spray water on the stones while unloading from the truck/dumper, at the primary crusher feeder chute and the transfer points from one belt conveyor to another, etc.

- Facility for regular cleaning and wetting of the unpaved roads and exposed soil on construction sites should be provided in dry weather.

- Trees should be planted to develop a green belt within and along the boundary of the yards and corridor. Vegetation may improve air quality by providing a cooling effect through transpiration (water loss) from their leaves and by filtering atmospheric pollutants through their leaves. By decreasing both the temperature and the amount of pollutants in the atmosphere, trees can have a positive effect in improving air quality.

- Concrete batching plant or other machinery liable to generate dust should be kept away at safer distance from residential areas and should not be in predominant upwind direction of these areas.

- Ensure that all major construction machineries including batching plant placed on construction sites are inbuilt with appropriate dust reduction measures.

- The water sprinkling of trucks used, as construction vehicles, should be properly and regularly undertaken, so that dust deposition problem on vegetation is minimized.

- The haul freight corridors inside the quarry should be properly watered to arrest the dust arising out of it.

10.1.4 Waste Generation

(1) Construction Phase

1) Impacts

The significant quantities of solid waste would be generated by the project, especially during the construction, including gravel; concrete; miscellaneous structures such as culverts, poles and cables, steel, and organic material such as cleared vegetation, timber; and soil. In addition, there will be oils, fuel, grease and chemicals from construction equipments and vehicle servicing. Any hazardous materials that are used will also need to be stored and handled correctly to prevent spills and pollution. It should be properly disposed of at identified locations. Waste generated by the construction activities including from the construction camps should be systematically disposed of.

2) Mitigation Measures

- Comply with relevant laws pertaining to the management and disposal of solid waste and hazardous waste.

- Before start of construction activities, all suitable disposal measures should be identified for solid waste and any other form of waste likely to be generated from the construction activities.

- A designated solid waste disposal site should be secured away from human settlements. In addition, a disposal site should be away from water streams and any archaeological and historical monuments. Generally barren lands are preferable for this purpose.

- No dumping should be carried out on private property without written consent of the owner.

- No dumping should be allowed on wetlands, forest areas, and other ecologically sensitive areas.

- All the workers at the disposal yard should be provided with safety attire.

- Prepare and implement a hazardous waste management plan for the disposal of waste oil, batteries and other hazardous materials.

- All areas designated for the storage of fuels, oils, chemicals or other hazardous liquids should have a dense base and be surrounded by a bund to contain any spillage. These areas should be covered by a roof structure to minimize the potential for infiltration and contamination of rainwater.

- Areas designed for the storage of hazardous materials are to be clearly designated and storage of such materials outside these areas strictly prohibited.

- Chip and mulch vegetation cleared and reuse it as an organic base for re-vegetation; ensure that materials, which may cause land/water contamination or create odour problems, are not disposed of on the site.

- Ensure that there is the adequate provision of correctly marked waste containers made available at convenient locations for the disposal of wastes.

10.1.5 Disaster

(1) Construction/Operation Phase

1) Impacts

- The Rewari-Dadri section of DFC Phase2 falls in the seismic zone IV as per seismic zoning map of India which makes the area susceptible to moderate to high intensity of earthquakes and is considered as High Risk Zone. This has the potential to impact on civil structures during seismic disaster.

- The Aravalli rocky hill ridge between Dhulawat and Rojka Villages in Mewat District is made up of quartzite which are highly jointed and fractured as well as tectonically disturbed as deciphered from the geological structure map showing major as well as minor faults passing through the area. Since the area falls in seismic zone IV, the deep rock cutting up to the depth of 28 m and removal of thick overburden could result in unstable conditions such as slippage of rock blocks, exposing weak joints with increased possibility of collapse of slopes during seismic disaster.

- Embankment structure along the major part of the DFC corridor could trap rain water and cause flood around the project area.

- In Vasai detour, though no major faults or shear zones are reported in the area (seismic zone III), the seismic activities at moderate level could enhance the rock-joint rupture hazard during rock cutting and excavation during construction of tunnel work.

2) Mitigation Measures

- The seismic factors should be appropriately incorporated in the civil and structural designs of major structures in DFC project.

- An engineering geologist should identify any slope instability potential among the uniform rock structure especially along the Aravalli ridge where deep rock cutting will be done. The study shall be clear through suitable experts/institutes during detailed engineering stage.

- Adequate cross drainage channels (longitudinal and median drains) should be provided along to the DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.

- Although the geological succession of the Vasai detour area along with the topography indicates that the hill block is fit for underground tunnel as the minimum 25 m overburden height is available for closed loop to provide arch section of the tunnel, any unstable or rock-joint rupture hazard should be identified by an engineering geologist.

10.2 NATURAL ENVIRONMENT

The natural environment is contrasted with the built environment which is strongly influenced by human activity. Various anthropogenic activities cause environmental degradation and the reduction of forest cover. Environmental degradation can be prevented or minimized by implementing suitable mitigation measures at appropriate stages of the project cycle. This section envisages the likely impacts of the proposed freight corridor on the natural environment and suggests a range of mitigation measures.

10.2.1 Flora

(1) Planning/Design Phase

1) Impacts

Conversion of forest land to non-forest land use - DFC route will affect many forest patches causing loss of trees and habitat. In Thane District, there exist about twenty patches of Recorded Forest Area through which both the parallel and detour alignment will pass. Nearly 32 ha of forest lands are to be diverted for the use as ROW for construction of new track. Similarly, in Gautam Buddh Nagar District, the alignment will pass through one patch of Recorded Forest Area with an affected land area of nearly 10 ha.

2) Mitigation Measures

- Review design and assess alternatives where feasible to reduce loss of forest land.

- Consult respective State Forest Department (FD) and submit timely consolidated application for Forest Clearance (FC) under the Forest Conservation Act (FCA). The procedure as given in Appendix-3 should be followed.

- Pay legally required compensation to FD to cover cost of compensatory afforestation program.

- Comply with any other conditions of FC when granted and incorporate in subsequent phases of the project.

(2) Construction Phase

1) Impacts

- Trees, herbs and shrubs in the ROW will be felled linearly along the alignment route in both the forest and non-forest areas which could adversely affect vegetation cover and local landscape, and may lead to habitat fragmentation and loss. There are some scheduled and non-scheduled trees which will be cut and

may impact the conservation and preservation planning and status of the local State Forest Department.

- Some private orchard farms in Dahanu area of Thane District will be affected by the project which will impact the landscape, local conservation and soil erosion prevention status in this notified eco-sensitive area as well as economic loss to the local people.

- Increased earth and rock extractions during the construction phase may affect or remove root structures and disrupt ecosystems.

- Construction workers demand for food and recreational hunting and fishing primarily impacts fauna but may have subsequent impacts on seed dispersal and overall ecosystem integrity.

- Construction workers use of local timber for small scale temporary housing or furniture and in particular for firewood and other small uses may have negative impacts on natural processes of biological degradation and regeneration.

- Deposition of fugitive dust on pubescent leaves of nearby vegetation may lead to temporary reduction of photosynthesis. Such impacts will be more pronounced in the immediate vicinity of the construction area.

2) Mitigation Measures

- Joint field verification should be conducted with the respective State Forest Department to agree and mark trees to be cut. This will avoid uncontrolled and indiscriminate tree felling.

- Appropriate compensatory plantation using suitable native species or pollution tolerant species should be initiated as per the applicable state level tree felling and preservation acts to compensate for the vegetation loss due to felling of trees during site clearing The rate of replacement shall be decided by the State Forest Department and informed to the DFCCIL through tree felling permissions for non-forest areas and forest clearance under the FCA for forest areas. If adequate space for compensatory plantation is not available along the DFC corridor, compensation plan should be provided by including trees in the design of yards, depots, stations, etc. or in degraded forest lands.

- Adequate discussions should be held with the local Forest Department or any leading NGO or academic/research institutions to avoid introduction of any alien or non-native or invasive species, weeds in the project area.

- For Dahanu area which is a notified eco-sensitive area, DFCCIL should follow the pre-afforestation scheme as adopted by Dahanu Taluka Environment Protection Authority (DTEPA). Under this scheme, ten trees are required to be planted for each tree cut. DFCCIL should timely submit detailed scheme of the project to the Deputy Conservator of Forests, Dahanu who will prepare pre-afforestation scheme for plantation of trees and will give plans and estimates for implementation of the scheme. DFCCIL needs to deposit necessary funds/social costs for implementation of this scheme.

- For trees to be felled in private land, compensation for trees based on fruit yield value, timber value and other economic value should be given to the owners.

- The need for wood as building materials for workers' temporary housing should be replaced with alternative eco-friendly building materials but if unavoidable, should only be bought from the sustainable source or authorized selling depots in the project area.

- Workers' labour contracts should specify no use of local timber or firewood as a term/condition. They should be provided with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract.

- All equipment and plants should be cleaned to the satisfaction of the project engineer prior to their relocation to project sites.

- During site clearing activity, care should be taken to ensure that the vegetation areas affected are to be minimised.

- Minimising clearing to only necessary amount of vegetation from the forest area.

(3) Operation Phase

1) Impacts

- Improper post-plantation care/maintenance as well as illegal felling of plantation along DFC track will offset all positive efforts by the project.

2) Mitigation Measures

- Plantation along the ROW should be maintained properly as well as protected from illegal felling.

10.2.2 Fauna

(1) Planning/Design Phase

1) Impacts

- In Thane District and Gautum Buddh Nagar District, the DFC route will pass through Recorded Forest Areas, notified either as Protected Forest or Reserved Forest, so fauna inhabiting these areas may be affected by the construction/operation.

2) Mitigation Measures

- Review design and make adjustments to ROW or alignment route to the extent feasible to reduce loss of Recorded Forest Lands to the minimum as well as to keep safe distance from the protected boundary of the notified forest areas.

(2) Construction Phase

1) Impacts

- Both terrestrial and avifauna may be affected in the construction phase by noise and vibration due to construction equipment and machinery as well as movement of construction bound vehicles.

- Fauna may be impacted by destruction of habitats such as bird nests, breeding sites etc. along the new alignment route.

- Construction workers having greater accessibility to the forest could lead to poaching activity in the forest areas along the corridor.

- Increased sediment loads into major water bodies during bridge construction work may impact aquatic fauna due to temporary loss of habitat and reduced water quality and flow.

2) Mitigation Measures

- Noise and vibration at the construction site should be minimized so as not to impact local fauna. All major noise producing construction equipment/machineries should be fitted with acoustic control measures.

- No construction yard should be set up in the forest areas.

- Honking should be strictly prohibited in the forest area by the trucks and dumper used for the construction activity.

- Heavy construction equipment/machineries should be kept away from the forest areas to minimize impact on local fauna. Construction schedule should be timely spaced so that the use of heavy construction equipment/machinery could be avoided near forest areas during the winter season when the migratory birds inhabit the area.

- Soil compaction for embankment work should be done immediately to avoid erosion and consequently increase in sediment loads to the water bodies. Such work should be avoided during the monsoon season.

- Major earth work during construction of important bridges should be done during the dry period.

- The coffer dams used for the construction of bridge piers may lead to increase of turbidity in the river water. Attempts should be made to minimize turbidity to the extent possible.

(3) Operation Phase

1) Impacts

- Division of habitats due to DFC line could affect faunal population range and distribution, ability to mate, connectivity between populations.

- Impact on aquatic fauna in case of accidental oil spill and toxic chemicals release find its way into the water bodies.

2) Mitigation Measures

- Immediate actions should be taken for speedy cleaning up of oil spills, fuel and toxic chemicals in the event of accidents.

- Crossing structures should be where the DFC line passes through the forest patches. The proposals should be discussed with the local Forest Department or local NGO or academic/research institutions to determine the location, frequency, basic design and number of crossing structures.

10.2.3 Protected Areas

(1) Planning/Design Phase

1) Impacts

- Routing near Protected Area - In Maharashtra, new DFC route will pass through the green buffer area, notified as Reserved Forest, between Sanjay Gandhi National Park (SGNP) and Tungareshwar Wildlife Sanctuary, so wildlife may be disturbed by the construction/operation.

- Routing through Mangrove Areas – In Thane District, new DFC route will impact mangrove areas in villages of Malodhi, Kasarali and Wadiv near Vaitarna Creek, Shirgaon Village and Ulhas River.

2) Mitigation Measures

- Review design and make adjustments to ROW or alignment route or loop length of a junction yard to the extent feasible to reduce loss of reserved forest land near protected area to the minimum.

- Consult the State's Chief Wildlife Warden and follow the procedure as given in Appendix-3 for obtaining clearance under the Wildlife Protection Act, 1972 for the protected area. Since there are number of stages involved in the clearance process, the timely application together with regular tracking of the progress would avoid unnecessary delay.

- Consult State Forest Department (FD) and submit timely consolidated application for Forest Clearance (FC) under the Forest Conservation Act (FCA) for mangrove areas.

(2) Construction Phase

1) Impacts

- Mangrove area with dominant species of Avicennia spp and Salvadora persica having conservation concern in the Maharashtra State will be affected by construction of DFC project.

- Some endangered species of trees such as Sterculia urens in the ROW near SGNP will be felled along the alignment route which could adversely affect conservation status and may lead to habitat fragmentation and loss.

- Fauna may be impacted by destruction of water holes and habitats such as bird nest and breeding sites along the new alignment route near protected area.

2) Mitigation Measures

- The loss of mangrove vegetation due to DFC project should be compensated by replanting at other mangrove sites so that there is no net overall loss of this important habitat type. DFCCIL should held discussions with the Forest Department and pay legally required compensation so that they can integrate it in their overall mangrove afforestation plan at the State Level.

- Appropriate compensatory plantation should be initiated for endangered species in degraded forest land within SGNP as per the guidelines of the State Forest Department.

- Water holes at strategic sites should be developed in consultation with the SGNP Authority. This should be developed inside the forest areas to encourage movement inside and minimum distraction outside.

- No earthen material or water from the springs present in the protected area should be used for the construction activity.

(3) Operation Phase

1) Impacts

- There is a potential direct impact of DFC trains hitting wildlife near protected area since DFC trains will be faster, more frequent and produce less noise.

2) Mitigation Measures

- Incorporate into the design underpasses, pipe culverts and/or other structures as needed to allow wildlife to cross line safely.

- Crossing structures should be provided where the line passes through paths used by wildlife in consultation with the SGNP and Tungareshwar Wildlife Sanctuary Authorities.

10.2.4 Hydrological conditions

(1) Construction Phase

1) Impacts

- In Vasai detour, the DFC line will pass through valley fill between two hills with construction of one closed tunnel of length 540 m in one hill and open cut in the other hill. The valley fill is surrounded by denudational hills and represent the trough of the typical undulating ridge topography. The natural drainage conditions could be affected during construction phase as well as due to filling (embankment) which will impact the ground water recharge as well as obstruct down slope availability in the west of the rail line resulting in reduction of discharge of well in downstream of the tunnel section.

- The DFC line intersects both perennial and non-perennial drainage system at several places which has the potential to directly affect the drainage conditions of the area. Moreover, construction sites and surrounding land may become flooded if drainage channels are blocked and if site drainage is not removed effectively.

- Increased incidence and duration of floods due to obstruction of natural drainage courses by the embankment.

- Natural drainage and recharge conditions in the project area near rocky hills of Aravalli may be affected due to the DFC project and related activities of deep rock cutting and filling.

2) Mitigation Measures

- The DFC corridor between the two hills (separated by 700-800 m) in Vasai Detour should be through via duct (elevated) so that the existing surface and ground water flow is not altered.

- No material should be dumped into natural drains or block, impede or alter drainage channels.

- Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.

- Capacity of existing drainage works, cross drainage structures in the parallel section should be duly augmented, wherever necessary or river channel should be realigned such as between Navsari and Sachin stretch, to accommodate high discharges to avoid flooding of DFC line and formation of water pool.

- Suitable drainage at construction site and camp should be provided to avoid formation of stagnant pool of water that lead to soil erosion, water logging and breeding of mosquitoes.

(2) Operation Phase

1) Impacts

- Local drainage is likely to be affected due to formation of embankment along DFC alignment.

2) Mitigation Measures

- Longitudinal drains of sufficient capacity should be provided on both sides of the DFC track to accommodate increased run-off. The outfall of these drains should be in the nearby culverts/bridges on nallas (canals)/rivers/drains.

10.2.5 Topography and Geology

(1) Construction Phase

1) Impacts

- The DFC alignment which passes through plain, rolling and hilly terrain could impact the overall relief of the region.

- The possibility of weak zones such as faults, joints, shear zones could enhance the rock-joint rupture hazard during deep cutting and rock excavation work in Aravalli hills in Taoru block of Mewat District.

- The geological succession of basaltic rock formation in hill block of Vasai detour where closed tunnel is to be built indicate enhancement of rock-joint rupture hazard during rock excavation work.

- Disfiguring of topography due to indiscriminate digging of borrow pits.

- Disturbance on geological setting of metal quarry mountainous site in Kundevahal detour due to DFC project activities.

2) Mitigation Measures

- The necessary details should be studied for rock-rupture hazards and bed rock geology along with characterization of weak zones in both Aravalli hills and Vasai detour before construction work.

- Only identified borrow pits and quarry sites should be used to avoid any disfiguring of topography.

- Construction materials should be procured from the approved and licensed quarry sites only.

10.2.6 Soil erosion

(1) Construction Phase

1) Impacts

- During construction of embankment, loose soil for embankment preparation could result in silt run-off if exposed to wind or rain and appropriate compaction or stabilization measures are not adopted immediately.

- Loss of productive soil may result from uncontrolled opening up of borrow pits.

- Loosening of top soil and loss of vegetative cover from the ROW along the detour and parallel section due to excavation, land cut and back filling could lead to soil erosion.

2) Mitigation Measures

- Embankment slopes made from earthen material as well as exposed surfaces of hills should be protected from low cost bio-engineering products for preventing soil erosion in areas which have high soil erodability or high intensity rainfall.

- As far as practicable, top soil removed from the construction sites should be used for construction of embankment to enhance growth of vegetation on the embankment surface and its consolidation.

- Adequate temporary or permanent drainage should be provided before slope construction begins with lagoons to allow silt to settle out.

- Top soils of the borrow pit sites should be conserved and restored after excavation is over.

- Stockpiles of construction materials should be located away from rivers, streams, fertile agricultural lands, recorded forest lands or inhabited area.

- Appropriate measures should be installed around stockpiles to retain runoff water and any silt it contains.

- Use of fly ash as a substitute to top soil in construction of embankment should be done but only after careful analysis of site conditions such as ground water level, soil texture, infiltration rate etc. The usage of the fly ash in different forms such as fly ash mix cement, fly ash bricks, ready-mix concrete etc. during construction phase should be enhanced to comply with relevant laws.

10.2.7 Groundwater

(1) Construction Phase

1) Impacts

- Significant part of project area especially in Rewari-Dadri and Gujarat section, is vulnerable to ground water both in terms of quality and quantity. Many locations in these stretches are overexploited as far as dynamic ground water resources are concerned. Uncontrolled use of ground water for concrete making, embankment compaction, dust suppression and other requirements in the DFC project would put further stress on ground water resource in these areas.

- In Vasai detour, the main ground water level in the underlying basaltic rock formation occurs at greater depth. The excavation work for construction of tunnel could result in changed ground water conditions in the area and may affect the ground water flow. This could affect the drinking water sources (open wells, dug wells, hand pumps etc.) in the immediate vicinity of the alignment route.

2) Mitigation Measures

- Based on the estimated quantity and expected quality of water requirement during construction stage for DFC project, discussions should be held with the Central Ground Water Authority for identifying the potential locations from where the ground water can be temporarily abstracted in critical stretches for the project.

- A comprehensive plan to conserve water during the construction process using best practices along with artificial recharging mechanism should be prepared and implemented.

10.2.8 Landscape

(1) Construction/Operation Phase

1) Impacts

- As long as the project implement appropriate mitigation measures to stabilize slopes, to prevent accelerated soil erosion, to grow vegetation on the cut faces and borrow pits, and to minimize impacts on existing vegetation, the project would cause no significant impacts on environmental aesthetics part of landscape.

2) Mitigation Measures

- The quarries should be at least 500 m away from human settlements.

- In sites where quarries must be close to the freight corridor, trees and other vegetation should be left between the quarry/crushing plant sites and the freight corridor. The vegetation acts as good filters of dust as well as improving environmental aesthetics.

10.2.9 Water Use

(1) Construction/Operation Phase

1) Impacts

- Water use will not be impacted except during the construction phase and during the operation phase at yards and stations. Possible impacts will be on quality and quantity of surface and ground water.

2) Mitigation Measures

- River water may be used only after obtaining necessary permissions from the respective Government authorities.

- Where there is no possibility for getting surface water for the construction, the ground water will be tapped after obtaining necessary permission from the authorities concerned such as Central Ground Water Board.

- The water courses should not be blocked while constructing the corridor, but suitable culverts and drains should be provided for the free flow of water.

- Implement suitable measures to minimize usage of water as well as reduce wastage of the existing water resource to avoid possible impacts on the local population's water supply.

10.3 SOCIAL ENVIRONMENT

The project has conducted detailed assessment of social aspects of the proposed dedicated freight corridor. All the villages along the freight corridor were considered for the study by collecting the required information from the affected population including displaced population using a structured questionnaire and other population who would be impacted in other ways too. The land acquisition is being done in accordance with the Gazette notifications published by the Ministry of Railways (MOR), Government of India. The baseline survey and census has thrown light on the issues faced by the local population. Some of the issues are discussed below i.e. several community structures like irrigation channels, village ponds, wells, bore wells, trees, metalled and unmetalled roads, electric lines, educational institutions and factories and industrial establishment etc. will be affected by the proposed project corridor. There will be loss of personal property including orchard and agricultural land.

There are a good number of employed and self employed populations residing along the corridor that will be losing their main employment or source of livelihood. A compensation package should be provided for the local population in accordance with the National Resettlement and Rehabilitation Policy. There have been public consultation meetings to discuss the ESIA results and the RRP report. The public reactions are recorded for the project.

Minimum land acquisition and disturbance to existing features should be the prime objective of the design. Socially sensitive stretches should be avoided and alternatives should be selected with detours around settlements.

Rehabilitation of PAPs and removal of affected structures should be planned in consultation with the PAPs and local authorities to ensure minimum disturbance to the

PAPs. This is required to minimize impacts within the limitation of technical requirements with an emphasis placed on cost effectiveness.

Most mitigation measures have already been adopted by DFCCIL, such as detours proposed at busy and dense locations and utilizing existing Railway land.

Table 10.3.1 Potential Social Impacts and Mitigation Measures

Impacts	Status	Mitigation Measure
Local Economy	Local economy such as employment and livelihood will be affected due to land acquisition and involuntary resettlement.	Negative impacts on the local economy could be mitigated through the creation of new employment or livelihood opportunities related to the railway e.g. Jobs for priority PAPs as station staff, or maintenance staff, construction workers.
Land Use and Utilization of local resources	Land use and utilization may be affected.	Restoration of agriculture land and orchards. Irrigation sources should be replaced.
Social Institutions (including regional severance)	Affected communities would be disturbed in terms of regional severance by construction work and new freight tracks and other related facilities.	Access to and connection with the community shall be secured by providing the alternative passage.
Socially vulnerable groups such as poor, indigenous and ethnic people	Socially vulnerable groups such as poor, indigenous and ethnic people may be affected.	Equitable opportunities for ethnic and vulnerable groups to participate in consultation processes and receive compensation or benefits. This may require printing of materials in different languages or use of interpreters.
Inequitable or unfair distribution of benefits and damages	PAPs may feel industrial and commercial sectors will benefit.	Proper compensation and livelihood assistance shall be provided as per the compensation policy to be established in the RRP.
Historical and cultural heritage	Religious structures affected.	It should be handled with a sensitive approach and carefully resolved between project managers and village leaders/local authorities.
Local conflict of interests	PAPs feel that their interests are not being adequately taken care of by the state government/DFCCIL.	Efforts made to incorporate local/PAP interests into design, construction and operation phases. Requires careful facilitation and again effective participation may require translation/interpretation for fair representation. Also make clear compensatory benefits and what PAPs are entitled to and how to get it.
Sanitation	An issue with the advent of construction workers.	Proper sanitation facilities should be installed.
Hazardous (risk) infectious diseases such as HIV/AIDS	Could arise with influx of construction workers.	Mass awareness campaigns and distribution of condoms should be planned.
Accident	During construction phase large vehicles and equipment may cause accidents.	Handling and implementation should be taken care to avoid accident. During major excavations, locals must be informed.
Occupational Safety	During construction phase, large vehicles and equipment may affect safety.	Safety rules should be followed.

Labor Issues: Labor issues are an important consideration to be emphasized in any major development project. The labour problem arises with bringing external labour force for work and likely impacts caused by the new work force at the site. The maximum use of local labour during the construction will increase benefits to the local community by providing employment opportunities and economic benefits. Increased traffic during construction should be managed through coordination between the contractor, project management unit and the local administration.

The site of construction camps has the potential to cause conflict with the local population if done without consideration for local traditions and customs. The influx of a large number of outside workers into small villages may lead to conflict. The employment of local labour on the project will go some way to decreasing the risks but there will still be a need for a sizable proportion of the workforce recruited from outside the area. Construction camps must therefore be sited well away from local communities so as to minimize interactions between the workforce and the local populations as well as dependency to the existing local infrastructure.

The construction sites are likely to have limited public health impacts due to their isolated location. However, contractors will ensure that no wastewater is discharged to local water bodies and that no site-specific landfills will be established at the construction camps. There will be a potential for diseases to be transmitted, exacerbated by inadequate health and safety practices. Each contractor should therefore be required to recruit an environmental, health and safety manager to address such concerns in the work sites and liaise/work with the labourers. Some of the mitigation measures for health and safety of construction workers are listed below:

- Provision of adequate healthcare facilities (first aid) within construction sites;
- Training of all construction workers in basic sanitation and healthcare issues, general health and safety matters, and on the specific hazards of their work;
- Personal protection equipment for workers, such as safety boots, helmets, gloves, protective clothing, spectacles and ear protection;
- Clean drinking water facilities for all workers;
- Adequate protection to the general public, including safety barriers and marking of hazardous areas;
- Safe access across the construction site;
- Adequate drainage throughout the camp to ensure that disease vectors such as stagnant water bodies and puddles do not form; and
- Septic tank and garbage bins will be set up in construction site, which will be regularly cleared by the contractors to prevent outbreak of diseases.
- Where feasible the contractor will arrange the temporary integration of waste collection from work sites into existing waste collection systems and disposal facilities of nearby communities.

10.4 OTHER ENVIRONMENTAL ISSUES

There are several other aspects which could result in significant impacts on environment in different phases of the project. These are listed below along with the mitigation measures.

10.4.1 Location of labour accommodation camps

(1) Planning/Design Phase

1) Impacts

- Accommodation camps for workers can damage trees, crops, habitats and landscape when built and affect water and air quality and cause social problems when in use.

2) Mitigation Measures

- Camp locations should be carefully selected to minimize loss of trees/habitats/crops.
- Camps should be located away from inhabited areas, fertile agricultural lands, recorded forest areas, and rivers or streams.
- Camps should be designed as per the local laws and guidelines.

10.4.2 Temporary use of land

(1) Planning/Design Phase

1) Impacts

- As land will be acquired temporarily for labour camps, stockpiles of construction materials, borrow pits etc., it will be affected and polluted by works.

2) Mitigation Measures

- Lease of land should be negotiated / agreed with owners.
- No fertile agricultural land or recorded forest area should be used for labour camps, stockpiles, borrow pits etc.
- Proposed use of land should be informed to the owners.
- Land should be reinstated to owner's satisfaction after use.

10.4.3 Labour Recruitment

(1) Construction Phase

1) Impacts

- Local people will benefit if employed in the contractor's workforce and this may help to compensate for disturbance by the works and reduce the size of labour camps.

2) Mitigation Measures

- Give priority to employment of local people as skilled or unskilled workers based on their availability in vicinity of construction sites.

- As far as possible, employ people affected by land acquisition and from disadvantaged households so as to provide temporary source of income and help them in strengthening of their skills.

10.4.4 Borrow Pits and Quarries

(1) Construction Phase

1) Impacts

- Indiscriminate excavation for construction materials could adversely affect landscape, topography, drainage and increase in vector borne diseases by encouraging mosquito breeding due to water logging in dug out areas.

2) Mitigation Measures

- All construction materials should be obtained from existing licensed quarries as far as practicable.

- If any new borrow area or quarry site is needed, necessary approval process, either internal or external, should be adhered to before excavation or extraction of materials.

- All those borrow areas and quarries which are affected by the DFC project activities should be rehabilitated after use in coordination with the local governmental departments.

10.4.5 Archaeological Structures

(1) Construction Phase

1) Impacts

- Construction work may affect designated monuments or sites if carried out close to these areas and excavation could reveal and damage previously unknown remains.

2) Mitigation Measures

- If construction work is carried out in the limits of prohibited area (within 100 meters) or regulated area (100-200 meters) of any designated heritage or archaeological sites and remains, permission should be obtained from the relevant authorities. The status of such structures should be checked with the archaeological department.

- No building or structure of historical importance which has been in existence for more than 75 years should be demolished without informing the relevant authorities.

- Prescribed procedures for taking permission from the local authority or village Panchayat or local community should be done before excavation of any burial ground, graveyard or Idgah[1].

10.4.6 Health and Safety

(1) Construction Phase

1) Impacts

- Associated risks from accidents and incidents could affect health and safety of workers and others on site.

- Since location of most of the construction sites will be away from the medical centers, improper first aid facilities on site could affect health and safety of workers and others on site.

2) Mitigation Measures

- Relevant labour laws should be strictly complied with pertaining to the health and safety of workers, employees and others.

- All workers and staff should be provided with Personal Protective Equipment (PPE) appropriate to their job on-site.

- All construction sites should be surrounded with secure tamper-proof fence, with security lighting, regular security patrols and other security measures.

- All materials and components should be stored and stacked safely in dedicated secure areas.

- No use of any paint containing lead or its products or material containing asbestos.

- Smoking should be prohibited near areas of fire or explosion risk.

- Sufficient supply of potable water should be ensured for all workers and employees on-site.

- Ensure that first aid kits are available in all work areas, supplied with adequate material to treat common workplace injuries.

- Dedicated transport should be provided at all work sites to take injured persons to hospitals if needed. Record of all nearest hospitals and health centers should be kept at each construction sites.

- A regular medical facility should be provided at each labour camp with suitable qualified staff and equipment to treat minor ailments and injuries.

- An effective alarm system should be established to warn track workers of approach of trains on existing IR lines in parallel route alignment.

[1] Idgah - It is a large place especially set aside for the large congregation who will attend the special Eid prayer early in the morning and can be an open field or flat piece of ground.

- Protect all electric sub-stations, high tension towers and other areas from electrocution risk by providing security fencing and lights, warning signs and security patrols.

10.4.7 Accommodation camp management

(1) Construction Phase

1) Impacts

- Poor quality accommodation could affect workers physically, physiologically and psychologically, damage the natural environment and cause social problems at the camp and in host communities

2) Mitigation Measures

- Proper accommodation should be provided to all employees who are working at a significant distance from their home.

- Water storage tanks should be located above ground and boreholes should be away from toilets/drains.

- Clean and properly staffed and equipped canteen should be provided at all camps.

- Separate accommodation and bathrooms should be provided for men and women.

- Wastewater from the camps should be suitably treated and disposed away from the sites as per the applicable standards and guidelines.

- Regular spray of a mixture made from diesel and insecticides should be done at all water stagnated areas to avoid mosquito breeding and spread of any vector borne diseases.

- Garbage bins should be provided at suitable locations and should be ensured that each site is tidied and refuse taken to a licensed site regularly.

10.4.8 Contractor's demobilization

(1) Construction Phase

1) Impacts

- The long term impacts of construction can be magnified unnecessarily if contractor demobilizes without reinstating land they have occupied temporarily and clearing away debris, garbage, waste oil and other construction waste.

2) Mitigation Measures

- All garbage, debris and hazardous materials should be removed from construction sites and deposed at licensed disposal sites.

- Consult with owner of the site and leave any building, well or any structure if wanted by them.

- All trenches should be filled and all equipment, plant and materials should be removed from the site.

- Compensate for reinstating the landscape and vegetation disturbed during construction activity.

10.4.9 Severance

(1) Operation Phase

1) Impacts

- Where the DFC alignment is along detour route away from an existing IR track, the operation of new line could disrupt people's activities and enhance hardships if sufficient road and rail crossings are not provided.

2) Mitigation Measures

- Where the DFC line crosses existing roads and major footpaths, appropriate structures should be provided such as rail flyovers, RUB, ROB, level crossings, pedestrian subways etc. with proper height and width to enable the crossings to continue.

10.4.10 Public Safety

(1) Operation Phase

1) Impacts

- Risks of accidents and fatalities in the early stages of DFC operations since the DFC trains will be much faster and quieter. This will be more pronounced in parallel sections.

2) Mitigation Measures

- Proper warning signals, alarm system should be provided to warn people from oncoming trains.

- Proper safety walls should be provided in accident prone areas such as in Faridabad-TKD line.

- Initial awareness campaigns on safety instructions and precautions should be done in nearest villages and communities along the alignment route.

- Safety measures should be incorporated into the design to discourage people from gaining access to the DFC line.

CHAPTER 11
ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

CHAPTER 11 ENVIRONMENTAL MANAGEMENT PLAN AND ENVIRONMENTAL MONITORING PLAN

11.1 Environmental Management Plan

The Environmental Management Plan (EMP) provides the measures to be undertaken during the various stages of the project to offset or mitigate the adverse environmental impacts to acceptable levels. The EMP is required to be integrated in the project covering all phases of the project cycle that is planning, construction and operation management. The provision of necessary safeguards in planning of the project itself can lead to reduction of environmental impacts of the project to a great extent.

The development of the DFC entails civil works including excavation, back filling, and construction of RUBs/ROBs, bridges and cross drainage structures and utility shifting. which are likely to cause adverse impacts on the natural and social environment. The impacts cannot be fully avoided; however, appropriate mitigation measures are suggested to minimize and compensate for the potential adverse impacts and enhance the positive impacts.

Environmental management is proposed based on the potential impacts assessed for the project. Assessment of the potential impacts is made based on the review of secondary information and substantiated by field survey and measurements, public consultation, household survey and discussions with concerned authorities. The implementation of the EMP requires the following:

- Implementation of the mitigation measures,
- Monitoring the implementation program,
- Reporting to the designated institutions,
- Training and capacity building,
- Allocation of budget for the mitigation measures,
- Organizational structures for the implementation of the mitigation measures, and
- Establishment of the EMP.

11.1.1 Basic Approach of Environmental Management Plan

The EMP is designed based on the impact assessment statement prepared which comprehensively covers all aspects of the natural and social environment so that adverse impacts if any are taken care of and the project does not create any hazard or affect the quality of life for present and future generations. The EMP should always have a long term perspective and make futuristic predictions considering the developmental activities likely to take place. The EMP often provides the financial outlay for all environmental related aspects. Detailing of the budgetary provisions for different activities is useful for the project authorities.

The technical approach for the EMP includes technical, social, economic, cultural, public health and institutional components. The components are described briefly in the following points:

- Noise and vibration management
- Air quality management
- Water management
- Cutting and filling at the slope
- Reclamation of borrow pits and quarry areas
- Waste management includes even the hazardous waste
- Social aspects
- Good construction practices

(1) Green Belt Development

Vegetative cover plays a vital role in pollution abatement. The greenery absorbs pollutants resulting from anthropogenic activities. The regular uprooting of vegetation in the name of development therefore deteriorates the environment. Open areas of land where plantation might be possible is converted to concrete pavements and structures whilst the water table has dropped considerably in recent years due to the choice of plants in the green belt areas. Unscientific and casual approaches have brought the present state of environment to a chaotic condition.

Vegetative foliage acts as a sink in absorbing the pollutants emitted from industrial units and other emissions. Greenery also may add aesthetic value to the development project. The plantation and vegetative cover in the rail right of way needs to be maintained on a regular basis to make the environment congenial to live.

An important aspect of the vegetative cover is the proper choice of plant species appropriate to the climate and soils of the area. It is also presumed that the selected plants will be grown as per normal horticultural practices and the authorities responsible for plantation, will also make adequate provisions for watering and protection of saplings.

The vegetative cover developed at the rail right of way will play a major role in absorbing pollutants and form a vegetative screen between the railway and human settlements. Trees planted at the rail right of way can help prevent the pollutants spreading all over the residential areas. Trees with proper crown shapes should be selected for the right of way. Crown shapes range from round, spreading, conical and oblong.

- Vegetation plays a vital role in controlling air pollution emitted from various anthropogenic activities. The presence of green vegetative cover enhances aesthetics in both urban and rural areas.
- The surfaces of green plants are capable of absorbing air pollutants and form a sink for the emitted pollutants.
- Growth and survival of trees planted should be ensured and monitoring carried out at least for a period of 3 years.
- Re-plantation of at least twice the number of trees that have been cut down along the corridor for the purposes of constructing the railway. Since the major portion of the proposed corridor passes through open lands, agriculture and barren land along the entire stretch, it is recommended as an enhancement measure which would also serve

as a mechanism to delineate ROW and prevent future encroachments / squatters into the right of way, wherever possible.

- Giving due protection to the trees within the corridor of impact shall be the prime focus during construction/post construction.

The creation of greenbelts around major infrastructure projects is mandatory as per the MoEF, Government of India.

(2) Queries / Borrow Areas Management and Rehabilitation

The borrow areas were selected largely on the basis of the material types and the quantities and distances from the project site. The borrow areas must be carefully planned and designed with due consideration given to environmental aspects. Long and shallow borrow areas are more suitable because they satisfy the environmental considerations. Topsoil from the borrow pit is extracted from and should be spread over the borrow area after excavation is completed. A proper drainage provision is to be provided for the used borrow pits.

The extent of treatment for the borrow areas will vary according to the type and location of the project. The minimum treatment should include proper drainage, topographic smoothing and promote conditions conducive to vegetative growth. Restoration of vegetative growth is important for both land side and riverside pits as it is not only pleasing aesthetically but also serves as protection against erosion.

The contractors are making the ground leveled and giving the area after providing proper drainage. The contractors should take the responsibility for restoring the top soil of the land used.

(3) Noise and Vibration Management and Control

The noise levels created by construction equipment will vary greatly depending on the type of the equipment used. The dominant source of noise from most construction equipment is from the engines, usually those which are diesel operated without sufficient muffling. In some cases like the pile driving and rock breaking, noise generated through the process dominates. Stationary equipment operates in one location for short periods of time with either a fixed power generation (pumps, generators and compressors) or variable noise-making operations like the pile driving and rock breaking. Mobile equipment moves around the construction site with power applied in cyclic fashion (bulldozers and loaders) or to and from the site (trucks and dumpers). The noise assessment depends on the scale of construction and the type of the project. If the project is a major one higher noise levels are experienced for longer periods.

To curtail noise levels there are various barriers designed. The type of the noise barriers most commonly employed consist of earth mounds or walls of wood, metal or concrete which form a solid obstacle between the communities and the construction site. There are several measures indicated to curtail the noise levels emanating from the construction sites in the EMP:

- Construct noise barriers such as temporary walls or piles of excavated materials between noisy activities and noise sensitive receptors.
- Reroute truck traffic away from the residential streets, if possible select streets with fewer homes if no alternative route is available.

- Site equipment to be placed away from the residential location and sensitive areas.
- Construct walled enclosures around especially noisy activities or clusters of noise-making equipment.
- All plant equipments and vehicles being fitted with appropriate noise suppression equipment to reduce noise levels as far as possible.
- All equipment should be operating in good condition.
- All site workers are trained in noise reduction (such as proper use of machinery and hearing protection)
- All outside workers must wear appropriate hearing protection if in close proximity to machinery for extended periods.
- Combine noisy operations to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.
- Avoid night time activities. Sensitivity to noise increases during the night time hours in residential neighborhoods.
- Avoid impact pile driving where possible in noise sensitive areas. Drilled piles or use of a sonic or vibratory pile driver are quieter alternatives where geological conditions permit their use.
- Noise barriers should be established around the yard near residential area and sensitive receptor during the activities, such as blasting and pile driving, generate the high level of noise.
- Use specially quieted equipment such as enclosed air compressor and mufflers on all engines.
- Plantations of trees and shrubs for instance contribute little to actual noise reduction, but they do have a psychological effect in reducing the perceived nuisance of the construction noise, and they are often used to soften the visual appearance of mounds and walls.

Vegetation, if it is high enough, wide enough and dense enough that it cannot be seen over or through, can decrease noise. A wide strip of trees with very thick under growth can lower noise levels. Thirty meters dense vegetation can reduce noise levels by 5 dB. Noise barrier erection is required at the places (where there are couple of generators running simultaneously or equipment functioning constantly) where excess noise is generated. Vibration is also associated with the heavy equipment usage at the construction sites. There are different ways for controlling the noise and vibrations occurring form the construction.

The purpose of mitigating vibration is to minimize the adverse impacts that project ground borne vibration will have on residents living nearby. Because ground borne vibration is not as common as environmental noise, the mitigation measures are not well defined. Perceptible ground borne vibration is generally limited to the areas within few hundred feet of the railway system. However, there are mitigation measures suggested for curtailing both the noise and vibration levels:

- The vibrations can be reduced considerably by ensuring and keeping correct track geometry by advanced measurement.
- Effective maintenance programs are essential for controlling ground borne vibrations.

- Expanding the rail right of way some times the easiest method of reducing the vibration impact.
- Controlling rail traffic time.
- Controlling noise and vibrations at the source. This includes track measures like rail grinding, welding to smooth discontinuity, lubrication, use of soft rail pads and relocation of signals or turnouts. The other mitigation measures include wheel lubrication, use of disc brakes, dampening of wheel and use of resilient wheels.
- Avoid vibratory rollers and packers near sensitive areas.
- Operate earth moving equipment away from the vibration sensitive areas
- Earth moving and ground impacting operations should not occur at the same period of time.
- Avoid night time activities. People are more aware of vibration in their homes during the night time hours.

Controlling the transmission of noise and vibration

This includes the construction of noise barriers, installation of resilient base plates and ballast mats and noise treatment on the bridges. Barriers should be used selectively. They are a high cost approach, and their effectiveness in controlling impacts will depend on the situation. Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the material used (absorptive or reflective) and their density. Barriers can take a number of forms including free standing walls, grass or earth mounds or bunds, trenches, and trenches or cutting with in which noise sources are sited.

Controlling noise and vibration at the receiver

The proposed corridor may affect the existing development, acoustic treatments such as insulation, double glazing and upgrading the construction of buildings located very near to the track. Green vegetative cover planting in the surrounding residential and sensitive areas may also help to reduce noise albeit that is mainly a psychological effect.

Construction activities can also produce varying ground vibration, depending on the equipment and the method employed. Ground vibrations from construction activities very rarely reach levels high enough to cause damage to structure, although special consideration must be made in cases where fragile historical buildings are very near to the site. The construction activities that typically generate the highest levels of vibration are blasting and impact of pile driving and these activities should not be carried out in the vicinity of old buildings of historical or religious significance.

(4) Solid Waste Management

Any construction project of this magnitude will create an enormous amount of solid waste and should be properly disposed of at the identified locations. The waste is generated by construction activities and from the construction camps. Prior permission from the relevant responsible authorities will be required before disposing of any solid waste material.

Properly disposing of solid waste generated from construction labour camps is a must to protect the environment. The main waste generated from the kitchen will comprise of organic waste (eggshells, discarded foods, vegetable peels, meat and bones), inert

materials like (polyethylene bags, and mineral water bottles) and wastewater flowing out of the construction yard. The waste water from toilets will flow into septic tanks. Improper management may give rise to a number of health problems.

- Uncontrolled solid waste dump sites could be breeding ground for vermin, and as such could pose a vector for disease.
- Uncontrolled solid waste dump sites invariably attract casual dumping by others. This could encourage improper disposal of hazardous wastes, thereby posing a hazard to soil and groundwater quality.
- Segregation of waste depending on the nature of the material should be carried out. Special attention should be given to diverting hazardous wastes for proper management in accordance with applicable regulatory requirements.
- Composting of appropriate organic wastes should be considered.
- Solid waste should be segregated in to recyclable wastes, inert wastes and plastic wastes. Most of the plastic resins can be recycled by applying steam, pressure and high heat. These separate most resins into monomers that can be refined and re-polymerized.
- The waste water can be sent out to the soakage pit.

(5) Storage, Handling and Emergency Response for Hazardous Materials

Safe handling of fuel is everyone's responsibility. One can take steps to ensure their own safety and health, as well as that of those around and ensure that the environment is protected. Improper handling of fuel and hazardous material can result in serious injury or death caused by fire, explosion, or asphyxiation. Fuel released into the environment can contaminate soil and groundwater resulting in costly cleanups. Contaminated groundwater supplies may sicken people and animals who unknowingly drink the polluted water. Gasoline vapours are harmful to human health even at low concentrations and are potentially dangerous at high concentrations. Hazardous materials must be stored based on their compatibility. Materials are stored in accordance to their hazardous nature. Hazardous substances should be stored in an orderly manner with older products most accessible and the newer products least accessible. Good housekeeping must be practiced in areas where hazardous products are stored. All hazardous materials must be properly labeled including their exact contents, hazardous properties, date of receipt, and if appropriate, date of expiration. Hazardous substances should be stored in original containers in which they were packaged at the manufacturing plant. If this is not practical, these products should be transferred according to manufacturers' recommendations into containers that are constructed to withstand the effects of the product over the maximum storage time. Incompatible materials must not be stored such that they may come in contact with each other with potentially dangerous consequences. Combining these materials may result in the following:

- Heat or pressure;
- Fire or explosion;
- Violent reaction;
- Toxic dusts, mists, vapours, or gases;
- Flammable vapours or gases.

Handling Hazardous Materials

Whenever it is feasible, engineering controls must be used to reduce employee exposure to hazardous materials. The two most common engineering controls are the use of local exhaust and general ventilation. These measures limit an employee's exposure to airborne contaminants. When engineering controls are not available, or they fail to adequately reduce hazards, other personal protective equipment is required. Examples of personal protective equipment include: safety glasses, hearing protection, gloves, respirators, etc. Personal protection devices must be provided and worn in accordance with the manufacturer's recommendations indicated on the label of the product or as stated in the Material Safety Data Sheet for the product. Hazardous chemical spills can be handled effectively when a plan of action has been developed. Spill procedures should include the following general procedures:

- If the spilled material is flammable, turn off ignition and heat sources.
- Attend to any person who may have been contaminated or affected.
- Notify individuals in the area about the spill.
- Evacuate non-essential personnel.
- Avoid breathing vapours of spilled material. Establish an exhaust or ventilation, if it is safe to do so. Air handling units are not to be used because they re-circulate the hazardous vapours. Contact Safety, Health and Environment (SHE) for information about the proper ventilation or exhaust required.
- If a spill is relatively large, or involves a highly toxic material, a carcinogen or flammable material, contact SHE for assistance in cleaning up the spill and disposing of the hazardous waste resulting from the cleanup.

Hazardous wastes undergo different treatments in order to stabilize and dispose of them.

- Recycling
- Neutralization
- Hazardous waste landfill

(6) Soil Erosion Control

Construction activities on site have potential to cause erosion and the deposition of sediment into adjoining lands and waters. Construction activities include:

- Land clearing
- Earth works
- Haulage operations
- Piling
- Construction of coffer dams
- Soil stock piling and temporary storage.

There are a wide range of techniques designed to reduce the risk of damaging the soil and to fit the project into its environment with minimal adverse impacts. Simple techniques

such as replanting will be an effective solution in many situations, whereas more sophisticated techniques, such as retaining walls are used only in the most difficult cases.

Replanting cleared areas and slopes is the most effective action to be taken in reducing erosion and stability problems. It should be undertaken as early as possible in the construction process, before erosion becomes too advanced. To be most effective, it should be done immediately after a disturbance takes place. Vegetation should be selected to serve a specific engineering function.

Engineering functions of vegetation includes its abilities to:

- Catch and retain material moving over the surface.
- Protect the surface against erosion and abrasion by intercepting raindrops
- Reinforce the soil profile by increasing its shear resistance
- Drain the soil profile by drawing water out through the roots and releasing it to the air by transpiration
- Facilitate infiltration of water through the soil profile, thereby reducing the proportion of water flowing over the soil surface
- Grasses can effectively limit surface erosion.
- Shape the slope surface for maximum seedling survivability
- Choose the right varieties, according to the soil type, climate, ease of maintenance, and desired engineering function. Local varieties are always preferable.
- Right season should be preferred for planting the saplings.

(7) Management for Land Acquisition and Resettlement

There is no forest land and extensive land will be acquired for the project in the Rewari, Alwar, Mewat, Palwal, Gurgaon, Faridabad Districts but about 1.6 km length of the forest land will be acquired in Gautam Buddha Nagar in the Rewari Dadri Section. In the Vadodara and JNPT section, the corridor would pass through forest patch, protected areas and semi urban stretches in the Thane District and in the districts (Valsad, Surat, Bharuch, Navasari, and Vadodara) of Gujarat. Diversion of Forest land will be carried out in compliance with the Forest Conservation Act, 1980. The acquisition of land and private property shall be carried out in accordance with the Rehabilitation and Resettlement Plan (RRP).

It has to be ensured that all R&R activities including the payment of the compensation may be reasonably completed before construction activities starts on any section of the DFC. There are some utility services along the proposed DFC alignment such as electric poles, telephone lines, cable line, pipelines etc the affected lines will be shifted in consultation with the concerned departments before the commencement of the construction activity. There are several roads crossing along the proposed dedicated freight corridor. The structures will be shifted in consultation with the concerned state departments.

Compensation and assistance package will be planned in RRP, separately from the ESIA.

(8) Occupational Health and Safety Management

During the construction phase construction/labour camps will be located along the project area. Large numbers of workers are likely to cause a significant increase in the local population in the project area. A proper Construction Camp Development Plan has to be formulated to control degradation of the surrounding environment due to the location of the proposed construction camp. The contractor must provide, and maintain adequate living conditions and ancillary facilities that must be included in the contract document provided to the Contractor.

The main health and safety risks during construction will arise from:

- Inadequate sanitation facilities in worker camps could lead to diseases like typhoid, cholera and malaria.
- Introduction of sexually transmitted, and other diseases, by immigrant workers; and
- Outbreaks of malaria, typhoid, cholera etc. amongst the labour force.

The following actions should be undertaken at construction/labour camps and stipulated in construction contracts:

- Sufficient supply of potable water must be provided at camps and working sites. If the drinking water is obtained from an intermittent public water supply then storage tanks must be provided. All water supply storage must be at least 15 m away from the toilets or drains.
- Adequate washing and bathing facility must be provided in clean and drained condition.
- Adequate sanitary facilities must be provided within every camp. The place must be cleaned daily and kept in strict sanitary condition. Separate latrines, bathing and changing areas must be provided for women.
- Collection of domestic waste and its suitable disposal must be carried out on a regular basis.
- Adequate supply of fuel in the form of kerosene or LPG must be provided to construction labourers to avoid the felling of trees or collection of firewood for cooking and other household activities. No open fires will be allowed in camps.
- The sites are to be access controlled.
- Construction equipment and POL products should be stored 500 m away from the local settlements, workers living areas and it should be away from the water resource.
- The contractor should be required to submit and obtain approval for a health and safety plan prior to the commencement of work;
- Adequate training on medical surveillance, engineering control, good work practices and handling of hazardous material, housekeeping and emergency response.
- There should be provision of adequate health care facilities; and
- Workers should be required to undergo pre-employment medical screening and treatment (if required) and periodic health checks thereafter.

Additionally, the project should support a health education programme for workers and villagers covering road safety, malaria, hygiene, and sexually transmitted diseases. The

district health departments should participate in monitoring and education of communities and workers affected by the project.

First Aid Facilities

- The employer should be responsible for ensuring that first aid, including the provision of trained personnel, is available. Arrangements should be made for ensuring the removal for medical attention of workers who have suffered an accident or sudden illness.
- The manner in which first aid facilities and personnel are to be provided should be prescribed by national laws or regulations, and drawn up after consulting the competent health authority and representative organizations of employers and workers concerned.
- Where the work involves risk of drowning, asphyxiation or electric shock, first aid personnel should be proficient in the use of resuscitation and other life-saving techniques and in rescue procedures
- Suitable rescue and resuscitation equipment, as required, including stretchers should be kept readily available at the construction site.
- First-aid kits or boxes, as appropriate, should be provided at the workplaces, including isolated locations such as maintenance gangs, and on motor vehicles, locomotives, boats and floating equipment, and be protected against contamination by dust and moisture.
- First- aid kits and boxes should be simple with clear instructions provided, and be kept under the charge of a responsible person qualified to render first aid and be regularly inspected and stock properly maintained.

Fire Prevention and Fire Fighting

- All the appropriate measures should be taken by the employer to avoid the risk of fire Control quickly and efficiently any outbreak of fire and bring about a quick and safe evacuation of persons.
- Secure storage areas should be provided for flammable liquids, solids and gases such as liquefied petroleum gas cylinder, paints and other such materials in order to deter trespassers.
- Smoking should be prohibited and no smoking notices be prominently displayed in all places containing readily combustible or flammable materials
- In confined spaces and other places in which flammable gases, vapors and dust can cause danger:
    - Only suitably protected electrical installations and equipment, including portable lamps, should be used.
    - Oil rags, waste and clothes or other substances liable to spontaneous ignition should be removed without delay to a safe place.
    - Adequate ventilation should be provided.
- Combustible materials such as packing materials sawdust, greasy/oily waste and scrap wood or plastic should not be allowed to accumulate in work places but should be kept in closed metal containers in a safe place.

- Regular inspections should be made of places where there are fire risks. These include the vicinity of heating appliances, electrical installations, and conductors, stores of flammable and combustible material, hot welding and cutting operations
- Places where workers are employed should, if necessary to prevent the danger of fire, be provided as far as practicable with:
- Suitable and sufficient fire-extinguishing equipment, which should be easily visible and accessible
- An adequate water supply at ample pressure.
- Fire-extinguishing equipment should be properly maintained and inspected at suitable intervals by a competent person.
- Where necessary to guard against danger, workers should be suitably trained in the appropriate actions to be taken in the event of fire, including the use of means of escape.
- Where appropriate, suitable visual signs should be provided to indicate clearly the direction of escape in case of fire.
- Means of escape should be kept clear at all times.

Sanitary Facilities

- The provision of toilet or sanitary facilities, and the construction and installation of water flush toilets, privies, chemical closets, plumbing or other toilet fixtures should comply with the requirements specified by the competent authority.
- No toilets other than a water flush toilet should be provided and they should be adequately ventilated and not open directly into occupied rooms
- Adequately washing facilities should be provided as near as possible to toilet facilities.

House Keeping

A suitable housekeeping program should be established and continuously implemented on each construction site which should include:

- The proper storage of materials and equipment
- The removal of scrap, waste and debris at appropriate intervals.
- Loose materials which are not required for use should not be placed or allowed to accumulate in the site so as not to obstruct access to and egress from workplaces and passageways.
- Workplaces and passageways that are slippery, owing to oil or other causes should be cleaned up or strewn with sand, saw dust, ash or the like.
- Special housekeeping staff would be in charge of each work section.
- Each section will maintain the site reasonably clean and keep from obstruction, and properly store any construction equipment, tools and materials. Any wreckage and/or rubbish shall be temporarily stored in wreckage and rubbish bins. These rubbish bins and wreckage shall be cleaned at frequent intervals.
- General housekeeping shall be carried out and ensured at all times at work sites, labour camps, stores and offices.

- Full height fence, barriers etc. will be installed at the site in order to preserve the surrounding area from excavated soil, rubbish etc.
- Arrangements to control dust pollution including silica dust through provision of wind screens, water sprinklers, and dust extraction systems will be provided at all site, likely crushers, concrete batching plants, quarry area and sand sites
- The contractor will ensure that all sub contractors maintain the site reasonably clean through sub contractor provision related to housekeeping.
- All staff and supervisors and engineers working at the site will also be educated on the necessity of good housekeeping.
- Immediate disposal of the weeds, trash and debris resulting from site clearing.
- The garbage will be separated into biodegradable and inert material and disposed of separately. The food items will be collected in trash cans with a firm lid.
- Oil and grease dripping from machinery will be collected in a drip pan of suitable size. The area will be cleared after the repair and maintenance of the construction equipment.
- Efficient drainage and leveling of the low lying areas will be done at all construction sites to prevent the creation of stagnant pools or puddles of water.
- Empty oil drums, cans and other receptacles which may retain water shall be disposed of regularly.

11.1.2 Stage Wise Activities of Environmental Management Plan

(1) Environmental Management Plan

The project will be executed in a stage-wise manner, Pre-construction (Planning/Design stages), Construction and Operation phases The design stage will be concentrated on the alignment and ground-truthing of the entire project area. Acquisition of land is essential for the construction stage. The location for the borrow pits and quarry areas will be identified for the construction work.

The major activities to be conducted are described below. The environmental issues during construction stage generally involve equity, safety and public health issues. The DFC will bisect numerous protected areas and mangrove forests therefore impacts on the natural environment and fragile ecosystems are one of the key issues. The contractor is required to comply with the laws with respect to environment protection, pollution prevention, forest conservation, resettlement and safety and any other applicable law. The EMP provides guidance and stipulations on how project activities are to be controlled, implemented and monitored in order to minimize environmental impact. Tables 11.1.1, 11.1.2 and 11.1.3 summarize the main mitigation and management measures for significant impacts in Planning/Design, Construction and Operation phases. They provide mitigation/ management measures for significant impacts and an estimated for their implementation. They also identify the parties to incur the costs and implement the measures.

Table 11.1.1(1) Environmental Management and Responsibilities during the Planning/Design Phase

No.	Item	Mitigation/Management Measures	Organization		Other Concerned Entitles	Estimated Costs of measures
			Planning and Implementation	Supervision and Responsible		
1	Land acquisition and resettlement	- The acquisition of land and private properties shall be carried out in accordance with the RRP and entitlement framework for the project approved by DFCCIL. - Social Environmental Management Unit (SEMU) has to ascertain that any additional environmental impacts resulting from acquisition of land shall be addressed and integrated into the EMP and other relevant documents.	Parties should be determined in a separate RRP Study.	DFCCIL	-	To be determined in a separate RRP Study.
2	Tree cutting and green belt development	- Avoidance of non-essential tree-cutting - Special care will be taken at the eco-sensitive areas like Dahanu area, Gulistanpur and Arawali region. - Green belt development at the container terminals and at the sensitive locations such as the residential areas.	Design Consultant and Contractor	DFCCIL	Respective State Forestry Department	Rs. 15,000,000 for tree cutting Rs. 20,000,000 for compensatory plantation
3	Crushers, and concrete Batching Plants	- All construction plants will be sited sufficiently away from settlements and agricultural operations and commercial establishments. - Plants will be located at least 100 m away from the nearest dwelling preferably in the downwind direction. - Arrangements to control dust pollution including silica dust through provision of wind Screens, water sprinklers, and dust extraction systems will be provided at all such sites. - Specifications for crushers, and concrete batching plants will comply with the requirements of the relevant emission control legislation. - Consent for the establishment and operation from statutory authorities shall be obtained before establishment and operation respectively.	Design Consultant and Contractor	Engineer and Supervisor Consultant	Respective, SPCB, State Ground Water Authority, and State Department of Mines	No specific cost for the measures. On the other, statutory consent fees will be required, which varies from State to State.
4	Construction Vehicles, Equipment and Machinery	- All vehicles, equipment and machinery to be procured for construction will conform to the relevant Bureau of India Standard (BIS) norms. - The discharge standards promulgated under the Environment Protection Act, 1986 and Motor Vehicles Act, 1988 shall be strictly adhered to. - The silent/quiet equipment available in the market shall be used for the Project. Planning should avoid route alignment to avoid residential areas.	Design Consultant and Contractor	DFCCIL	State Transport Department and SPCB	No specific cost for the measures to be considered.
5	Construction Water	- Ground /surface water as a source of water for construction requires necessary permissions which will be obtained from the respective State Irrigation Departments and State Ground Water Boards.	Design Consultant and Contractor	Engineer and Supervisor Consultant	-	No specific cost for the measures. On the other, statutory consent fees will be required, which varies from State to State.

Table 11.1.1(2) Environmental Management and Responsibilities during the Planning/Design Phase

No.	Item	Mitigation/Management Measures	Organization		Other Concerned Entitles	Estimated Costs of measures
6	Quarry area and Sand sites	- Procurement of construction materials for quarries will be finalized after assessment of the availability of sufficient materials, quality and other logistic arrangements. - Locations finalized and the necessary clearances should be obtained from the statutory agencies like the State Pollution Control Boards and from the Mining Department. - Planning of haul roads for accessing quarry areas will be undertaken during this stage. - The haul roads shall be routed to avoid agricultural areas as far as possible and will use existing village roads wherever available. - The sand will be procured from identified sand mines as far as possible. - Permission to be obtained from the statutory departments of the state.	Design Consultant and Contractor	Engineer and Supervisor Consultant	-	No specific cost for the measures.
7	Borrow Areas	- The earth material is to be borrowed from select borrow areas, until the formal agreement is signed between landowner and the executing agency. - Locations finalized and the necessary clearances should be obtained from the statutory agencies like the State Pollution Control Boards and from the Mining Department. - Planning of haul roads for accessing borrow areas will be undertaken during this stage. - The haul roads shall be routed to avoid agricultural areas as far as possible and will use the existing village roads wherever available.	Design Consultant and Contractor	Engineer and Supervisor Consultant	-	No specific cost for the measures.
8	Labour	- Preferably use unskilled labour drawn from local communities to maximize benefits to the local community.	Contractor	DFCCIL	-	No specific cost for the measures.
9	Construction Camp	- Setting of the construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. - Location for stockyards of construction materials will be identified at least 300 m away from watercourses. - The sewage and solid waste for the camp will be designed, built and operated.	Contractor	DFCCIL	-	No specific cost for the measures.
10	Disaster	- The seismic factors should be appropriately incorporated in the civil and structural designs of major structures in DFC project. - An engineering geologist should identify any slope instability potential among the uniform rock structure along the Aravalli ridge where deep rock cutting will be done. DFCCIL should take up such study through suitable experts/institutes during detailed engineering stage. - Adequate cross drainage channels (longitudinal and median drains) should be provided along DFC route at suitable locations for the smooth passage of the surface run-off to prevent flooding.	Design Consultant and Contractor	DFCCIL	-	(Rs. 500,000 for engineering geologist)

Note: SPCB: State Pollution Control Boards, *No separate EMP cost but in-built as part of Good Construction Practice.

Source: JICA survey team

Table 11.1.2(1) Environmental Management and Responsibilities during the Construction Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of measures
			Planning and Implementation	Supervision		
1	Air pollution	- The air pollution can be observed from the excavation, dismantling activities and emissions from the vehicles and equipment used for construction. - Sprinkling of water at the dust prone areas will reduce dust emissions. - Equipment and trucks will be properly maintained at regular intervals. *No separate EMP cost but inbuilt as part of Good Construction Practice. However, sprinkling system for prevention of dust emission could cost Rs 300,000 per site	Contractor and Supervisor Consultant	DFCCIL	SPCB	No specific cost for the measures.
2	Noise	- Construction activities producing high noise levels should be done at different time intervals to curtail the noise levels. - The equipment used should have mufflers to reduce noise levels. All equipment should be properly lubricated. - The construction yards should be surrounded by barriers near the sensitive receptors. The plants absorb noise levels. - Avoid night time activities. Sensitivity to noise increases during the night time hours in residential neighborhoods. - Periodical inspection and effective maintenance of vehicle and equipment	Contractor and Supervisor Consultant	DFCCIL	SPCB	No specific cost for the measures.
3	Clearing and grubbing	- If required, vegetation will be removed from the construction zone before commencement of construction after obtaining necessary permissions. - All works will be carried out such that the damage or disruption to flora other than in those areas identified for cutting is kept to a bare minimum. - Trees identified under the project will be cut only after receiving clearance from the Forest Department.	Contractor	DFCCIL	SPCB and Respective State Forestry Department	No specific cost for the measures.
4	Disposal of debris from dismantling structures	- Debris will be separated into hazardous material, construction waste (concrete) and organic waste (bio-degradable). - Construction waste will be disposed of at the identified and approved locations. - No disposal will be permitted in the eco-sensitive areas. - Disposal will not be permitted into watercourses. - The disposal sites should be provided with drainage structures. - If solid wastes are to be deposited on private land then necessary prior permissions and agreements will be obtained	Contractor	DFCCIL	SPCB and Respective State Forestry Department	No specific cost for the measures.

Table 11.1.2(2) Environmental Management and Responsibilities during the Construction Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of measures
5	Stripping, stocking and preservation of top soil	- Stockpile will be designed such that the slope does not exceed 1:2 (vertical to horizontal), and height of the pile is restricted to 2 m. To retain soil and to allow percolation of water, silt fencing will protect the edges of the pile. - Stockpiles will not be surcharged or otherwise loaded and multiple handling will be kept to a minimum to ensure that no compaction will occur. - The stockpiles shall be covered with sheets or vegetation. - Proper drainage systems will be provided to prevent stagnation of water.	Contractor	DFCCIL	-	No specific cost for the measures.
6	Traffic diversions and detours	- The temporary traffic detours will be kept free of dust by sprinkling water during the day time depending on weather conditions.	Contractor	DFCCIL	State Transport Department and SPCB	No specific cost for the measures.
7	Borrow areas and quarry sites	- Borrow areas and quarry sites should be away from human settlements. - The excavation of borrow should be specified as per the guidelines. - Access to the quarry operated area and borrow sites should be strictly controlled. - All workers at the quarry site will be provided with personal protective equipment. - All the haul roads are watered regularly to reduce dust emissions. - A vegetative barrier should be planted to surround the borrow area and quarry sites.	Contractor	DFCCIL	-	No specific cost for the measures.
8	Transporting construction materials and haul road management	- Dumpers and trucks carrying the construction material should be spill-proof. - Trucks and dumpers should be properly maintained. - Water will be sprinkled on the haulage roads. - Strict speed limits will be followed at the settlement areas and on the haulage roads. - All the truck and dumper drivers will be properly trained.	Contractor	DFCCIL	State Transport Department and SPCB	No specific cost for the measures.
9	Construction water and waste water from construction yard and labour camps.	- Water required for construction will be drawn from surface water bodies only after obtaining prior permission from the appropriate government departments. - If ground water is drawn then permission from the state ground water authority has to be obtained. - The wastewater from construction yard and labour camp should be treated before being discharged into surface water bodies to avoid siltation.	Contractor and Supervisor Consultant	DFCCIL	SPCB	No specific cost for the measures.

Table 11.1.2(3) Environmental Management and Responsibilities during the Construction Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of measures
10	Siltation of water bodies	- Construction of silt fencing at the base of the embankment construction site and around the stockpiles at the construction sites. - The fencing will be provided prior to commencement of earthwork and continue until the stabilization of the embankment slopes on the particular sub-section of the freight corridor is completed. - Construction materials containing fine particles are stored in an enclosure such that sediment-laden water does not drain into nearby water bodies.	Contractor and Supervisor Consultant	DFCCIL	SPCB	No specific cost for the measures.
11	Slope protection and control of soil erosion	- Soil erosion and sedimentation can be minimized by constructing breast walls, retaining Walls, pilot bioengineering methods, dykes, sedimentation chambers, basins, fibre mats, mulches, grasses, slope, drains and other devices. After completion of embankment building, the embankment will be turfed for slope stabilization purposes. - Cascading drainage system will be provided for controlling of the erosion from the embankments.	Contractor	DFCCIL	-	No specific cost for the measures.
12	Petroleum oil and lubricants	- POL products will be handled with special care. - The necessary permissions will be obtained for handling and use of the POL Products. - The used oil and lubricants will be sold to authorized parties. - The storage places for POL will have restricted entry. - Accidental spillage of oil and lubricant will be immediately cleared. - The trucks and dumpers will not be washed at the nearby water bodies, instead of that they will be cleaned in the construction yard and the waste water will be collected in a settling tank before it can be re-used for some other purposes like gardening etc.	Contractor	DFCCIL	SPCB	No specific cost for the measures.
13	Public health and safety risks	- Barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access to the freight corridor except at designated crossing points. - The general public/local residents shall not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation. - Speed restrictions shall be imposed on Project vehicles and equipment when traversing areas with sensitive receptors (residential, schools, temples, etc.).	Contractor and Supervisor Consultant	DFCCIL	-	No specific cost for the measures.
14	Environmental and social disruption from construction camp	- Hire as many local people as possible and train them. - Site construction camps should minimize adverse impacts by good management practices. - Implement malaria control, HIV/AIDS education. - Plan and carry out post construction site clean-up.	Contractor and Supervisor Consultant	DFCCIL	-	No specific cost for the measures.

Table 11.1.2(4) Environmental Management and Responsibilities during the Construction Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of measures
15	Risk from electrical equipment	- No material will be so stacked or placed as to cause danger or inconvenience to any person or the public. - All necessary fencing and lights will be provided to protect the public in construction zones. - All machines to be used in the construction will be kept in good working order, and will be regularly inspected and properly maintained.	Contractor	DFCCIL	-	No specific cost for the measures.
16	Occupational safety to the labour	- All site workers will be provided with personal protective equipment such as safety shoes, and helmets - Welders will be provided with eye shields and gloves. - Ear plugs will be provided for workers working in high noise zones. - Workers will not be allowed to work without the appropriate personal protective equipment. - Workers shall be provided with an adequate potable water supply. - Provision of distinguishing clothing or reflective devices or otherwise conspicuously visible material when there is regular exposure of workers to danger from moving vehicles. - Monitoring and control of the working environment and planning of safety and health precautions should be performed as prescribed by national laws and regulations. - Construction camps shall be provided with adequate drainage to avoid accumulation of stagnant water. - HIV/AIDS awareness and prevention program shall be implemented under the Project. - The following facilities shall be provided at the workers' camps: - Washing facilities or showers shall be provided at the workers' camps. - Toilets/sanitation facilities with proper flushing provisions in accordance with local regulations to prevent any hazard to public health or contamination of land, surface or groundwater. These facilities shall be well maintained to allow effective operation. - Accommodation for taking meals and for shelters during interruption of work due to adverse weather conditions. - First aid room or station under the charge of qualified first aid personnel or a nurse should be provided at a readily accessible place for treatment of minor injuries and as a rest place for seriously sick or injured workers. - Construction equipment shall be operated by workers who have received appropriate training in accordance with national laws and regulations. - The drivers and operators of vehicles and materials handling equipment shall be medically fit, trained and qualified and of at least the prescribed minimum age as required by the government rules and regulation.	Contractor	DFCCIL	-	No specific cost for the measures.

Table 11.1.2(5) Environmental Management and Responsibilities during the Construction Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of measures
		- Suitable scaffolds from the ground shall be provided for the work force, who are working at elevated heights, if a ladder is used proper foot holds and hand holds shall be provided on the ladder. - Safety provisions shall be brought to the notice of all concerned by displaying on a notice board at a prominent place at the work locations. - The contractor shall be responsible for observance by his sub-contractors, of all health and safety provisions. - The contractor should take adequate measures for the control of malaria, typhoid, dengue, cholera etc. - All vehicles used in the construction yard should have reverse horns - There should be proper demarcation of work areas with sign boards showing the work areas. The signboards should be in local language. - Suitable warnings should be displayed at all places where contact with or proximity to electrical equipment can cause danger. - Persons operating electrical equipment should be fully instructed as to any possible dangers associated with the equipment concerned. All electrical equipment should be inspected before use to ensure that it is suitable for its purpose. - Water transport tanks, storage tanks and dispensing containers should be designed, used, cleaned and disinfected at suitable intervals in a manner approved by the competent authority. - Water that is unfit to drink should be conspicuously indicated by notices prohibiting workers from drinking it. - Secure storage areas should be provided for flammable liquids, solids and gases such as liquefied petroleum gas cylinder, paints and other such materials in order to deter trespassers. - Smoking should be strictly prohibited and no smoking notices be prominently displayed in all places containing combustible or flammable materials - Only suitably protected electrical installations and equipment, including portable lamps, should be used. - Oil rags, waste and clothes or other substances liable to spontaneous ignition should be removed without delay to a safe place. - Fire-extinguishing equipment should be provided at construction camps, asphalt plants, storage areas for combustible materials and other areas where fire hazards are found. Such equipment shall be properly maintained and inspected at suitable intervals by a competent person.	Contractor	DFCCIL	-	No specific cost for the measures.

Source: JICA survey team

Table 11.1.3 Environmental Management and Responsibilities during the Operation Phase

No.	Item	Mitigation/Management Measures	Responsible Organization		Other Concerned Entitles	Estimated Costs of Measures
			Planning and Implementation	Supervision		
1	Noise	- Noise barriers should be erected at appropriate locations such as residential areas and sensitive receptors which are adjacent to the corridor.	EMU	DFCCIL	-	Estimated at the detail design stage
2	Maintenance performance	- Monitoring of the operational performance of the various mitigation/ enhancement measures carried out as a part of the project. - The indicators selected for monitoring include the survival rate of trees; utility of enhancement provision for relocated utilities, hand pumps and other relocated structures if any; status of rehabilitation of borrow areas; and noise barriers, which are proposed at different locations.	EMU	DFCCIL	-	Incl. in normal cost of operation
3	Borrow areas and quarry sites.	- Incorporate adequate drainage and fill in borrow pits and quarries. Before doing the activity local concerns should be considered. The village authorities should also be consulted. - Maintain borrow pits and quarries by landscaping them after operation by growing native species. - All borrow areas are to be reclaimed properly and it should be restored to a level that is acceptable level to the land owner.	EMU	DFCCIL	-	Shown in Table 11.4.1
4	Green belt development	- Maintenance of plantation - Green Belt would arrest the noise levels.	EMU	DFCCIL	-	Incl. in normal cost of operation
5	Training for the staff	- The training should be for all the executives regarding the environment and safety. - The process should for a minimum period for first six months.	EMU	DFCCIL	-	
6	Disaster	- Maintenance of cross drainage channels (longitudinal and median drains) should be carried out.	EMU	DFCCIL	-	

Source: JICA survey team

(2) Organizations Responsible at Different Phases

Construction

- State Pollution Control Board: At the time of construction for giving the necessary permissions for the construction yards and the equipments brought for the construction activity.

- The Department of Mines & Minerals: The Department is responsible for giving all necessary permissions for the borrow sites and quarry pits.

- The State Department of Irrigation: if the contractor uses surface water or river water, then necessary permission from the Irrigation Department.

- The State Ground Water Authority: If the Contractor uses ground water for the construction then necessary permission should be obtained from State Ground Water Authority.

- The State Forest Department: For cutting any forest trees or encroaching into the forest land requires the permission from the Forest Department.

- The Labour Department: The labour laws are to be strictly to be followed during the construction and at the time of operation.

- The Department of Explosives: The Contractor should obtain necessary permission for using explosives and for storing the same.

- State Pollution Control Board will also play a major role at the time of hazardous material management.

- The Disposal of Waste requires proper permission from the local municipal authorities.

- The road crossing requires permissions from the National Highway Authority (NHA) of India or from the State Government Highway Department.

- For utilities like the pipe lines the permission are required from the respective State water Boards.

- For utilities like power transmission lines requires permission from the State Electrical Department.

- The State Transport Department: The necessary permission for the construction vehicles should be obtained from the State Transport Authority.

- The State Police and the State Medical Departments are considered during any exigencies.

Operation

The most important government agencies during the operation stage is the Ministry of Railways, Local administration, Forest department and State Pollution Control Boards

11.2 Environmental Monitoring Plan

11.2.1 Introduction

An Environmental Monitoring Plan (EMoP) provides a basis for monitoring potentially adverse environmental impacts of the project during its execution. The information derived from environmental monitoring activities can be used to mitigate and reduce environmental impacts and enhance project benefits through adaptive management. The implementation of the EMoP is adopted in all project works. An EMoP is important as it provides useful information and helps to:

- Assist in detecting the development of any unexpected environmental or social situation and thus provides opportunities for adopting appropriate control, management or mitigation measures.

- Defines the responsibilities of the project proponents, site engineers, contractors and environmental monitors and provides means of effectively communicating environmental issues among them.

- Defines the monitoring mechanism and identifies monitoring indicators, methods and parameters.

- Provides information which allows for the evaluation of the performance and effectiveness of mitigation measures proposed in the EMP and enables managers to make improvements in management plan.

- Identifies training requirement at various levels.

11.2.2 Environmental Monitoring Plan

A monitoring plan normally involves two main types of activity:

Routine supervision of the work: Observation of the construction/operation work to ensure mitigation actions will be conducted during routine site inspections. This work will be conducted as general operation working/maintenance progress including daily work. (See Table 11.2.1)

Environmental and social impact/mitigation monitoring: The monitoring to be conducted to determine the actual and social impact. (See Table 11.2.2)

Table 11.2.1(1) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
							Planning and Implementation	Supervision and Responsible
1	Social impact	Planning /Design phase	To ensure that the adverse impacts of land and property acquisition and resettlement are addressed and compensated	- Inventory of losses - Implementation of Rehabilitation and Resettlement Plan (RRP) - Public consultation	- Check notification & DFC Payment record	Monthly	Design Consultants	DFCCIL assisted Supervision Consultant and SPCB inspecting
		Construction	To ensure that the adverse impacts of construction activities are minimized and mitigated	- DFCCIL will employ an NGO to address resettlement issues associated with the project.	- Check if the community has brought the problem to the notice of the Consultant and Client	Monthly	Constructor	DFCCIL assisted Supervision Consultant and SPCB inspecting
2	Crops and vegetation	Planning /Design phase	To minimize the direct impacts on crop production and other vegetation	- Clearing of surface cover for construction for borrow pit, cutting trees and other important vegetation during construction should be minimized - Follow procedures with regard to spoil dumping - Replacement of topsoil and restoration of vegetative cover	- Interviews with local residents will also help in this matter.	Before commencement date	Design Consultant	DFCCIL and Supervision Consultant
3	Impacts on freight corridor design	Planning /Design phase	To ensure that the recommendations given with the conditional approval by the DFCCIL and followed by design consultant	- ROB and RUB have been designed - Existing irrigation, protection measures have been identified.	- Check final design drawing and original plan	Before the commencement of construction activities	Design Consultants	DFCCIL assisted Supervision Consultant
4	Air Pollution	Construction	To minimize air pollution from freight corridor construction	- Watering on earthen surfaces especially in the settlement areas - All construction vehicles should be maintained in good condition to minimize emissions.	- Check watering as per the frequency given in the EMP. - Proper implementation can be achieved by site inspection along with interviews with local residents.	Weekly One check	Contractor	DFCCIL

Table 11.2.1(2) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
5	Noise and vibration	Planning /Design phase	To minimize the noise and vibration level resulting from freight corridor To control noise pollution from exceeding tolerable levels on embankment sections taking into account the increase in traffic volume	- Establishing standards and regulations for noise levels for various equipment used at the site - Strict enforcement of regulations. - Awareness programs	- Determination of critical sites and methods of mitigation during the construction period.	Monthly/ As necessary	Design Consultants	DFCCIL assisted Supervision Consultant
		Construction	To minimize the noise and vibration level resulting from road traffic, To control noise pollution from exceeding tolerable levels on embankment sections taking into account the increase in traffic volume	- All road construction vehicles must have working mufflers and be maintained in good condition - Noise barriers should be established around the yard near residential area and sensitive receptor during the activities such as blasting and pile driving.	- Check that the Contractor is performing mitigation measures. - This can be achieved by interviewing the locals and site inspection.	A monthly inspection of the construction yards must be carried out.	Contractor	DFCCIL
		Operation	To minimize the noise and vibration level resulting from rolling stock	- Maintenance of the rail, sound barrier as wall as well as equipment rolling stock	- Visit site and compare with Normal situation	Periodical	EMU	DFCCIL assisted Supervision Consultant
6	Water quality	Planning /Design phase	To control the impacts on the quality of surface and groundwater	- Maintain existing concentrations of chemicals sediments and water at specific locations. - Design appropriate mitigation measures	- Check final planning and approve if proposal suitable	Before the commencement of construction activities	Design Consultants	DFCCIL assisted Supervision Consultant

Table 11.2.1(3) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
6	Water quality	Construction	At the bridge construction areas	- Avoiding chemical discharge and spills in soil and water at specific locations like bridge construction areas. Design appropriate mitigation measures	- Visit site and check drain provision/ functioning	During the construction stage a weekly site inspection is necessary for the proper assessment of the site.	Contractor	DFCCIL assisted Supervision Consultant
7	Oil spills and hazardous wastes	Construction	To avoid and minimize oils spills and spills of other hazardous wastes	- Establish standards for safe handling, storage and transport to avoid spills - Establish emergency response and containment/ clean up procedures	- Check the mitigation measures. - A fortnightly inspection is necessary until the completion of the project.	One check	Contractor	DFCCIL
8	Spoil Disposal	Construction	To ensure adequate disposal options for spoil	- Identify sufficient locations for disposal sites and design disposal sites in the contract	A monthly inspection of the disposal sites along with the review of the design plan is a better way of assessment.	Weekly	Contractor	DFCCIL
9	Construction Waste Disposal	Construction	To minimize the impacts from the disposal of construction Waste	- Preparation and implementation of waste management plan based on Estimating the amounts of construction waste	Interviews with local residents will also give a proper assessment of the issue.	Weekly	Design Consultants and Contractor	DFCCIL
10	Land slide and soil erosion	Planning /Design phase	To minimize landslides resulting from excessive erosion of slopes and water ways with corresponding silting of the eroded soil.	- Maintaining proper vegetation cover and erosion protection - Constant surveillance as part of routine maintenance	Visit site and Check land plans, alignment	Site visits, one check	Design Consultants	DFCCIL
		Construction	Constructed embankments could be a source of silt if not protected from erosion by rain fall	-Work plan: excavate and embankment mainly in dry season	A site inspection along with the review of the design plans is necessary.	During construction and specially during rainy seasons	Contractor and Supervision Consultant	DFCCIL

Table 11.2.1(4) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
11	Loss of or Damage to Religious places and eco-sensitive areas.	Planning /Design phase	To minimize damage to religious sites and eco-sensitive areas	- Avoid encroachment on religious and eco-sensitive areas in planning the alignment	Check encroachment on religious and eco-sensitive areas	- Before and during construction phase	Design Consultant, DFCCIL	DFCCIL assisted Supervision Consultant
12	Earthworks operation	Construction	To ensure that the earthworks are safe and do not have adverse environmental impacts	- Use appropriate designs and size of drainage structures in accordance with designs approved by the client, - Structural stabilization of drainage system - Hauling material to be carefully transported to designated dumping areas	- Ensure the contractor performs detailed design and instability checks - Check if erosion or instabilities were observed. - The conditions at the site can be observed by a site inspection along with review of the design plan.	Before commencement date of construction	Contractor and Supervision Consultant	DFCCIL
13	Traffic safety	Planning /Design phase	To avoid and minimize traffic accidents during construction	- Make traffic marking such as sign boards - Observe speed limits - Safe loading and covering of materials being transported - Planning of transport routes	Visit site and Check around traffic situation and construction plan	- Before commencement date of construction	Contractor	MoEF, DFCCIL. State Ministries, PMC and Supervision Consultant.
		Construction	To avoid and minimize traffic accidents during construction	- Traffic sign boards for proper movement of construction vehicles, - limit speed of vehicles - Safe loading and covering of materials being transported - Planning of transport routes	Checking the traffic problems at the construction site.	Monthly	Contractor and Supervision Consultant	DFCCIL
14	Disturbance to flora	Construction	To minimize direct impacts on vegetation Prevent damage to vegetation outside RoW	- Prohibit vegetation cutting outside Row - Record Row , Check no cutting out side	Inspect RoW boundary and adjacent area	Weekly/Monthly	Contractor and Supervision Consultant	DFCCIL

Table 11.2.1(5) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
15	Disturbance to fauna	Construction	To minimize direct impacts on fauna. This applies in the case of Gulisthanpur and at Arawali region and at Eco-sensitive areas in Maharashtra	- Consultation with Forest Department Authorities and Department of Wildlife. - No construction camps or quarries in wildlife habitat areas eg. Ecosensitive areas - Avoiding alignment of route with sensitive habitats of important species, keystone tree species, conservation areas etc. - No hunting, poaching, or unnecessary habitat destruction - Training for staff working in wildlife areas (or at least briefings)	Visit site and check the proposed alignment and construction area	Monthly	Contractor and Supervision Consultant	DFCCIL
16	Plantation	Operation	Growth of development trees	-	- The number of trees surviving during each visit shall be compared with the number of sapling plant - Record the growth of plantation	Assess growth every year for initial five years	SEMU	DFCCIL
17	Mangroves	Construction	The impact on the mangroves should be minimized. This should be observed in the State of Maharashtra	- Avoidance of mangroves in the alignment - Not to encroach into the mangrove areas. - Disposal of construction waste material should be strictly restricted - No storage should be allowed near the sensitive areas.	Visit site and check the proposed alignment and drain/waste material around mangroves	Monthly	Contractor and Supervision Consultant	DFCCIL Supervised by District Authorities (Maharashtra), SPCB, State Environment Department,

Table 11.2.1(6) Environmental Monitoring Plan - Supervision Work

No.	Environment Component	Project Stage	Issue	Mitigation Management	Supervision Method	Duration /Frequency	Organization	
18	Loss or Damage of cultural sites or religious places	Construction	To avoid or minimize damage to cultural sites or religious places.	- Avoid alignment encroachment to the cultural site - Local population will also be consulted if there are any religious place	Interviews with local residents will also give a proper assessment of the issue.	Before and during construction. Monitoring should be done once in six months.	Contractor/ Subcontractor and Supervision Consultant	DFCCIL
19	Construction labour force and its impacts	Planning /Design phase	To minimize impact on workers	- Establish minimum standards for construction workers camp layout and housing provision, provide sanitary facilities and insect control particularly as related to Malaria and other vector borne diseases	- Check construction workers camp layout and equipment	Before the start of construction work As necessary	Constructor	DFCCIL
		Construction	To minimize impact on workers during construction	- Conduct special briefing on site training on environmental requirements and safety for the workers. - Strictly instruct workers not to interfere in local affairs	- Check the Contractors are following the Mitigation measures - Check with the communities and construction staff if any conflict has occurred, if yes find out reason. - This can be achieved by regular site inspections. The frequency should be once in fifteen days.	Weekly	Constructor	DFCCIL assisted Supervision Consultant and SPCB inspecting
20	Work camp Operation	Construction	To ensure that the operation of work camps does not adversely affect the surrounding environment and residential areas	- Identify sufficient locations for disposal sites and design disposal sites in the contract - The location shall be approved by the consultant	During construction and after completion of the works. The inspection should be planned once every two months throughout the project period	Monthly	Contractor and Supervision Consultant	DFCCIL

Source: JICA survey team

Table 11.2.2 Environmental Monitoring Plan – Impact and Mitigation Monitoring

No.	Environment Component	Project Stage	Environmental Monitoring Program				Institutional Responsibility		Estimated Cost
			Parameters	Methodology	Location	Duration /Frequency	Implementation	Supervision	
1	Air pollution	Construction	PM_{10}, $PM_{2.5}$, CO, SO_2, NO_X, Lead	Analysis as specified in the National Ambient Air Quality Standard	At construction sites in sensitive and critical areas along alignment. Final decision shall be taken in consultation with SPCB.	24 hours or 8 hours (CO), at least once in every season (once in 3 months) except monsoon for minimum 3 days. The frequency of monitoring will depend on the sensitivity of locations as well as extent of construction activities.	Construction Contractor through MoEF Approved Laboratories	DFCCIL assisted Supervision Consultant and SPCB inspecting	Rs. 100,000 per site per season
2	Noise and Vibration	Construction	Noise level in dB (A) and Vibration in dB	Ambient Noise level is measured with the noise level meter according to the Noise (regulation and control) rule. Ambient Vibration level is measured with vibration level meter according to international standard.	Next to identified sensitive receptor along alignment basically near predicted points, major construction site in any inhabited areas as well as the operational areas like crusher units and batch mixing plants	Hourly records, for 24 hours for minimum 3 days, 4 times a year (preferably in each season)	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting	Rs. 50,000 per site per season
		Operation	Noise level in dB (A) and Vibration in dB	Noise level emitted from rolling stocks is measured with noise level meter according to international standards. Vibration level emitted from rolling stocks is measured with vibration level meter according to international standard.	Next to identified sensitive receptor along alignment basically near predicted points	Monthly during first operation year, Once a year	SEMU	DFCCIL	No separate cost
3	Water quality	Construction	See Note	Sampling and analysis as per Standard Methods for Examination of Water and Wastewater	Surface water: at two point of (upstream and downstream) 14 Important Rivers	Monthly during construction periods near the river	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting	Rs. 5000 per river per month
					Ground water: location shall be decided by SPCB	Monthly during construction/excavation periods			Rs. 5000 per location per month
					Drinking water and waste water: each labour camps	Weekly			Rs. 10,000 per sample per week

Table 11.2.2 Environmental Monitoring Plan – Impact and Mitigation Monitoring

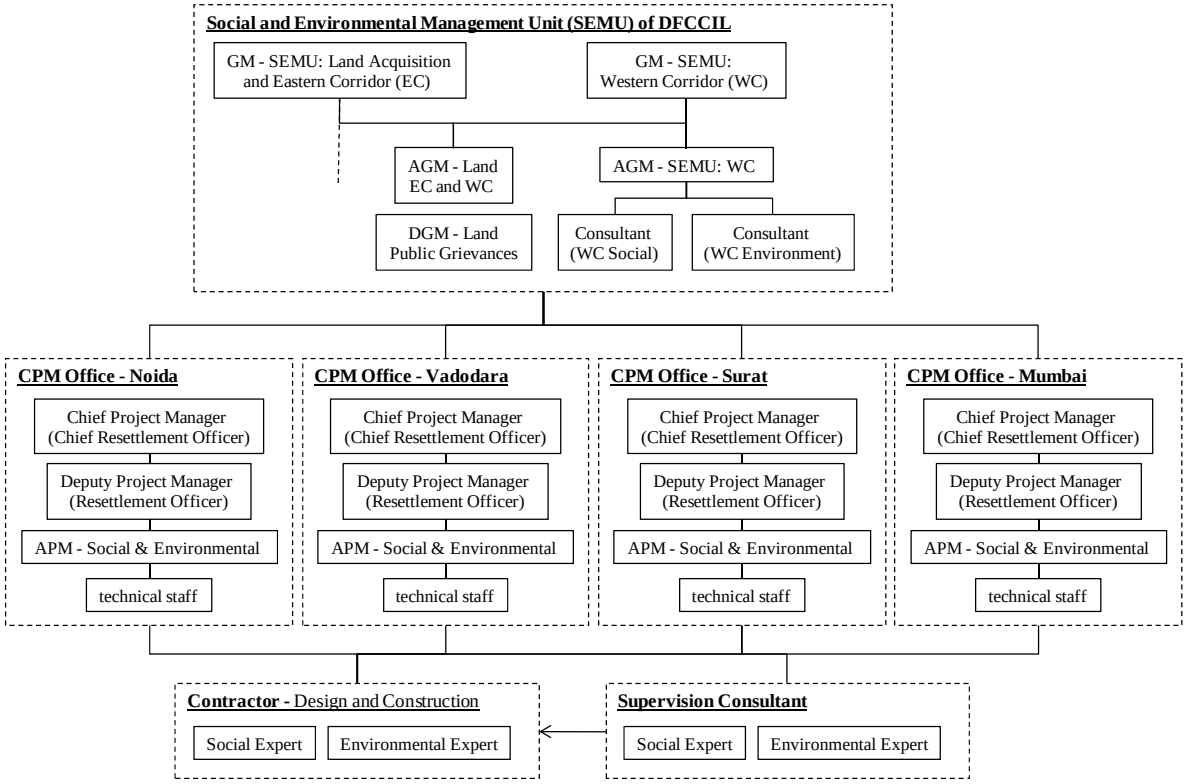
No.	Environment Component	Project Stage	Environmental Monitoring Program				Institutional Responsibility		Estimated Cost
			Parameters	Methodology	Location	Duration /Frequency	Implementation	Supervision	
4	Ground water level	Construction	ground water level	Measurement of ground water level	Dahanu Taluka and Aravalli site. The location shall be decided by SPCB	Before construction monthly During construction/excavation periods continuous	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting	Rs. 5000 per site per month
5	Land slide and soil erosion	Construction	Surface status of ground modification	Contractor report implementation of the measures for land slide and soil erosion preservation	A site inspection along with the review of the design plans if necessary.	Rainy seasons.	Construction Contractor	DFCCIL and Supervision Consultant.	No separate cost
6	Plantation	Construction	No. of railway side plantation	Progress of measures suggested as part of the strategy is to be reported.	Along the side of the track	Comparison should be done for every six months	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting	Rs. 5,000 per supervisor per month for every 50 km
7	Borrow Area	Construction	Borrow areas redevelopment	Location of borrow areas have to be finalized from identified lists and parameters indicative of environment in the area has to be reported. Undertaking site visit to determine how many borrow areas have been rehabilitated in line with the landowners request and to their full satisfaction	Identified borrow areas	4 times a year (preferably in each season)	Construction Contractor	DFCCIL assisted Supervision Consultant and SPCB inspecting	No separate cost

Note: Odor, conductivity, pH, DO, BOD, TDS, TSS, oil and grease, chlorides, sulphates, total nitrogen, total phosphate, coli forms and heavy metals
SPCB: State Pollution Control Board
Source: JICA survey team

11.3 Institutional Framework of Implementation of EMP and EMoP

11.3.1 Institutional Framework

Organizational structure for implementation of EMP and EMoP is shown in Figure 11.3.1. The responsibility for implementation and supervision of the EMP and EMoP is vested with the Social and Environmental Management Unit (SEMU) of DFCCIL, respective CPM offices, Supervision Consultant, and Contractors.



Source: Modified from the Environmental and Social Management and Monitoring Plan (ESMMP) for Phase 1 Section of the Western Corridor, NK Consortium, April 2011.

Figure 11.3.1 Organizational Structure for Implementation of EMP and EMoP

To ensure that the EMP and EMoP produce acceptable outputs, it is important that the following parties fulfill their key responsibilities allocated as follows.

1) Social and Environmental Management Unit (SEMU):

The Social and Environmental Management Unit (SEMU) is the section of DFCCIL that is responsible for managing environmental and social matters relating to the project, and ensuring compliance with the environmental and social safeguard policies of the Government and lender(s), and relevant national laws.

According to an Office Order issued by DFCCIL in January 2011, SEMU is responsible for:

- All matters relating to environment, land acquisition, rehabilitation and resettlement with respect to the DFC project;
- Internal DFCCIL policy and guidelines on environmental and social issues;
- Internal and external coordination on environmental and social matters (including coordination with zonal railways, the National Planning Commission, the Prime Minister's Office and other projects);
- Responding to Parliamentary questions, public representations, court cases and Right To Information queries on environmental and social issues;
- Any other environmental and social matters or enquiries.

During project implementation, SEMU will be responsible for the following:

(i) procuring the environmental permits/clearances that the project proponent is required to obtain;

(ii) ensuring necessary budgetary provision for implementing the Environmental Management Plan and Environmental Monitoring Plan (EMP and EMoP) and the Rehabilitation and Resettlement Plan (RRP);

(iii) coordinating and monitoring progress of CPM offices in implementing the EMP and EMoP, the land acquisition process, and the provisions of the RRP;

(iv) routinely reporting to the Director (Project Planning) and the Director (Infrastructure) on the above in relation to the eastern and western corridors respectively;

(v) planning and commissioning training for project staff and others involved in managing environmental and social aspects of the project; and

(vi) providing guidance to field offices in matters related to environment, social issues and RRP implementation.

Under the required organizational structure as shown in Figure 11.3.1, there are currently two SEMU General Managers: one responsible for the Eastern Corridor and land acquisition along both corridors; and one responsible for the Western Corridor. They are supported by one Assistant General Manager (AGM Land) and one Deputy General Manager (DGM Public Grievance). Assistant Project Manager (AGM) for SEMU WC is currently vacant. In addition, consultants for SEMU cover both Eastern and Western Corridors. Therefore, the consultants in charge of each corridor are required.

2) Chief Project Manager (CPM) Office

The CPM offices are responsible for dealing with the environmental and social issues of the project at the field level, and the main specific tasks in this regard are:

- Implementing the land acquisition and resettlement process and disbursing compensation to PAPs in conjunction with the Competent Authority as set out in the RRP;
- Managing local implementation of the EMP and EMoP for work conducted in the CPM area, including supervision of the Contractor to ensure mitigation is

provided, and site observations of environmental practice and environmental and social impacts;

- Coordinating supervision and monitoring activity with the Engineer's Senior Environmental Officer/Manager and staff of construction Contractors to avoid duplication and ensure full EMP and EMoP implementation;
- Reporting on progress of the EMP and EMoP and LA/RRP to SEMU and responding to queries, data requests, etc;
- Managing the Grievance Redress Mechanism (GRM) and participating in site reviews and meetings to consider and resolve complaints.

Presently all CPMs and Deputies are in place, together with one or more APMs. Some APMs have been designated to deal with environmental and social aspects (mainly involving land acquisition at present)

3) Supervision Consultant

The Social and Environmental Experts of the Supervision Consultant are responsible for preparing the Environmental and Social Management and Monitoring Plan (ESMMP) in the early stage of the Engineering Consultancy Service based on the EMP and EMoP in the ESIA Report, and carrying out day-to-day monitoring on Contractor's compliance with the mitigation measures; and provide a quarterly monitoring report to DFCCIL in the stage of the construction supervision.

4) Contractor

The key responsibilities of the Contractor are based on the EMP and EMoP and ensure the implementation of the environmental mitigation measures for the construction phase. Site-specific Environmental and Social Management Plan has to be prepared based on the EMP and it is reviewed and approved by the Project Management Consultant. The contractor is responsible for obtaining the necessary permits from the statutory organizations such as for quarry site, borrow area, construction yard, and the labour camp.

11.3.2 Grievance Redress Mechanism under EMP

The main complaints associated with railway projects are normally related to the process of compulsory acquisition of land and property, and include the amounts of compensation offered, the way the process is conducted, and other issues. For this project these and other related matters will be dealt with through a Grievance Redress Mechanism (GRM) for Land Acquisition and Resettlement, which was established via the RRP. This involves consideration by Grievance Redress Committees at local/field and headquarters/ central level if necessary, with further recourse to the Competent Authority and an official government Arbitrator/Ombudsman if necessary.

Grievances/complaints on environmental matters are expected to be relatively few and more straightforward, so a simplified procedure is more appropriate in this case. Local concerns mainly arise as a result of inappropriate implementation of the EMP and EMoP, the main aim of which is the reduction of negative impacts to acceptable levels. These issues are best addressed through open dialogue and a responsive approach, with frank acknowledgement of

errors where appropriate, followed by rapid remedial action. This will be the principal philosophy of the Environmental GRM.

The CPM office will be the point of contact for any such grievances, and local communities will be informed of this at consultation meetings. Any complaints will firstly be assessed to determine whether they are genuine and reasonable, and where this is the case the CPM will meet to discuss the issue with the APM-Environment and other relevant officers, and senior managers from the Contractor and Engineer when relevant. Affected sites will also be visited and inspected. The CPM will respond in writing to the complainant within 30 days of receipt, and will give the decision, with an explanation of the rationale, and proposed remedial action where appropriate.

If an acceptable solution cannot be agreed locally the matter will be referred to GM-SEMU, who will consult within DFCCIL as necessary and inform the complainant in writing, again within 30 days of receipt. He will take into account the views of the CPM and the complainant, and any precedent set by responses to similar complaints in other CPM areas in either Eastern or Western Corridors. He may also seek expert advice from others as may be necessary. DFCCIL will consider the response from the CPM or GM-SEMU as final, though the complainant can seek further redress through the courts if he wishes.

Any complaints relating to deficient design or matters of policy will be referred immediately to GM-SEMU, who will consult with relevant DFCCIL officers and senior representatives of Contractors and the Supervision Consultant as appropriate, before responding to the complainant as above.

In all cases, remedial action will be implemented by the appropriate agency (Contractor, Supervision Consultant or DFCCIL - head office or CPM), and the agency and responsible officer will be identified in the written response. A timescale for completion will also be given. The affected party will be entitled to make a further complaint if he feels the action has not addressed the problem or has not been conducted adequately.

DFCCIL will keep a record of all complaints received and action taken to resolve, and will monitor the degree of satisfaction of complainants regarding the outcome.

11.3.3 Reporting Arrangement

Effective project management and supervision requires clear monitoring and reporting structures in order to ensure that the project is being implemented in accordance with the specifications of the EMP. Monitoring and progress reporting enables managers to make timely decisions that address project bottle-necks and social and environmental issues or problems arising.

The monitoring and evaluation of management and mitigation measures envisaged are critical activities in implementation of the project. Monitoring involves periodic checking to ascertain whether activities are going according to plan. It provides necessary feedback for the project management to keep the program on schedule and delivering against the requisite standards and targets. The reporting system is intended to demonstrate accountability and as a means of ensuring that mitigation measures are implemented as per the EMP. The main actors in the monitoring and reporting process are:

DFCCIL: The Client holds overall responsibility for the implementation of the environmental mitigation measures and execution of the project and the sole responsibility would lie with the Supervision Consultant recruited by the Client in implementing the EMP and other project activities. The Supervision Consultant will interact with the client on a regular basis and inform the client about progress and issues arising.

Supervision Consultant: The Supervision Consultant should be involved in implementation of the mitigation measures and in developing the required training material for the client. The various tasks to be performed during the project cycle are:

- Monitoring of the progress of the project on the implementation of the environmental provisions as per planned schedule.
- Supervising and implementing the mitigation measures.
- Assist the engineers at the site by providing appropriate mitigation measures.
- Documenting the experience in implementation of the environmental process.

The overall responsibility will be on the Environmental Section of the Supervision Consultant. The environmental expert in the Environmental Section will have the following responsibilities:

- Review the ESIA and RRP documents for the project.
- Liaise with the central and state Environmental Departments and with the Pollution Control Boards.
- Continuous interaction with local communities in implementing the EMP.
- Preparation of the environmental compliance reports for the ministry and for the funding agency (JICA) at regular intervals.

Contractor: The supervision consultants should have a role in advising the contractor on key environmental and social issues and mitigation measures and how they should be implemented. The contractor should adopt environmentally sound practices. The contractors should have sufficient environmental awareness necessary for the successful completion of the work entrusted. The activities envisaged are:

- Develop and detail an implementation plan for the environmental management, mitigation and monitoring specified in the EMP and EMoP
- Continuations interaction with the environmental specialist of the Supervision Consultant and Project management Consultants.
- For all activities there should be a formal approval from the Supervision Consultant.
- Liaise with the Government Agencies like the State Pollution Control Board and other Government Departments.
- Carrying out environmental monitoring.

11.4 Cost for Implementation of EMP and EMoP

Table 11.4.1 shows approximate costs for implementation of the EMP and EMoP. Detailed cost should be estimated in preparation of the Environmental and Social Management and Monitoring Plan (ESMMP) in the Engineering Consultancy Service stage.

Table 11.4.1 Indicative Costs for Implementation of the EMP and EMoP

Items	Quantity	Unit	Unit Cost (Rs.)	Total Cost (Rs.)
Environmental Mitigation/Management Measures				
(1) Compensation for tree cutting	Approx. 50,000 (tree cutting) and 100,000 (tree plantation)	No. of trees	Rs. 300 per tree cutting[1] and Rs 200 per tree plantation[2]	Rs. 15,000,000 for tree cutting, Rs. 20,000,000 for compensatory plantation
(2) Noise barrier construction, if necessary.	Estimated at the detail design stage with identification of location where the noise barrier is required.			
(3) Maintain borrow pit site by landscaping and re-vegetating after operation	11	site	250,000	Rs. 2,750,000
(4) Maintain quarry site by landscaping and re-vegetating after operation	76	site	500,000	Rs. 38,000,000
(5) Sprinkling water on the road, especially in/near the settlement areas	36	month	100,000	Rs. 3,600,000
(6) Re-vegetate where riverside vegetation is cleared by bridge construction	15	bridge	Rs, 250,000	Rs. 3,750,000
(7) Make workers aware on STD and HIV/AIDS	lump sum	-	1,000,000	Rs. 1,000,000
(8) Post construction clean-up to ensure no dangerous debris are left behind the camp site.	lump sum	-	-	Rs. 5,000,000
			Sub-total	Rs. 89,100,000
Environmental Monitoring				
(1) Air pollution	6 (1 site for every 100 km)	site[3]	Rs. 900,000 (Rs. 100,000/site/season X 3 seasons X 3 years)	Rs. 54,00,000
(2) Noise and vibration	6 (1 site for every 100 km)	site	Rs. 600,000 (Rs. 50,000/site/season X 4 seasons X 3 years)	Rs. 36,00,000
(3) Water quality (surface water)	14	important river	Rs. 60,000 (Rs. 5,000/river/season X 4 seasons X 3 years)	Rs. 8,40,000
(4) Water quality (ground water)	42 (3 locations in each District)	Site and 14 Districts	Rs. 30,000 (Rs. 5,000/location/6 month X 36 months)	Rs. 12,60,000

[1] Tree cutting will involve expenses on measurement, labour for cutting, dressing/fashioning, stacking and transport.
[2] Green Belt Development will involve soil conservation works, fencing, protection, maintenance for 5 years. The total cost is Rs. 300,000 per Ha and considering 1500 trees per Ha. For Compensatory plantation, 2 trees have to be planted for each tree cut for all areas except in Dahanu, Thane District where 10 trees have to be planted for each tree cut.
[3] Site refers to construction site

Items	Quantity	Unit	Unit Cost (Rs.)	Total Cost (Rs.)
(5) Water quality (drinking and waste water)	12 (1 labour camp for site at every 100 km)	sample (2 samples /labor camps)	Rs. 180,000 (Rs. 5,000/sample/month X 36 months)	Rs. 21,60,000
(6) Ground water level	6 (1 site for every 100 km)	site	Rs. 60,000 (Rs. 10,000/site/6 months X 36 months)	Rs. 360,000
(7) Plantation	12 (1 supervisor for every 50 km)	Km	Rs. 180,000 (Rs. 5,000 per supervisor per month for 36 months)	Rs. 21,60,000
			Sub-total	Rs. 15,780,000
			Total	Rs. 104,880,000

CHAPTER 12
CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 12 CONCLUSIONS AND RECOMMENDATIONS

The proposed DFC Phase 2 project alignment will pass through well-developed industrialized areas like the Gujarat, Haryana, Maharashtra, Uttar Pradesh, and moderately industrial areas in Rajasthan and it will flourish industrial and markets activities. The DFC Phase 2 project will also provide connectivity to Jawaharlal Nehru Port Trust and make movement of goods easier and timely to western and central part. The corridor will enhance the job potential for the local residents through market development and enhance employment facilities after the execution of the project. Traffic congestion due to the movement of freight trucks will be reduced drastically by operating the DFC Phase 2 project.

The ESIA study reveals that PAPs were mainly concerned with the compensation and the job opportunity related to the impacts caused by the project. Some of the PAPs may lose their agricultural land, residential areas and job. These issues are major concerns of the local residents. These aspects have been discussed in the ESIA study. The ESIA study will be supplemented with the Baseline Survey and Census Report and RRP on social aspects related to the land acquisition for the project. Major findings of the ESIA study have been provided in Table 12.1.1.

Table 12.1.1 Major Findings from the ESIA

Item	Issue	Findings	Responsible organization	Remarks
Alignment Route				
Rewari-Dadri • Detour	Alignment route	It moves near settlements areas in Bukharpur, Faridabad, and Lakhuwas, Gurgaon	• Survey agency • DFCCIL	Fencing to be installed to avoid accident.
JNPT-Vadodara • Parallel with existing track • Detour	Alignment route	In Gujarat, it will disturb the productive cultivable land in detour section. In parallel section, ROW was noted 20-30 m in semi-urban areas, which will have high impact of vibrations and noise	• Survey agency • DFCCIL	ROW to be decided with approach of long term planning, not with the immediate settlement issues.
Pollution Control				
Air Pollution	Minor impact during construction phase	The construction work would emit some amounts of air pollutants, so it requires a regular monitoring and sprinkling at the dust prone areas would arrest the dust.	Contractor under the supervision consultant.	Mitigation measures to be implemented as and when it is required
Water Pollution	Minor impact during construction phase.	• The construction yards and the labour camps are the worst offender, unless some proactive measures are taken • The best way of handling is to provide soakage pits and settling tanks. The waste water to be regularly monitored. The ground water sources along the construction yard should be tested for the bacterial load.	Contractor under the supervision consultant.	A regular water quality monitoring shall be conducted.

Item	Issue	Findings	Responsible organization	Remarks
Noise and Vibration	Major impact near residential areas and sensitive receptors	• Construction activities emit a large extent of noise and vibration levels. • The contractor should give an awareness campaign for the locals about the likely impacts. • Suitable mitigation measures to be implemented at the time of operation.	Contractor under the supervision consultant.	• Mitigation measures to be implemented at the time vibrating roller usage, compaction, and blasting activity. • Necessary precaution measures to be implemented at the site.
Ground Water Table	• No impact • Precaution to be taken near tunnel and bridge construction sites.	The nearby wells around the quarry and borrow pits should be regularly monitored as there will be fluctuation of the water table.	Contractor under the supervision consultant.	-
Soil	• No impact • Precaution should be taken for waste disposal and soil erosion.	• Erosion due to vegetation clearance • Waste dumping	• DFCCIL • Contractor under the supervision consultant.	-
Natural Environment				
Tree Cutting	All trees falling under the ROW will be cut.	• The extent of tree cutting can be curtailed by afforestation. • Native plant species should be selected for afforestation.	• Department of Forest • Department of Horticulture	• The tree cutting should be minimised to the maximum extent as possible. • Compensatory afforestation of native tree species.
Tree Cutting	Forest area encroachment	• Encroachment to be restricted. • The eco-sensitive areas like mangroves to be preserved and rehabilitated.	• Department of Forest • Department of Wildlife	• It better to avoid the forest and eco-sensitive areas to the maximum extent as possible.
Flora and Fauna	No major impact	The proposed corridor is not affecting any dense forest area or habitat of endangered species.	-	-
Social Environment				
Land acquisition	Compensation cost evaluation	During land acquisition, some portion of agricultural land will be bifurcated and may not be of any use for the PAP.	• Ministry of Railway • DFCCIL	• Compensation to be provided for damaged land as well, if in case it is not being acquired.
PAPs	The proposed intervention will not give direct profit to PAPs.	Different categories of PAPs have their own issue of concern.	• District administration • Ministry of Railway	• Problem is more severe in semi urban areas for loss of residential house. • Small land holding PAPs with no other source of income need support on livelihood recovery.

Item	Issue	Findings	Responsible organization	Remarks
Vulnerable people	About 14% vulnerable persons will be affected; this includes elderly people more than 11%.	Elderly people, unmarried girls, and widow may have serious issue.	District administration	Awareness of wisely utilization of the compensation should be given to the vulnerable persons.
Loss of agricultural land and properties	Major impact	• The land and property acquisition should be minimum. • Give proper value for the lost property.	District administration	The land and property acquisition should be minimum.
Impacts to religious places	Religious structures are coming in RoW, and those coming near alignment will have impact due to vibration and noise.	The religious places should be avoided or relocated after considering the public opinion.	The local communities should be taken into consideration while handling this religious matter.	It is being a sensitive issue and it requires a careful handling.
Rehabilitation and Resettlement	Livelihood recovery for PAPs	RRP is required.	DFCCIL	Baseline Survey and Census will generate base for Rehabilitation and Resettlement Plan.
Sensitive Receptor	Major impacts to the public facilities such as school, hospital and religious places	To develop avoidance mechanism near Sensitive receptor.	DFCCIL	-

12.1 POLUTTION CONROL

ESIA study showed that air quality will not be disturbed along the corridor in operation of the DFC Phase 2 project as the freight train will be electrified. The air quality may be disturbed even though it is a temporary impact during the construction period due to the excavation and movement of dumpers. Implementation of regular monitoring efforts by the respective State Pollution Control Boards would help in plug in the air pollutants to some extent which is caused by the industrialization.

The water quality will not receive any adverse impacts due to the proposed project. In construction phase, preventive actions are required to avoid short term impacts. The constructions on the bridges have already been started at several locations in JNPT-Vadodara section of the proposed project. There will be a considerable increase in the silt, oil and grease content in the river waters. The impacts are due to the cofferdams and for bridge construction. The impacts caused during the construction stage are short lived and by implementing suitable mitigation measures would reduce the impacts to a great extent.

The water quality monitoring results showed that the river waters are already polluted due to the industrialization and disposal of sewage. The untreated wastewater and the sewerage join the rivers and further pollute the river water quality. Therefore, it is recommended that only treated wastewater should be disposed into the river.

The problem of noise and vibration will be occurred in construction as well as in operation stages. Therefore, preventive measures should be taken so that impact can be reduced in residential areas, sensitive receptors, and eco-sensitive areas. The necessary engineering design should be worked out and implemented during the construction of the project. ESIA study revealed that some sensitive receptors and residential areas are falling near corridor and will have impact due to noise and vibration. Therefore, preventive measures should be taken in such areas.

The solid waste should be disposed at the designated locations so that leaching and runoff can be prevented and it should not pass through the natural drainage system. The quarry and borrow areas should be reclaimed after use and the excavated areas should be back filled regularly. Hazardous waste generated should be suitably disposed off as per the regulations.

12.2 NATURAL ENVIRONMENT

The entire corridor passes through semi arid part of Gangatic plain and Aravalli area touches parts of Mewat, Rewari and Alwar. Gulistanpur Reserved Forest in Gautama Buddha Nagar is coming in the alignment. In the JNPT-Vadodara section, the proposed freight corridor runs parallel to the existing line near to the Sanjay Gandhi National Park and forest villages of Dahanu, Palghar and Vasai. The freight corridor traverses about 600 m away from the Tungareshwar Wildlife Sanctuary. Mangrove vegetation is in abundance at the JNPT and Panvel section. Sanjay Gandhi National Park and Tungareshwar Wildlife Sanctuary will not have impact due to this proposed project. During the study it was also noticed that the alignment is in left of the existing track towards highway in the outer part of the SGNP, therefore, wild animal and migratory paths will not be blocked while executing the project. The implementation of timely mitigation measures would curtail the adverse impacts to other forest areas as well. There will be tree cutting along the alignment in the RoW, which can be compensated by green belt development. The vegetative barrier would absorb both the noise and vibrations caused by the movement of the freight trains along the corridor.

There should be strict implementation of the environmental management plan while executing the project. The tree cutting should be fulfilled by plantation and the scrub areas of the forest villages should also be developed with plantation. Proper care should be taken at the mangrove areas.

12.3 SOCIAL ENVIRONMENT

There was resentment of PAPs in the public consultation meetings for ESIA Study as well as Baseline Survey and Census for RRP. This was mainly due to lack of relevant compensation in the past government projects. The agricultural area will mainly be affected due to the proposed DFC alignment. Residential areas in rural as well as in semi urban and urban areas (mainly in JNPT-Vadodara) is also being affected. There will be loss of the agricultural land along the proposed corridor. The corridor has provision of ROBs and RUBs so that the local conveyance is less interrupted. Villagers are also very cautious for the safety, as the trains will pass by high speed and it may increase the accidents. Fencing of the railway lines so that children and cattle cannot pass the corridor will be effective to avoid the accidents. The farmers are losing some of their basic facilities like the bore wells which comes directly under the ROW, these needs to be managed so that drinking water and irrigation problem does not arise. The construction of the project

would generate temporary employment to the local population. Many school are coming in the ROW, therefore, proper arrangement of study for the affected students should be done.

The implementation of the suggestions given by the local peoples during the public consultation meetings and the recommendation given in the ESIA report should be followed up while executing the project with a regular monitoring of the of the progress by the Supervision Consultant, and DFCCIL.