DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

DRAFT ENVIRONMENTAL ASSESSMENT

FOR

KHURJA- LUDHIANA SECTION

OF

PROPOSED EASTERN DEDICATED FREIGHT CORRIDOR

March 2012

Prepared By

Engineering and Technological Services, Delhi

TABLE OF CONTENTS

List of Tables

List of Figures

List of Annexure

Part II: Strip Maps (Separate Volume)

Abbreviations

ACF	Assistant Conservator of Forest
ADB	Asian Development Bank
AIA	Advanced Informed Agreement
AIDS	Acquired Immune Deficiency Syndrome
CBR	California Bearing Ratio
Ch	Chainage
CITES	International Trade in Endangered Species of Wild Fauna and Flora
CPCB	Central Pollution Control Board
CPM	Chief Project manager
Cum	Cubic Meter
CWR	Continuous Welded Rail
DFC	Dedicated Freight Corridor
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
EIA	Environmental Impact Assessment
EMoP	Environment Monitoring Plan
EMP	Environment Management Plan
ESMC	Regional Environment and Social Management Cell
FFP	Food, Feed and Product
GDP	Gross Domestic Product
GIS	Geographic Information System
GOI	Government of India
GHG	Green House Gases
Ha	Hectare
HDPE	High Density Poly Ethylene
HFL	Highest Flood Level
HIV	Human Immunodeficiency Virus
HTL	High Tension Line
ICAR	Indian Council of Agricultural Research
IR	Indian Railways
IRC	Indian Road Congress
IS	Indian Standard
IUCN	International Union for Conservation of Nature
Jn.	Junction (The term used by Indian Railways for the Stations where two or more lines meet)
JICA	Japan International Cooperation Agency
kV	Kilo Volt
LC	Level Crossing
LMO	Living Modified Organism
LRTAP	Long Range Trans-boundary Air Pollution on the Reduction of Sulphur Emissions
LTL	Low Tension Line
MIS	Management Information System
MMD	Maximum Moving Dimension
MoEF	Ministry of Environment and Forests
MoR	Ministry of Railways
MVA	Million Volt Amperes
NAAQS	National Ambient Air Quality Standard
NBFGR	National Bureau of Fish Genetic Resources
NGO	Non-governmental Organization
NH	National Highway
NOx	Oxides of Nitrogen
NRSC	National Remote Sensing Centre
PETS	Preliminary Engineering and Transportation Study
PF	Protected Forest

PHC	Public Health Centre
$PM_{2.5}$	Particulate Matter less than 2.5 micron
POP	Persistent Organic Pollutants
PPEs	Personal Protective Equipments
PPTA	Project Preparation Technical Assistance
PUC	Pollution Under Control Certificate
OFC	Optical Fibre Cables
OHE	Over Head Equipment
RITES	Rail India Technical and Economic Services
R&R	Resettlement and Rehabilitation
RF	Reserved Forest
RHS	Right Hand Side
RoB	Road over Bridge
RoW	Right of Way
Rs.	Indian Rupees
RSPM	Respirable Suspended Particulate Matter
RuB	Road under Bridge
SEMU	Social and Environmental Management Unit
SO_2	Oxides of Sulphur
SOI	Survey of India
SPCB	State Pollution Control Board
SPM	Suspended particulate Matter
SPS	Safeguard Policy Statement
SPV	Special Purpose Vehicle
T & C	Transport and Communication
TMS	Train Management System
TOMA	Tropospheric Ozone Management Area
TVU	Traffic Vehicle Units
UNCED	United Nation's Conference on Environment and Development
UP	Uttar Pradesh
VOC	Volatile Organic Compound
WSSD	World Summit on Sustainable Development

EXECUTIVE SUMMARY

I.Introduction

Ministry of Railways initiated action to establish a Special Purpose Vehicle for construction, operation and maintenance of the dedicated freight corridors. This led to the establishment of "Dedicated Freight Corridor Corporation of India Limited (DFCCIL)", to undertake planning & development, mobilization of financial resources and construction, maintenance and operation of the dedicated freight corridors. DFCCIL was incorporated as a company under the Companies Act 1956 on 30th October 2006. Mumbai-Delhi and Mumbai-Howrah route have a current capacity utilization of more than 140%. This has led to the saturation of the Railways system in terms of line capacity utilizations on these corridors, which are specifically called the Western and Eastern corridor respectively. Dankuni -Sonnagar-Ludhiana section has been identified as part of the eastern corridor while from JNPT to Dadri via Vadodara – Ahmedabad - Palanpur-Phulera - Rewari is called western corridor. These corridors encompass a double line electrified traction corridors. The total length of EDFC works out to 1843 Kms. The present EIA study pertains to development of **Khurja to Ludhiana section** of the Eastern Dedicated Freight Corridor covering about **404.36 km** in length, out of which 361.57 km in parallel & 42.79 km in detour section.

II. Environmental Regulatory Requirement and Project Category

Current regulations of Government of India do not include railway project for Environmental Clearance from the Ministry of Environment and Forests (MoEF) requiring Environmental Impact Assessment (EIA) studies. However, considering the magnitude of activities envisaged as part of EDFC, the DFCCIL needs to conduct an Environmental Assessment (EA) and prepare an Environmental Management Plan (EMP) to mitigate potential negative impacts for the project. Environmental Management Framework (EMF) developed during earlier EA of 272 km Bhaupur-Khurja remains valid for this current Khurja-Ludhiana section also.

III. Scope of Environmental Assessment

The scope of current assignment includes Environmental Assessment of Khurja-Ludhiana section based on Environmental management framework prepared for Bhaupur-Khurja section of EDFC.

IV. Key Environmental Laws and Regulations

Following **Table-1** presents key environmental laws and regulations promulgated by the Government of India and relevant to the Khurja-Ludhiana Section of EDFC.

Table 1: Environmental Regulations and Legislations

Sl. No.	Act / Rules	Purpose	Applicability to the project	Authority
1	Environment Protection Act-1986	To protect and improve overall environment	The project activities should maintain emission standards	MoEF. GoI; DoE, State Gov. CPCB; SPCB
2	Environmental Impact Assessment Notification- 14th Sep-2006 and its amendment	To provide environmental clearance to new development activities following environmental impact assessment	Railway project not included in the Notification Hence not applicable in this project	MoEF
3	Notification for use of fly ash	Reuse large quantity of fly ash discharged from thermal power plant to minimize land use for disposal	Possibility of use of fly ash shall be explored in engg. designs	MoEF
4	National Green Tribunal Act, 2010 National Green Tribunal (Practices and Procedure) Rules 2011	Address Grievances regarding cases related to environment protection & compensation against other natural resources	Applicable	MoEF

Sl. No.	Act / Rules	Purpose	Applicability to the project	Authority
5	Forests (Conservation) Act. 1980; The Forest (Conservation) Rules 1981	To check deforestation by restricting conversion of forested areas into non-forested areas	Applicable.	Forest Department, Govt. UP (for land conversion below 5 hectare & 40 % density).
6	Wild Life Protection Act 1972, amendment	To protect wildlife through certain of National Parks and Sanctuaries	No wild life Sanctuary or National park in the project area Not Applicable	-
7	Air (Prevention and Control of Pollution) Act, 1981	To control air pollution	Applicable Emissions from construction machinery and vehicle should be checked time to time.	UPPCB
8	Water Prevention and Control of Pollution) Act,1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards	Applicable Various parameters in Effluents from construction sites and workshops are to be kept below the prescribed standards	UPPCB
9	Noise Pollution (Regulation and Control Act) 2000	The standards for noise for day and night have been promulgated by the MoEF for various land uses.	Applicable DG sets at construction sites and workshops should be provided with acoustics enclosures.	UPPCB
10	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010	Conservation of cultural and historical remains found in India	Not Applicable, no Archaeologically protected monument within 500 m of DFFCIL RoW. However, it's applicable in case of 'chance find'.	Archaeological Dept GoI, Indian Heritage
11	Public Liability and Insurance Act, 1991	Protection form Hazardous materials and accidents.	Applicable	UPPCB
12	Explosive Act, 1884	Safe transportation, storage and use of explosive material	Applicable Respective Authorization shall be obtained from CCE	Chief Controller of Explosives
13	Central Motor Vehicle Act, 1988 and Central Motor Vehicle Rules,1989	To check vehicular air and noise pollution.	Applicable All vehicles in Use shall obtain Pollution Control Check certificates	Motor Vehicle Department
14	The Mining Act	The mining act has been notified for safe and sound mining activity.	Applicable Quarry Licenses shall be obtained by Contractors.	Department of mining, GoUP
15	Railway (Amendment) Act, 2008	Land acquisition for special railway project	Applicable	GoI
16	Hazardous Wastes (Management, Handling and Transboundary) Rules,2008	Management of hazardous wastes like used & waste oil etc.	Applicable during construction	SPCB
17	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident during handling hazardous chemical	Applicable	SPCB
18	The Petroleum Rules, 2002	Storage of petroleum products for operation of construction machineries	Applicable	Chief Controller of Explosive/ District Magistrate

The project funding is planned through World Bank. This will require project to comply with World Bank Operational Policies. The description of these policies and relevance to the project has been presented below:

The World Bank Operational Policies

The operational policies of the Bank, both triggered and not triggered with details and the applicability to the Project are provided in the following **Table.-2.** The World

Bank Environment Assessment (EA) requirements are based on a three-part classification system such as Category A, Category B and Category C as defined by the World Bank OP 4.01. A Project designated as Category A, requires a full Environmental Assessment (EA) whereas Category B projects require a lesser level of environmental investigation. Category C projects require no environmental analysis beyond that determination.

Table-2: World Bank Safeguard Policies

Sl. No.	Safeguard Policy	Subject Category	Triggered	Triggered By	Mitigation Measures	Documentation
1.	OP 4.01	Environment Assessment	Yes	Sensitive areas and impacts on environmental and social components	Mitigation measures incorporated	EIA and EMP prepared
2.	OP 4.04	Natural Habitats	Yes	Reserve forests issues	Incorporated	EIA and EMP
3.	OP 4.11	Physical Cultural Resources	Yes	Risk to cultural properties	Adequate mitigation measures if affected	EMP & RAP prepared
4.	OP 4.36	Forestry	Yes	Diversion of forest land	To be carried out as per Forest (conservation) Act, 1980	Not Applicable

Since this is a large scale project and likely to have some reversible impacts on environment during construction phases & some impact, not of much significance, during operation, this project is being considered as **'A' category** project as per the World Bank safeguard policy. This will help not only in tweaking the construction stage to be more eco-compliant but setting systems to have better and more environment friendly construction in forthcoming railway projects. DFCCIL is committed to establish most efficient and eco-friendly system.

V. Project Description

The project section from Khurja to Ludhiana covers three states starting from Khurja Jn. in Uttar Pradesh passing through Haryana and finally terminating at Sanehwal near Ludhiana city in Punjab covering districts of Bulandshahar, Ghaziabad, Meerut, Muzaffarnagar, Saharanpur, Yamunanagar, Ambala, Fatehgarh Sahib, Patiala and Ludhiana.

The DFC rail lines are generally co-planned adjacent to existing rail line except at detours (Hapur, Meerut, and Khurja flyover, Tapri, Ambala, Shambhu, and Sirhind) and grade separations (Khurja Fly over, Hapur, Meerut, Tapri, Ambala, Shambhu, and Sirhind). Under this project, an electrified single line of **404.36 km** between Khurja and Ludhiana is proposed to be constructed. The alignment from Ludhiana to Khurja will be single line with no surface crossing.

The key project components and activities:

The key project components and activities involve laying of formation alignment, construction of crossing station, Junctions stations, new bridges , Rail Flyovers (RFOs), RUBs, ROBs, level crossings, staff quarters (at each crossing or junction stations), temporary workshops, offices maintenance yards /depots, flyover/grade separator, signalling, telecommunication, and safety infrastructure. The DFC length in parallel and detours portions are given in Table-**3** below:

Table-3: Lengths in Parallel and Detour Sections Khurja- Ludhiana Section of EDFC

S. No.	Section	Length in Parallel Section (km)	Length in Detour Section (km)	Total Length (km)
1	Khurja- Talhedi	167.60	30.00	197.60
2	Talhedi- Sahnewal (Ludhiana)	193.97	12.79	206.76
Total	**Khurja-Ludhiana** (incl. Khurja-Dadri)	**361.57**	**42.79**	**404.36**

VI. Description of Environment

The existing environmental conditions are studied based on primary and secondary data collection and analysis. For effective analysis, the entire alignment was divided into four stretches of 100 km each and in core zone (within 100 m) and buffer zone (7 km radius).

The primary data were collected through sampling, testing and analysis for physical environment namely- air quality, water, soil, noise & vibration, biological and socio-economic aspects at various locations to assess the baseline status both in the core and buffer zone. The baseline status is summarised below in **Table-3**:

Table-3: Summary of Environmental Features

S. No.	Components	Environmental Features	Remarks
1.	Ecological	No ecologically sensitive areas in both core and buffer zone of the study area	Presence of Kalanaur Protected Forest and Gangol Reserved forest near Yamunanagar and Meerut respectively. The Protected Forest land diversion is 4.0 Ha and Reserved Forest land diversion is 3.4 Ha.
	Tree cover	Poplar, Eucalyptus, Mango, Neem and Shisam are the most dominant species observed. Approximately 5707 trees need to cut.	-
	Birds Nesting	Birds commonly found in Gangetic plains such as Cattle Egret, House Crow, common Myna, Weaverbird commonly sighted.	No endangered specie involved
2.	Archaeological Monuments	None falls within 300 m of proposed track, but 'chance find' can not be rules out.	-
3.	Water Bodies	The surface water quality largely conforms to the CPCB prescribed standards while the groundwater quality conform to the drinking water standards (BIS:10500). The alignment passes through	Crossing Rivers – Yamuna, Markanda, Tangri and Ghaghhar Crossing Canals – Upper Ganga, Western Yamuna

S. No.	Components	Environmental Features	Remarks
		Over exploited blocks of Jagadhari, Mustafabad, Rajpura, Sirhind and Khanna. Critical blocks of Barara and Doraha. Semi-critical blocks of Khatauli, Deoband and Gulaothi	Canal
4	Land-use	Primarily agricultural (62%) followed by settlement area (17.3%), water bodies (0.7%), open land (18%), vegetation (1.8%), barren land (0.2%).	-
5	Socio-Economic	Agriculture Dominated Area. Presence of large no of industries, Poverty – highest in U.P. followed by Haryana and least in Punjab	-

VII. Alternative Analysis

Since development is proposed along the existing railway track, the alternative analysis was carried out for 'with' and 'without' project options and detour areas. 'With-project' option is deemed as the optimal solution, as far as its feasibility and sustainability during its project life and beyond can be ascertained. It will generate overall positive social, environmental, and economic impacts. In the 'without project' scenario, additional pressure will increase on our already stressed roads, which will further deteriorate the air quality and noise levels due to idling of vehicles. Further, the project area will be deprived of benefits such as the timely and faster movement of, coal, steel, fertilizers and agricultural products to market places resulting in substantial employment, and business opportunities of the area.

Alternatives alignment for detours at Hapur, Meerut, Ambala, Tapri, Shambhu and Sirhind was carried out with respect to land use change, rehabilitation and resettlement, ecological aspects, environmental impacts, traffic management, public acceptability, and technical feasibility. The alignments proposed by DFCCIL were found best suited and acceptable from environmental perspective.

VIII. Social Impact

- Social impact affecting number of PAFs/ PAPs is 3079 & 16404 respectively. Affected structures will be 620 in the entire length of project corridor. Details are indicated in the relevant sections of the report. Total 648.38 Ha land will be acquired, out of which 484.39 Ha is private land, and balance 128.38 Ha is Govt. land. Detailed resettlement action plan report has been prepared in separate cover.

IX. Public Consultation and Information Disclosure

The proponents consulted are of the view that the proposed project activities are not likely to cause any significant environmental impacts. However, they are appreciative of the possible impacts during the construction and operation phases of the proposed project and have shown their willingness to implement suggested mitigation measures in the EIA.

The project received over-whelming support and consent from all local people including those who will be rehabilitated, provided adequate compensation is paid. During the consultations public demanded that there should be minimum inconvenience to locals due to construction related activities. Environmental awareness and likewise concern were found low and issues such as drainage, solid waste, tree loss, air quality etc did not raise any significant concern amongst many people. The only point of concern of the villagers, residents in the encroached area was pertaining to compensation against loss of land and the mode of payment.

People are looking forward for quick compensation and start of work. The Government Regulators like Forest Department, Pollution Boards, Municipal Authorities and Local NGOs also supported and favored the project. All the concerns of public consultations have been addressed in Resettlement Action Plan and Environmental management Plan.

X. Anticipated Environmental Impacts and Mitigation Measures

The project is unlikely to cause significant environmental impacts. The environmental impacts are largely temporary in nature and can be mitigated with minimal residual impacts. The project involves **648.38 Ha. land acquisition**, diversion of total **7.4 Ha. Forest land** i.e., reserved and protected forests' land (3.4 Ha Reserved Forest, 4.0 Protected Forest), shifting of physical cultural structures and borrowing of earth. Most major impacts are associated with these activities. Total number of trees to be felled is estimated at **5707.**

The significant impact during construction is mainly associated with minor increase in dust borne air pollution, increased noise level, nuisance due to movement and operation of vehicles, establishment of temporary facilities and hindrance in accessibility to common property resources. The mitigative measures have been suggested to eliminate or minimise the impacts. Some of the measures suggested include:

The compensatory afforestation shall be undertaken as per the forest clearance conditions or a minimum 1:2 ratio, i.e. for every tree to be cut two new trees will be planted).

Key measures suggested to control increased noise level during construction include provision of temporary noise barriers and measures such as regulating construction timings near sensitive locations. Sitting and management of temporary construction facilities i.e. construction camp, workers camp, hot mix plant, batching plant, dumping sites, shall be done in an environmentally acceptable manner as mentioned in EIA

Operation stage mitigation includes multilayered plantation and reduction of wait time at crossings. A proper traffic management plan shall be in place well before the start of construction. Access to community structures/resources shall not get affected during any stage of the project.

Soil erosion along embankment slope, bridge approaches, river/canal banks shall be checked regularly as per details in EMP. Dismantled material shall be reused to the extent possible. Leftover debris shall be disposed off in an environmentally acceptable method and at designated sites as per the guidelines suggested in the EIA.

Borrow area shall be rehabilitated as per EMP recommended mitigation measures.

There are no other environmentally sensitive resources found in the project area that are likely to be affected due to the project.

XI. Environmental Management Plan and Institutional Arrangement

The Environmental Management Plan (consisting of summary of environmental Impact, mitigation measures, locations, period, costs and implementation and supervisory responsibility) is included in the EIA report. The Environmental Management Plan also provides a detailed monitoring plan. Air, surface water quality, ground water quality, noise and vibrations, soil erosion, drainage pattern, water logging, tree survival rate monitoring and reporting along with the follow up actions in case of deviation from the norms has been detailed out. The frequency has been set in consideration to the likely impacts

Project implementation will be through Project Management Units (PMU) headed by Chief Project Managers at Meerut and Ambala. DFCCIL has also created a Social and Environmental Management Unit (SEMU) headed by General Manager level officials. SEMU will ensure that the environmental mitigation measures implementation is effective. The SEMU shall, among others ensure that the EIA Reports comply with national and World Bank guidelines, monitor the status of implementation, and preparation of monitoring reports. The concern/grievances reddressal mechanism is also defined as part of EMP.

The mitigation cost, inclusive of monitoring cost and training during the project life cycle (construction and operation phase) amounts is estimated to be INR 53.0 millions or US $ 1.06 Million. The costs of establishment and training are estimated as Rs 7.5 million.

Chapter 1. Introduction

1.1. Project Background

Indian Railway (IR) is one of the largest railway systems in the world. It serves a landmass of over 3.3 million sq.m. and a population of over one billion. The last 50 years have seen a tremendous growth in the Indian transportation sector. In the past few years, the volume of rails freight has increased by over five times and the number of passenger kilometers has increased over seven times. The tonnage handled by Indian ports has increased 16 times while the air freight has increased 30 times. Railway freight, which was 73 MT in 1950-51, had increased to 474 MT in 2000-01, at an average annual increase of 10.98 percent. However, post 2001, the freight traffic has grown at an annual average of 8.50 percent. Annual freight carried by IR was about 794 MMT in 2007-08, 833 MMT in 2008-09 and 888 MMT in 2009-10. This rapid increase in freight traffic is attributed to India's economic growth, which resulted in traffic congestion on the existing railway track.

1.2. Current Project

The Government of India has decided to take the financial assistance from the World Bank for the implementation of EDFC. In order to comply with the World Bank safeguard policy and to streamline environmental consideration in project design, the environmental assessment (EA) for the Khurja- Ludhiana portion of EDFC has been undertaken.

The environmental assessment of Khurja- Ludhiana section was initially undertaken by EQMS India Private Ltd., as per safeguard policy of Asian Development Bank in November 2010. The work of updation of this already prepared EA has been awarded to **M/s Engineering and Technological Services, Delhi**. The aim of updation of the EA is to verify the ground data and make EA report to suit the World Bank safeguard policy requirements. The location of EDFC in India map and alignment map for the Khurja-Ludhiana section are shown in Map 1 and Map2.

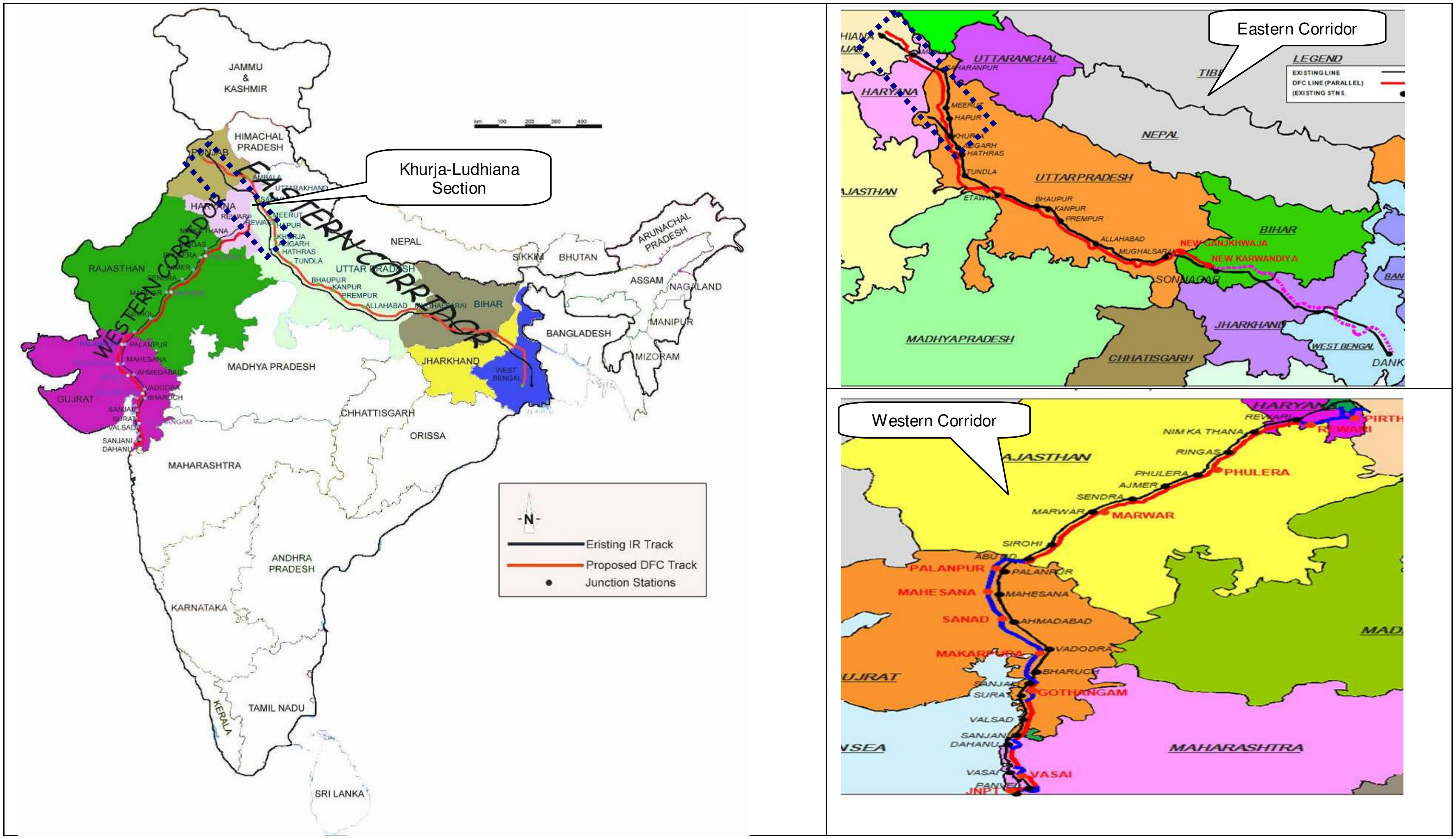
1.3. Objective of the study

The prime objective of the EA study was to identify the likely environmental impacts and their magnitude during various stages (design, construction and operation) of the project and develop cost effective mitigation and monitoring measures along with institutional mechanism to enhance the environmental sustainability of the project.

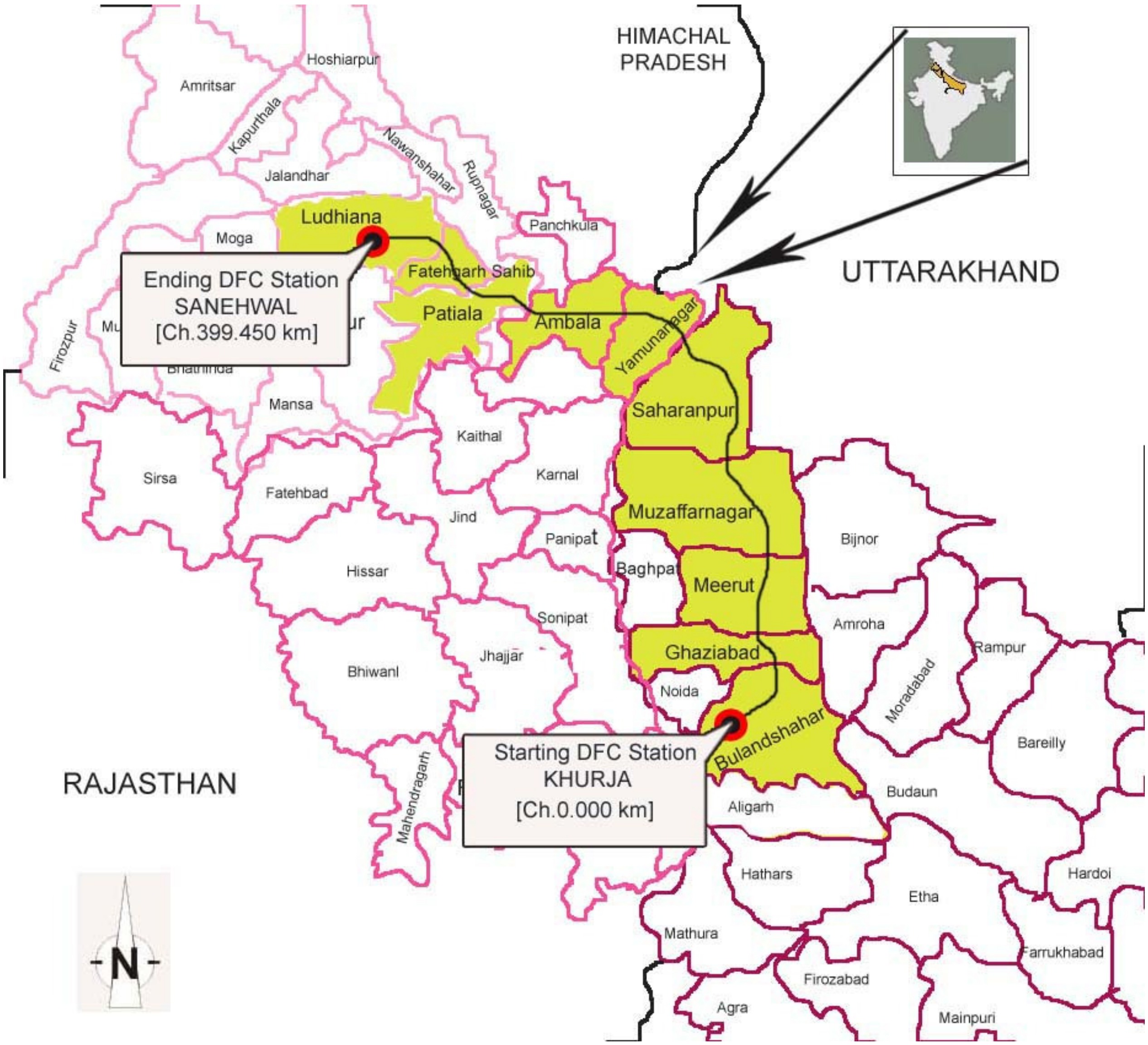
1.4. Purpose of the report

This report primarily focuses on the environmental impacts of the proposed dedicated freight corridor development including design, construction and operation stages impacts and their mitigation. The impacts are identified for all project activities on physical, terrestrial, and aquatic ecology. Environmental management and monitoring programme is devised to minimise these impacts and sustain the benefits. Institutional mechanism is also recommended for effective implementation of EMP and EMoP.

Map 1: Location and Route Map of Eastern and Western Dedicated Freight Corridors



Map 2: Proposed Khurja-Ludhiana Section of the Eastern DFC



1.5. Extent of the EIA Study

The EIA is updated after site visits, verification of data, and interaction with DFCCIL offices at Meerut, Ambala and Ludhiana and by updating the design changes made after preparation of EA report by the ADB PPTA Consultants.

The EIA study covered all activities proposed for the development of Khurja –Ludhiana section of EDFC. The impact of the project covers area within 100 m on either side of the proposed rail corridor alignment including detours. The study area was extended to cover a buffer zone of 7 km wide[1] on either side of the proposed alignment, to analyse the land-use identify environmentally sensitive locations, if any and understand the overall drainage pattern of the area. Geographical Information System (GIS) techniques are used based on recent satellite data of the project area to analyse the baseline physical and ecological landscapes and to gather the relevant data for EIA purpose. Impact on aquatic life, including their breeding/spawning areas or migratory route of fishes if any, is also assessed. Assessment of vegetation cover, migratory route of animals if existing and sourcing of construction material particularly borrow earth, aggregate ballast, stone chips and sand has also been undertaken.

1.6. Environmental assessment report contents

This EIA report is presented in nine chapters, consistent with the World Bank operative directive-4.01. This includes the following chapters:

Chapter 1: Introduction,

Chapter 2: Policy, Legal, and Administrative Frame Work,

Chapter 3: Description of Project,

Chapter 4: Description of Environment (environmental profile and base line of the project and study area),

Chapter 5: Analysis of Alternatives,

Chapter 6: Anticipated Environmental Impacts and Mitigation Measures

Chapter 7: Information Disclosure, Consultation, and Participation

Chapter 8: Environmental Management Plan

Chapter 9: Conclusions and Recommendations

1.7. Methodology

The EIA study was carried out using reconnaissance survey, review of previous studies, field visits, consultation with stakeholders & NGOs, review of existing data and primary data collection.

Extensive use of geographic information system is made to depict the EDFC route on the map, analyse the land use, develop the drainage pattern and identify the borrow earth areas. Also it is used to contribute in defining the magnitude of mitigation measures needed to minimise the impacts on land use, landscape, terrestrial ecology and physical cultural resources. Toposheets (scale 1:50,000) procured from Survey of India and satellite imageries of 4.8 m resolution obtained from national remote sensing centre (NRSC), were used for the above.

The scope of the EIA extends well beyond the vicinity of the proposed alignment. 7 kilometres radius around the alignment is considered as the general impact zone. The immediate 100-meter corridor centred along the proposed corridor was considered as the primary impact zone where most of the adverse impacts are likely to occur. The decision to expand the environmental assessment impact zone to 7-kilometre radius is based on the following considerations:

to provide comprehensive environmental baseline information and to ensure that environmental impacts associated with the project are extensively identified and assessed,

to identify appropriate locations for construction camps and other temporary activities,

to identify the probable borrow areas and other construction material sources

In view of long length of the Khurja-Ludhiana section (about **404.36** km), the entire length has been divided into four sub sections of about 100 km each for effective data collection, consultation, interpretation and presentation. Since this section is traversing through three States, the above approach facilitates in providing state specific information as well.

Alternate analysis was primarily carried out for detour since, the proposed EDFC is planned to run parallel to the existing ir track. It was carried out considering probable routes, physical, biological and socio-economic impacts and technical and financial feasibility.

Periodic feedback and interactive approach were followed during the study period. DFCCIL has adopted dynamic approach and modified the alignment on environmental and social considerations. The details including the baseline data presented in the reports pertains to the finalised alignment. However, studies were also carried out around the different alignment option/detours proposed to identify the environmentally more suitable alignment. The details of various such alternatives are discussed under 'Analysis of Alternatives Chapter'.

The established practices were followed to identify potential impact associated with the proposed project activities. Appropriate tools and techniques were used to identify and predict the magnitude of the impacts. Suitable mitigation measures are suggested based on the intensity of the impacts identified. The environmental management and monitoring plan is also prepared to ensure effective implementation of the mitigation measures proposed.

1.7.1. Data collection

The objective of data collection was to provide a database of existing conditions. These conditions will be used for predicting the likely changes that are expected and for monitoring such changes. The first step was to undertake a project scoping exercise, identify the parameters consideration, and outline the activities for collecting data on identified parameters. Sources of data were identified. Relevant available data pertaining to physical, biological, and socio-economic aspects of the environment was collected from these identified sources. Data collection sources, information obtained from these sources, and application in current EA are summarized in the succeeding Table **1.1**.

Table 1.1 : Information Collected and Sources

Information Collected	Sources	To be Used in
Project location, project objectives, project designs, and sourcing of construction materials	Preliminary engineering and transportation study by RITES, Feasibility Study by JICA and Concept design prepared by ADB PPTA Consultant team and DFCCIL, Detailed project report prepared by the DFCCIL	Project description and impact assessment
National Park, Wild Life Centuries, Reserved forests and other forest areas in project vicinity, flora and fauna details (Terrestrial and Aquatic)	Concerned District Forest Offices; CPCB, Ministry of Environment and Forests, Govt. of India	Project description, alternative analysis, impact assessment and mitigative actions
Project Components and related engineering details	DFCCIL offices at Delhi, Ludhiana and Meerut, Detailed Project Report	Project description, impact assessment, and mitigative actions
Baseline Environment quality with respect to air, noise and vibration, soil, water, land use, meteorological conditions, identification of ecologically sensitive locations, socioeconomic aspects, archaeological	Primary data collection; Department of Forests/ District Forest Office, Department of Fisheries; Census Report, Govt. of India, IMD Regional Offices, and IMD Delhi/Pune, Guwahati; State Pollution Control Boards, Indian Agricultural Research Institute,	Project description, impact assessment and mitigative actions, management plan, and environmental benefit analysis

Information Collected	Sources	To be Used in
protected monuments, Socio- economic details, regulatory compliance	Central Ground Water Authority, Archaeological Survey of India, rehabilitation and Social Impact assessment	
Geology, Seismicity, socio-economic,	Geological Survey of India, Published Research; Govt. Reports; Building Material and Technology Promotion Council, Zoning Atlas, Ministry of Housing and Urban Poverty Alleviation Govt. Of India	Project description, description of environment, alternative analysis and impact assessment

Primary data was also collected with focus on sensitive receptors like religious places, schools, hospitals, habitat areas, commercial places, for noise, vibration, water quality, (ground and surface water both), air quality and soil. The air quality data was collected also for $PM_{2.5}$ as per national ambient air quality standards and with focus on urban setting, rural setting, religious places, and at varying distances from the alignment. The primary data was collected between June 2009 and February 2010 by the ADB -PPTA Consultants and ETS has collected data in November and December 2011..

1.7.2. Public consultation

Local knowledge about the ecosystem and problems associated with such a linear development including sourcing of construction material and men and rail interface were carefully recorded and used in impact assessment and for developing mitigation plans. Consultations were held focusing on air quality, noise and vibration effect, water supply, drainage, aquatic and terrestrial flora and fauna, physical cultural resource of importance, environmental sensitive ecosystems or areas that may be affected by the project. Formal institutional level public consultation and opportunistic informal meetings involving local villagers and those who are likely to be affected due to the proposed projects were organized to determine potential socio-economic impacts. Interactions were also made with various NGOs and concerned Government officials. Public consultations were also held with the stakeholders during and after impact assessment. A detailed description of the public consultation has been presented in Chapter 7.

The consultations have been carried out afresh in December2011 and January 2012 along with the SIA team.

Chapter 2. Policy, Legal and Administrative Frame work

India has well defined institutional and legislative framework. The legislation covers all components of environment viz air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in india are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. Asian development bank and World Bank have also defined their environmental and social safeguard policies. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards. These chapter summaries the following:

- Applicability of various National and local laws and regulations at different stages of project implementations
- Applicability of World Bank safeguard policy and categorisation of the project
- Legal Administrative Framework of India
- Summary of international treaties and applicability to the project

2.1. Environmental Regulatory Requirements of Government of India and State

The Government of India has framed various laws and regulations for protection and conservation of natural environment. These legislations with applicability to this project are summarised below in **Table 2.1**. There is no separate state level legislation. However, various acts like water and air are enforced through state level authority: State Pollution Control Board.

To obtain the forest clearance for diversion of forestland for non-forest use - following steps are followed:

Submit proposal for diversion of forests to non forestry purposes in the prescribed form (Form ‘A’) to the Nodal Officer of the concerned State Government along with requisite project information.

A copy of the proposal, along with a copy of the receipt obtained from the office of the Nodal Officer, is also submitted to the concerned Divisional Forest Officer (DFO) or the Conservator of Forest, regional office as well as the monitoring cell of the Forest Conservation Division of the Ministry of Environment and Forests

The DFO or the Conservator of Forests shall examine the factual details and feasibility of the proposal, certify the maps, carry out site-inspection and enumeration of the tree and forward his findings in the format specified in this regard to the Nodal officer within a period of ninety days of the receipt of such proposal from him.

The Nodal officer, through the Principal Chief Conservator of Forests, shall forward the proposal to State Government along with his recommendations, within a period of thirty days of the receipt of such proposal from the divisional forest officer or the Conservator of Forests.

The State Government shall forward the complete proposal, along with its recommendation, to MoEF regional office in the specified forms within a period of sixty days of the receipt of the proposal from the Nodal officer, provided that all proposals involving clearing of naturally grown trees on the forest land or a portion thereof for the purpose of using it for reforestation are sent in the form of working plan or management plan. If the forestland diversion is < 40 ha, the proposal will be processed by regional office otherwise by Ministry of Environment and Forests (MoEF) at New Delhi.

Table 2.1 Summary of Applicable and Non Applicable Environmental Legislation

S. No.	Law / Regulation / Guidelines	Relevance	Applicable Yes / No	Reason for application	Implemen-ting / Respons-ible Agency
1	Environmental (Protection) Act. 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere.	Applicable	Environmental notifications, rules and regulations are issued under the Act	DFCCIL
2	The EIA Notification, 14th September 2006 and amendments till date	Railway projects are exempted from this notification	Not Applicable	Railway project is not included	-
3	Fly Ash Notification, 2003	Use of fly ash for alignment, if it falls within 100 km of thermal power plant	Applicable	No specific consent required, to be followed	Contractor / DFCCIL
4	National Green Tribunal Act,2010 National Green Tribunal (Practices and Procedure) Rules,1011	Address grievences regarding cases related to environment protection & compensation against other natural resources	Applicable	-	MoEF
5	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the act	Applicable	Forest land diversion for the project	DFCCIL
6	Wild Life (Protection) Act, 1972	Protection of wild life in sanctuaries and National Park	Not Applicable	No wildlife sanctuary / national park involved	MoEF
7	The Air (Prevention and Control of Pollution) Act. 1981	Empowers SPCB to set and monitor air quality standards	Applicable	Consent required for establishing & operation of Construction camps, concrete batch Mix Plants, Hot Mix plants	Contractor / DFCCIL
8	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish/enforce water quality and effluent standards,	Applicable	Consent required for not polluting ground & surface	Contractor / DFCCIL

S. No.	Law / Regulation / Guidelines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
		monitor water quality, and issue licenses for construction/operation of certain facilities.		water during construction. Contractor need to obtain consent to establish construction camps	
9	Noise Pollution (Regulation And Control) Act, 2000	Standards for noise pollution control	Applicable	Machineries and vehicles to conform to the standards during construction & operation.	SPCB
10	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act,2010	To protect and conserve cultural and historical remains found.	Not Applicable	No ASI Protected monument within a distance of 300 m.	NMA
11	Public Liability And Insurance Act,1991	Protection to the general public from accidents due to hazardous materials	Applicable	Hazardous materials shall be used for road construction	DFCCIL
12	The Explosives Act 1884	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying.	Applicable	If contractor decides to store hazardous materials such as HSD and Lubricants at project site.	Contractor / DFCCIL
13	Central Motor Vehicle Act. 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate is issued to reduce vehicular emissions.	Applicable	All vehicles used for construction will need to comply with the provisions of this act.	Contractor
14	The Mining Act	For safe and sound mining activity	Applicable	for querry, licence to be obtained by Contractor	Contractor
15	Railways (Amendment) Act, 2008	Related to compensation to PAFs, PAPs, CPRs etc.	Applicable	Land acquisition is involved	DFCCIL

S. No.	Law / Regulation / Guidelines	Relevance	Applicable Yes / No	Reason for application	Implementing / Responsible Agency
16	Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008	Protection to the general public against improper handling and disposal of hazardous wastes	Applicable	Hazardous wastes shall be generated due to activities like of maintenance and repair work on vehicles at Construction camps	Contractor / DFCCIL
17	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemical	Applicable	Handling of hazardous (flammable, toxic and explosive) chemicals during road construction	DFCCIL/ Contractor
18	The Petroleum Rules, 2002	Applicable	Contractor may store more than the prescribed quantity at camp site	Chief Controller of Explosive	Contractor/ DFCCIL

2.2. Social Regulatory Requirements of the Government of India and State

There are many rules and regulations framed by the Government of India for the protection of workers. Most of these legislations will be applicable to contractors in charge of construction. DFCCIL will ensure compliance to these social legislations through contractual obligation and regular checks & penalties. These legislations are:

The building and other construction workers (regulation of employment and conditions of service) Act, 1996,

Child labour (Prohibition and Regulation) Act; 1986,

Minimum wages Act; 1948,

Workmen compensation Act 1923,

Payment of gratuity Act 1972,

Employee State Insurance Act,

Employees P.F. and miscellaneous provision Act 1952,

Maternity benefit Act 1951,

Payment of wages Act 1936,

Equal remuneration Act 1979,

Inter-state migrant workers' (Regulation of Employment & Conditions of Service) Act 1979,

2.3. The World Bank Safeguard Policies

The EA study was conducted according to Asian Development Bank safeguard policies (SPS 09). Similarly, The World Bank has defined its safeguard requirement under its operational policies. The policies of both the banks require almost similar assessment, mitigation and commitment towards environmental protection. The prime objectives of these safeguard policies are to (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible.

An assessment is made about applicability of various policy components and project activities to classify the project and define the scope of study. Applicable and non applicable safeguard policies of the World Bank are given below.

Table-2.2 : World Bank Safeguard Policies

Sl. No.	Safeguard Policy	Subject Category	Triggered	Triggered By	Mitigation Measures	Documentation
1.	OP 4.01	Environment Assessment	Yes	Sensitive areas and impacts on environmental and social components	Mitigation measures incorporated	EIA and EMP prepared
2.	OP 4.04	Natural Habitats	Yes	Reserve forests issues	Incorporated	EIA and EMP
3.	OP 4.09	Pest Management	No	Not applicable	Not applicable	Not Applicable
4.	OP 4.11	Physical Cultural Resources	Yes	Risk to cultural properties	Adequate mitigation measures if affected	EMP & RAP prepared
5.	OP 4.36	Forestry	Yes	Diversion of forest land	To be carried out as per Forest (conservation) Act, 1980	Not Applicable
6.	OP 4.37	Safety of Dams	No	Not Applicable	Not Applicable	Not Applicable
7.	OP 7.50	International Waterways	No	Not Applicable	Not Applicable	Not Applicable
8.	OP 7.60	Disputed Area	No	Not Applicable	Not Applicable	Not Applicable

Environmental Categorization and Need of Environmental Assessment

According to Asian Development Bank (ADB) as well as the World Bank a project can be classified into following three categories

Category A: A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An Environmental Impact Assessment is required.

Category B: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category a projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category a projects. An initial environmental examination is required.

Category C: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

2.4. Category of the Project

The category of project has been decided visualising the level of impacts during construction and operation phases. All environmentally sensitive areas along the proposed alignment were critically analysed to assess the magnitude and extent of likely impacts. This stretch does not pass through any protected areas neither is near any archeologically important monument. It passes through only one reserved forest near Meerut. Other reserve forests areas have already been bypassed through alignment modifications. The track primarily passes through agricultural and residential areas. The stretch crosses some of the major water bodies and acquisition of land is involved at few stretches. Since this is a large-scale project and likely to have some reversible impacts on environment during construction phases & some impact, not of much significance, during operation. **Based on the above considerations, this project is being considered as 'A' category project as per the World Bank safeguard policy**. This will help not only not only in tweaking the construction stage to be more eco-compliant but setting systems to have better and more environment friendly construction in forthcoming railway projects. DFCCIL is committed to establish most efficient and eco-friendly system.

This project does not come under purview of EIA notification 2006 of MoEF, as railway projects do not require environmental clearance.

2.5. Clearance Requirements for the Project

The summary table showing time requirements for agency responsible for obtaining clearance, and a stage at which clearance will be required is given below in **Table-2.3**.:

Table-2.3: Summary of Clearances Requirements

Sl. No	Type of clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
1	Prior Environmental Clearance	SEIAA/ EIAA	Not applicable	Pre construction	-	NA
2	Clearance for working / diversion of sanctuary land	Chief Wild Life Warden	Not applicable	Pre construction	-	NA
3	Forest Clearance	State Environment & Forest dept. and MoEF regional office	Diversion of Forest land	Pre construction	6-8 months	DFCC
4	Tree felling permission in Private Land	Forest department	Felling of trees	Pre construction	2-3 months	DFCC
5	NOC And Consents Under Air , Water, EP Acts & Noise Rules	State Pollution Control Boards of Uttar Pradesh, Punjab and Haryana	For establishing plants	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor

Sl. No	Type of clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
6	NOC And Consents Under Air , Water, EP Acts & Noise rules of SPCB for Establishment of Construction camps	State Pollution Control Boards of Uttar Pradesh, Haryana and Punjab	For operating Hot mix plants, Crushers and batching plants	Construction (Prior to work initiation)	1-2 months	Concessionaire / Contractor
7	Permission to store Hazardous Materials specially fuel oil and Lubricants at Construction camps	State Pollution Control Board and Controller of Explosives	Storage and Transportation Of Hazardous Materials and Explosives	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
8	Explosive license	Chief Controller of Explosives	Storage of Explosive materials	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
9	PUC certificate for use of vehicles for construction	Department of Transport	For all construction vehicles	Construction (Prior to work initiation)	1-2 months	Concessionaire / Contractor
10	Quarry lease deeds and license	Dept. of Geology and Mines, GoUP	Quarrying and borrowing operations	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
11	NOC for water extraction for construction and allied works	Ground Water Authority	Ground water extraction	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor

2.6 Conclusion

Review of environmental regulations clearly indicates that the subject DFC project does not require any environmental clearance. However, clearance for the diversion of forest land and permission for cutting the trees within the proposed right of way of the alignment will be required from the Forest Department. In addition to the above, the contractors of various construction packages would require the following NOCs & licenses from the authorities during construction:

- NOC And Consents Under Air , Water, EP Acts & Noise rules of SPCB for establishing and operating Construction Camps from respective State Pollution Control Boards where construction camp is proposed to be located.
- PUC certificate for use of vehicles for construction from Department of Transport
- Quarry lease deeds and license and Explosive license from Dept. of Geology and Mines & Chief controller of explosives
- NOC for water extraction for construction and allied works from Ground Water Authority

Apart from the above clearances, the contractors also have to comply with the following:

- Clearance of Engineer for location and layout of Worker's Camp, Equipment yard and Storage yard.

- Clearance of Engineer for Traffic Management Plan for each Section of the route after it has been handed over for construction.
- An Emergency Action Plan should be prepared by the contractor and approved by the Engineer for accidents responding to involving fuel & lubricants before the construction starts. Submit a Quarry Management Plan to the Engineer along with the Quarry lease deed.

Chapter 3. Description of the Project

3.1. Size and Location of the Project Section

The project section (Khurja-Ludhiana) is part of eastern DFC and covers three states starting from Khurja Jn. In Uttar Pradesh passing through Haryana and finally terminating at Sanehwal near Ludhiana city in Punjab covering districts of Bulandshahar, Ghaziabad, Meerut, Muzaffarnagar, Saharanpur, Yamunanagar, Ambala, Fatehgarh Sahib, Patiala and Ludhiana (map 2).

The Indian Railways chainage of 1366.750 to the north of Khurja junction is the point at which this section of corridor study commences. The Khurja flyover is the part of this corridor. The Khurja-Ludhiana section ends at Sanehwal, as it is not possible to connect it with Ludhiana railway station because of enormous growth of Ludhiana town. Further, because of space constraint at Dhandarikalan and nearby airport, the corridor is now being terminated at the Sanehwal station (**Figure 3.1 and Figure 3.2**)

Traffic to destinations in northern India and originating in the eastern region gets bifurcated into two sections at Khurja; firstly, toward Dadri/Delhi and secondly, towards Saharanpur/Ludhiana. The route passes through three divisions of northern railway (zone) viz. Khurja - Meerut under Moradabad division; Meerut - Saharanpur under Delhi division; and Saharanpur - Sanehwal under Ambala division as shown in Table **3.1**

Table 3.1 : Features of Existing Khurja-Ludhiana Section

Section	Zonal Railway	Division	Route length (km)	Electrification/Single-Double Line
Khurja (0.0 km) to Meerut (92.25 km)	Northern	Moradabad	92.25	Non-electric; Single
Meerut (km 62.9-Talheri Bujurg(km156.540)	Northern	Delhi	89.37	Non-electric; Single
Talheri Buzurg (156.00 km) to Tapri (176.30 km)	Northern	Delhi	20.3	Non-electric; Single
Tapri (176.30 km) to Saharanpur (180.79 km)	Northern	Delhi	4.49	Non-electric; Double
Saharanpur (180.79 Km) to Sanehwal (359.00 Km)	Northern	Ambala	178.21	Electrified; Double
Sanehwal (359.00 km) (360.30 km)	Northern	Ferozpur	1.30	Electrified; Double

Source: CPM Offices Meerut and Ambala

The length in parallel and detour section is as given below:

S. No.	Section	Parallel Section (km)	Detour Section (km)	Total (km)	Districts	Village	LA (Ha.)
1	Khurja- Talheri	167.60	30.00	197.60	5	115	275.90
2	Talheri-Sahnewal (Ludhiana)	193.97	12.79	206.76	6	159	372.48
Total	**Khurja-LDH (incl. Khurja-**	**361.57**	**42.79**	**404.36**	**10 (1 common)**	**274**	**648.38**

S. No.	Section	Parallel Section (km)	Detour Section (km)	Total (km)	Districts	Village	LA (Ha.)
	Dadri)						

The proposed alignment is suitably finalized with due considerations to engineering aspects like available gradient, need of curve improvement, demolitions & cuttings and environmental/social aspects like land acquisition in densely populated areas and agricultural lands. All efforts have been made to utilize the existing RoW.

Figure 3.1 : Alignment View of Khurja-Ludhiana (Sanehwal) DFC With Respect to Existing IR track

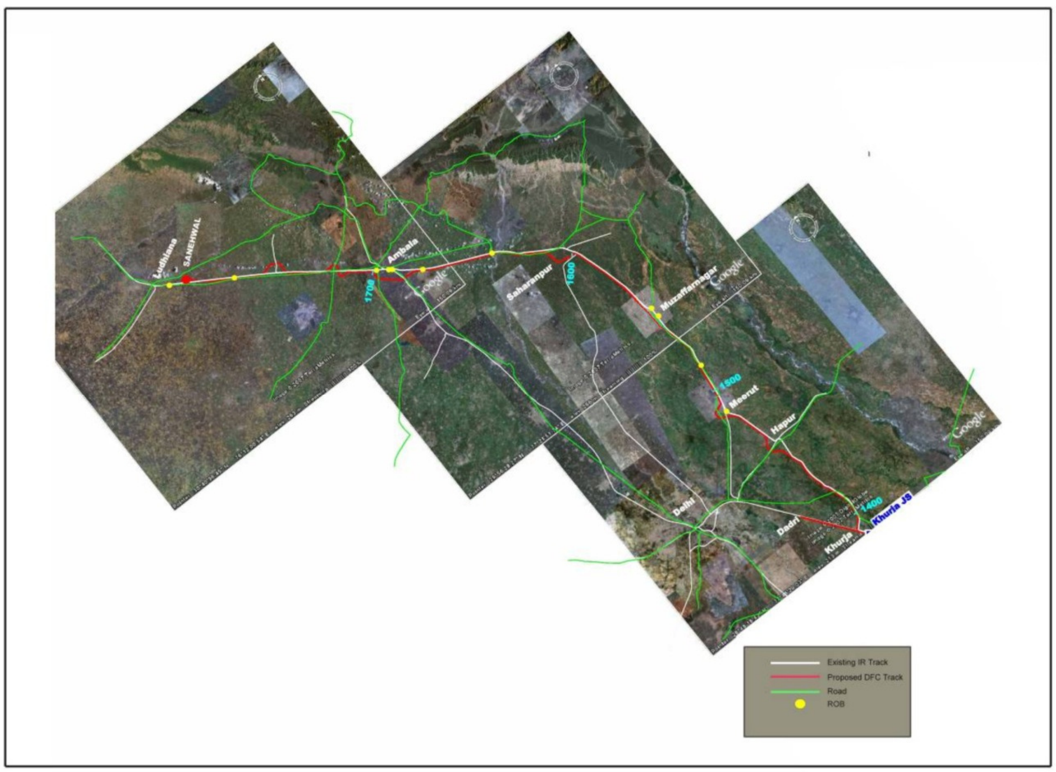
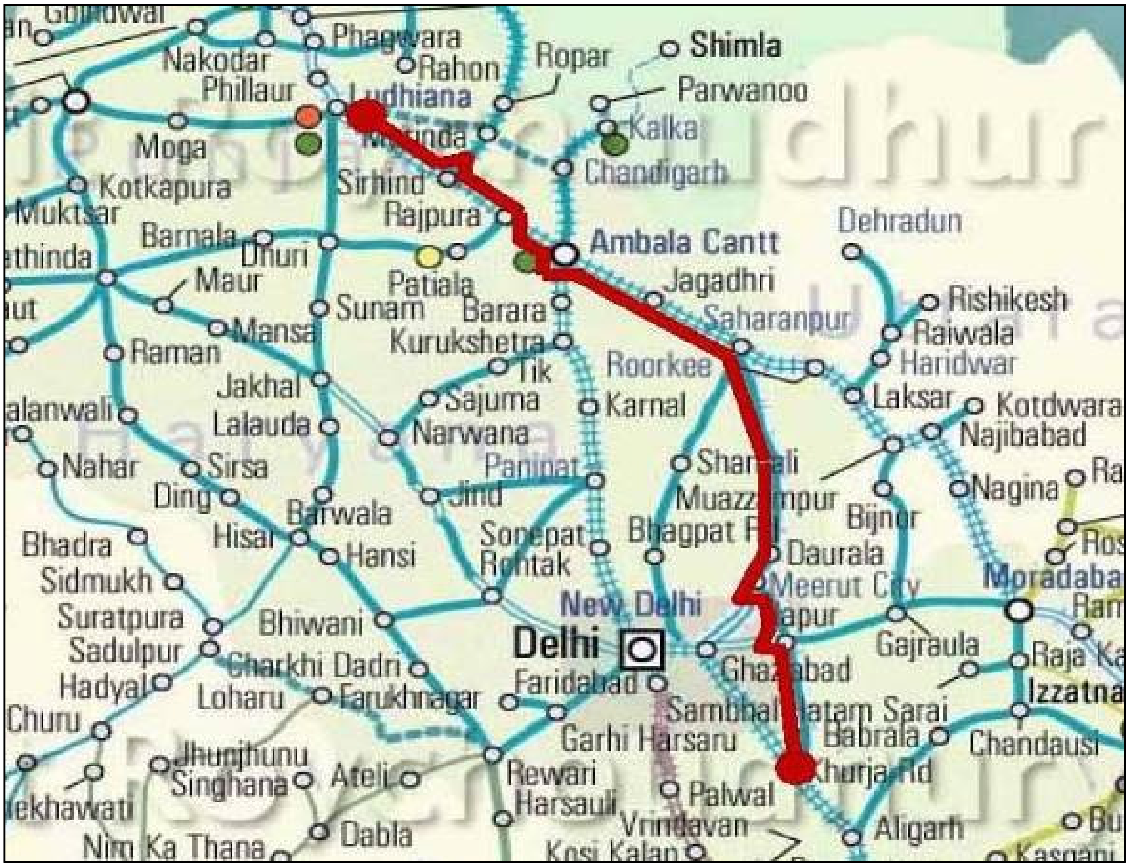


Figure 3.2 : Location and Route Map of Khurja – Ludhiana DFC



3.2. Need of the Project

Transport sector. India's transport sector is large and diverse; it caters to the need of 1.1 billion people. According to latest estimates, transport and communications' (T&C), gdp rose by 7.4% in 2008. For the 2009-2013 forecast period, it is expected that T&C sector will continue outpacing the economy as a whole by a small margin. It will achieve average annual growth of 6.8%, versus 6.7% for overall GDP. However, due to hetrogeneous distribution of load among two major transportation sectors(road and rail), dedicated services are required to reform their performances to support the economic growth of country. Keeping this in view, the ministry of Railways (MOR) has embarked on a long-term plan to construct high axle load, high speed and dedicated freight corridors along a part of its network.

3.2.1. Khurja - Ludhiana Section

Development of dedicated freight corridor in this stretch is an important and timely initiative for providing effective and faster mode of goods transportation in an environmentally acceptable manner as well as contributing in improving the overall socio-economic conditions of the area. The need of EDFC in this section is evident from the following facts pertaining to existing route capacity, demand forecast, traffic projection, socio-economic benefits, environmental advantages and other commercial considerations.

Constrained route capacity: the Delhi-Howrah route is heavily loaded with passengers as well as freight services. Every year new passenger services are added on the route but the demand is still unfulfilled. Currently the freight loading on the Zonal Railways over this route increased by 10-12%. As a result, the pressure on this route is ever increasing. The traffic demand would further increase and reach the existing capacity by 2010-2015. In certain section, it has already reached its existing capacity (**Table 3.2**). Capacity enhancement of this section is required to accommodate future requirements. It is considered that for sustainable growth of the national economy and for regaining/improving its share in the total land transport of goods, the Indian Railways need to achieve a major leap in the provision of additional rail transport capacity.

Table 3.2 : Rail Capacity and Utilization (Ludhiana-Khurja), 2009

S. No	SECTION	Capacity With Maintenance Block	Freight Trains	Total Trains	Estimated % Utilization
1	Khurja -Hapur	12	2	7	58%
2	Hapur-Meerut	12	2	7	58%
3	Meerut- Tapri	23	7	31	135%
4	Tapri Saharanapur	50	5	27	54%
5	Saharanapur-Jagadhari	54	14	48	89%
6	Jagadhari-Ambala Cantt	54	12	46	85%
7	Ambala Cantt-Rajpura	74	29	87	118%
8	Rajpura-Sirhind	74	23	69	93%
9	Sirhind-Sanehwal/Ludhiana	54	12	52	96%

Source: PPTA Feasibility Study, 2009

A dedicated freight corridor with independent management exclusively for freight movement along with the feeder routes will ensure availability of sufficient capacity in the face of rising demand for transport and will provide speedy and reliable services to various freight customers.

Need for bulk transportation and faster connectivity: there are number of thermal power plants, iron and steel plants and food grains industries located in this section. Transportation of these commodities in bulk to the users in a time bound and reliable manner is a matter of concern today. Currently trains from eastern India to Ludhiana District are operated through congested Delhi metropolitan area causing delays in train movement. The proposed EDFC section between Khurja to Ludhiana will connect it with eastern India bypassing congested Delhi metropolitan area. This section once constructed will largely address the issue of availability of bulk transportation infrastructure with faster connectivity. This will also facilitate the containerised movement of goods from eastern port to northern areas and vice versa.

Transportation demand – current and forecasted: the traffic on this section is expected to increase substantially and by 2021 is likely to be five times of 2007 base level at 22.9 t axle load and four times at 25 t axle load. The traffic projection as per different studies (rites, jica, and dfccil business plan) in the Khurja - Ludhiana section is shown in **Table 3.3**

Table 3.3 : Traffic Projection for 22.9 t and 25 t Axle load between Khurja - Kalanaur Section

Source	RITES (2007)	JICA (2007)	DFCCIL BP (2009)	DFCCIL BP (2009)
	25 t Axle	25 t Axle	22.9 t Axle	25 t Axle
Forecast Years	Total Trains per Day-Both Directions (Khurja Kalanaur Section Only)			
2007	-	-	**12**	12.
2011/13	27	-	**25**	25
2016/18	47	61	**47**	39
2021/23	54	63	58	**48**
2026/28	-	66	64	**53**

Source	RITES (2007)	JICA (2007)	DFCCIL BP (2009)	DFCCIL BP (2009)
	25 t Axle	25 t Axle	22.9 t Axle	25 t Axle
Forecast Years	Total Trains per Day-Both Directions (Khurja Kalanaur Section Only)			
2031/33	-	67	72	**60**
2036/37	-	-	78	**66**

Source: PPTA Feasibility Study, 2009

It is advantageous to go for 25 t axle load. According to dfccil business plan, the change from 22.9 to 25 tonnes makes a considerable difference in train movement i.e. each train carries a higher volume thus, reducing train movements (**Table 3.4)**. If transport of food grains is taken as an example from the table below, the introduction of 25 tonne axle wagons would optimally require only 55% of the movements with 22.9 tonne axle loading. This makes a considerable difference in the projection of train movements as shown in **Table 3.3**.

Table 3.4 : Reduction in Train Movements with 25 tonne Axle Load

		Existing Rail Wagons			DFC Wagons			Conversion Factor*
Axle Loading		22.9 tonnes			25 tonnes			
Commodity	Wagon Type	No. of wagons	Load (TEU or tonnes) per wagon	Load per Train	No. of wagons	Load (TEU or tonnes) per wagon	Load per Train	
Container	BLC_ Well Wagons	45	2	90	32	4	128	70%
Container	BLC_ Flat Wagons	45	2	90	45	4	180	50%
Coal	BOXN	58	65	3770	58	82	4756	79%
Food grains	BCN	41	62	2542	58	80	4640	55%
Fertilizers	BCN	41	62	2542	58	80	4640	55%
Cement	BCN	41	62	2542	58	80	4640	55%
Salt	BCN	41	62	2542	58	80	4640	55%
Steel	BRN / BOXN	48	62	2976	Same as before			100%
POL	BTPN	45	48	2160	47	77	3619	60%

* Number of trains with 22.9 t axle reduced by this factor if axle loading increases to 25 t
Source: ppta feasibility report, 2009

Socio-economic benefits. 1) the movement of commodities like coal, iron and steel, food grains, cement, salt and limestone to the steel plants along different parts of this section will be easier and faster, 2) the development will provide employment opportunities to the local people and 3) the demand supply gap in these regions will decrease.

Environmental advantages. The project will result in CDM benefits by reduction of air emissions through a) decrease in road share of freight transport along the alignment b) construction of robs which will reduce the traffic congestion and c) electrification of the railway network along the section.

3.3. Project Components and Activities

The EDFC is proposed to be co-planner with adjacent railway except at detours and grade separations. Under this section of EDFC project an electrified single line of 404.094 km between Khurja and Ludhiana is proposed to be constructed. The key project components and activities involve laying of formation alignment, construction of crossing station, new bridges, RUBs, ROBs, maintenance yards /depots, flyovers/grade separators; signalling, telecommunication, and safety infrastructure; construction of staff quarters, temporary workshops, offices and construction camps.

As per Ministry of Railway (MOR) and DFCCIL, the alignment from Khurja to Ludhiana will be single lined with no surface crossing. The centre-to-centre spacing between DFC track and existing Indian railway track will be of 6m. Inter station distance to be 10km and maximum moving dimensions (mmd) will be 5.1m.

The details of standard criteria followed and project components are given in the following sections.

3.3.1. Standards Criteria and Salient Features

The performance requirement applied to the route by dfccil and salient features are given in **Table 3.5.**

Table 3.5 : Standards Criteria and Salient Features of Khurja Ludhiana DFC

Description	**Standards Criteria/Features**
Standards Criteria	
Gauge	1676 mm of Broad Gauge
Loading	32.5t axle load for bridge foundations 25t axle load for formation and track structure
Maximum Speed	100 kmph on Main line 30 kph on Loops with curved switches
Minimum radius of horizontal curve	700 m (2.5 degree curve)
Curve compensation	At the rate of 0.04 % per degree of curvature
Ruling Gradient	1 in 200 (0.5%) compensated
Steepest Gradient in yards	1 in 1200, 1 in 400 in exceptional cases
Track Spacing	6.0 m Centre to Centre in DFCCIL Tracks & 6.0 m minimum between the DFC and nearest IR Track
Switch and crossings	1 in 12 with curved switches and CMS crossings on PSC fan shaped sleepers or FFU (Fibre reinforced Formed Urethane) sleepers 1 in 8 ½ turnout in Minor loop lines and non-running lines.
Rails	UIC 60 Kg 90 UTS rails
Sleeper	PSC 1660/km spacing for main freight line and 1540/km spacing for loop line
Fastenings	Elastic type of fastening i.e. Elastic clips, grooved rubber pads
Cant	Limited to 140 mm maximum
Cant Deficiency	Limited to 75 mm
Cant Gradient	1 in 720 maximum
Salient Features	
Alignment Features	
Route length	**404.36** km
Alignment	Single electrified Line
Moving Dimension	Single Stack container with MMD as 5.1 m
Parallel Track	368.336 km.
Detours and Track length	6 Nos (Detours at Hapur, Meerut Tapri, Ambala, Shambu and Sirhind. Total detour length 40.762 km
Junction Stations	5 No. at Khurja, Kalanaur, Rajpura ,Sirhind and Sahnewal
Maintenance Depot	5 No.(at km80 , km148 , km191 , km280 and km346)
Crossing Stations	36 No., inter station distance 10 km (19 numbers in Khurja-Talheri section and 17 numbers in Talheri-Sahnewal section)
Passing Through or by existing Stations	52 Numbers (25numbers in Khurja-Talheri section and 27 numbers in Talheri-Sahnewal Junction)
Flyovers/Grade Separators	8 no at Khurja, Hapur , Meerut, Tapri, Ambala Cantt, Rajpura (2 numbers), and Sirhind
Soil Subgrade	1000 mm with CBR value (min) 8%& balance with CBR value (min) 5%

Description	Standards Criteria/Features
Blanketing	600 mm CBR value more than 25%
Ballast	300 mm cushion (65 mm size stone ballast)
Bank formation width for double and single line at top	13.5 m for double lines, and 7.6 m for single line
Slope of embankment	2H: 1V
Cutting width for double line at formation top	13.25 m integrated with existing IR track and 14.5 m independent.
Slope of cutting	1:1.5
Cutting width for double line	19.30m
Track spacing	6 m between centre to centre of two DFC track
	Minimum 6 m between DFC track and IR track
Embankment height	Average 2 m. (about 6 m in the detours).
Bridge Infrastructure	
Important Bridges	7
Minor Bridges	449 (Small span box culverts upto 4.0 M)
Major Bridges	61 (warren truss, plate girder, and precast concrete beams type)
ROBs a) ROBs under construction b) ROBs required as per Norms c) ROBs required at DFCCIL Stations	 15 82 17
RUBs	43 (29 in Khurja-Talheri section and 14 in Talheri-Sahnewal section)
Pedestrian underpasses	42
Foot bridges	10
Existing ROB alteration	5
Level Crossings	196 (roughly one crossing at every 2 km)
Station signaling	Electronic Interblocking system
Block signaling	Absolute Block working
Telecommunication	GSM network
	Electronic Telephone Exchange of 2000 lines at control office (likley at Ambala)
	24 fibers Optical Fibre Cable (OFC) network as per Indian Railway Standard on each side of the DFCCIL rail line.
	Multiplexer equipment at each station
Electrification	2 x 25KV Electric Traction System With 60 MVA transformers spaced at 60 km apart
	Traction substation spacing of 60 km
	Major OHE maintenance depot at 60 km and Minor at 30 km
	Local power supply connection from State Electricity Authorities and OHE supply for signaling through 25 KV/230 V single phase. Two auxiliary transformers at each station for colour lighting.
Land Acquisition	648.38 Ha (240.29 Hectares in Khurja- Talheri Section and 372.48 Hectares in Talheri- Sahnewal section)
Shifting of Community Resource	39 (30 religious places)

3.3.2. *Track Standards*

In order to accommodate 32.5 tonne axle load the rail used will be uic 60kg 90 uts installed as continuously welded rail (CWR), PSC sleepers at 1660/km spacing for the main freight lines and 1540/km sleeper spacing on loop lines and siding. Minimum ballast depths are proposed to be 300mm.

3.3.3. Alignment and Detours

The single electrified line of DFC will broadly follow the alignment of existing IR track except at detours. Diversions are unavoidable at some places, for reasons such as heavily built-up areas, technical considerations and/or land acquisition constraints. Such locations are Hapur, Meerut, Ambala, Tapri, Shambhu, and Sirhind

Various alignments and detour alternatives were analysed and studied prior to finalisation of alignment. The analysis of these alternatives is given under 'Analysis of Alternatives' (Chapter no. 5).

The space requirements between two EDFC tracks or between IR and EDFC track are considered as 6 m. However, spacing of EDFC track would be more at the locations of new bridges and new RUBs. Existing structures, viz. Station buildings, sidings, OHE sub-stations; falling on the alignment of the proposed EDFC track would necessitate adoption of larger track centre.

Chainage and existing stations: current (nearest) IR chains and the proposed continuous project chainage are shown in **Table 3.6.** The total length of Khurja- Ludhiana sction of EDFC is **404.36** km..

Table 3.6 : Project Chainage with Location of Detours

Northern Railway Stations	Location	IR Chainage (km)	Northern Railway Stations	Location	IR Chainage (km)
0	**Khurja Junction**	0 (Khurja line)	26	**Saharanpur Jn.**	180.790
1	Khurja City	6.570	27	Pilkhani	188.510
2	Maman	15.650	28	Sarsawa	194.080
3	Bulandshahar	22.660	29	Kalanaur	204.560
4	Baral	34.660	30	Jagadhri	210.930
5	Chhaprawat	39.950	31	Jagadhri Workshop	215.810
6	Gulaothi	44.270	32	Darazpur	220.570
7	Hafizpur	54.590	33	Mustafabad	228.410
1	**Start of Hapur Detour**	61.196	34	Barara	237.210
8	**Hapur Junction**	63.640	35	Tandwal	242.560
1A	**End of Harpur Detour***	67.107	36	Kesri	248.900
9	Kaili	70.430	37	Dukheri	254.450
10	Kharkhauda	76.490	3	**Start of Detour (Approx)**	259.174
2	**Start of Meerut Detour**	81.008	38	**Ambala Ca ntt Jn.**	261.930
2A	**End of Meerut Detour****	66.361 (Delhi line)	3A	**End of Detour (Approx)**	262.655
11	**Meerut City**	67.170	39	Ambala City	269.480
12	Meerut Cantt	71.490	40	Shambu	279.090
13	Pabli Khas	76.040	41	**Rajpura Jn.**	289.840
14	Daurala	83.620	42	Sarai Banjara	299.250
15	Sakhuti Tanda	91.320	43	Sadoo Garh	307.410
16	Khatauli	100.470	44	**Sirhind Jn.**	315.220
17	Mansurpur	109.930	4	**Start of Detour (Approx)**	315.735
18	Jaruada Nara	115.300	4A	**End of Detour**	318.468

Northern Railway Stations	Location	IR Chainage (km)	Northern Railway Stations	Location	IR Chainage (km)
				(Approx)	
19	Muzaffarnagar	122.660	45	Mandi Govind Garh	324.790
20	Baman Heri	127.170	46	Khanna	333.100
21	Rohana Kalan	138.840	47	Chawapail	343.900
22	Deoband	146.530	48	Doroha	353.310
23	Talheri Buzurg	156.540	49	**Sanehwal**	360.540
24	Nagal	164.180		Dahandari Kalan	368.360
25	**Tapri Jn.**	174.190		Ludhiana Jn.	375.650

Source: PPTA Feasibility Study, 2009

3.3.4. Gradient

A ruling gradient of 1 in 200 (0.5%) is proposed. Since the terrain of entire project area is largely flat as it falls in indo-gangetic plains, there is no difficulty in providing this gradient. Maximum gradient of 1 in 400 may be permitted in certain yards on economic considerations, as the corridor will not carry passenger traffic.

3.3.5. Curves

For permitting maximum permissible speed of 100 kmph, a radius of 638 m is adequate with cant as 140 mm and cant deficiency as 75 mm. However, the minimum horizontal curve radius specified is 700 m (2.5 degrees) in the proposed corridor. In case of providing connections to the existing yards for inter-operability, curves up to 4 degrees will have to be provided to reduce the length of connections, which will cause in reduction of speed at those locations.

As per engineering code, vertical curves will be provided only at those locations where the algebraic difference in change of grade is equal to or more than 4 mm/m i.e. 0.4%. For vertical curves minimum radius of 2500 m will be adopted.

3.3.6. Ballast

The depth of good quality hard stone ballast (65 mm size) cushion below PSC sleepers will be 300 mm for main lines. Therefore, a quantity of 2.33 (2.158+8% shrinkage) cum/m for straight lwr single line track and 2.36 (including 8% shrinkage) cum/m for LWR single line track for curves will be required. There are many approved quarries available in or around the project districts some being very near to the railway track/stations (**Annexure 3.1**)

3.3.7. Right of Way (RoW) and Embankment Formation

RoW: since the alignment will run parallel to the existing IR track and maximum efforts will be made to use the existing railway land to minimise the land acquisition, the RoW vary at different locations. About 5 m extra, land is proposed to be acquired beyond the toe of the formation. Drain, as may be required, will be constructed in this extra land portion. No specific provision is made for service road.

Formation and earthwork profile: the formation width for independent (non integrated but parallel with existing IR track) is 13.5 m with side slopes of 2:1 and formation width at top width as 7.60 m. Extra width of formation shall have to be provided on curves to accommodate extra width of ballast and extra clearance of stocks. The formation width will be more at detour due to higher embankment height of about 6 m.

For higher axle loads of 30t, RDSO guidelines recommend provision of increase in blanketing thickness to the extent of 450 mm over and above that required under present axle loads up to 22.9 t and the thickness as per the guidelines may be up to 1.45 m. However, in the proposed project it would be difficult to provide such thickness for most of the length due to bank height being about 1 to 2 m above ground level. To reduce the depth of blanketing, ideally, geotechnical investigation of sub-grade earth and that of sub-soil is necessary. As per design, consultants finding an average depth of 600 mm for blanketing could be adequate. However, design has proposed 800 mm blanketing. Mechanical compaction at optimum moisture content is proposed. Near bridge approaches stone pitching and other protective measures are proposed.

Earthwork: the total quantities of the earthwork required for embankment on this corridor will be 1, 72, 98,509 m^3. The quantity of blanket material estimated is 2463906 m$^{3.}$ The earthwork formation may be independent or integrated with existing IR. The cross section profile of both type of earthwork is shown in **3.2**, and **Figure 3.4** It may be mentioned that cross sections shown are **schematic** only and not to the scale. The formation width for two lines is 13.5 m and for single line is 7.6m. Initially it was planned 14.5 and 8.5 m for double and single track respectively.

Turfing: 150 mm thick seeded soil turfing is proposed on embankment slopes.

Service roads and side drains: no provision of service roads is made. However, provision for shifting of existing roads of about 17 km is made in the project costs provisions. The provision of side drains depends on the nature of formation viz independent or integrated with existing IR track. Concreted side drains (about 165 km in length) are proposed of 900 mm width (with 600 mm bottom width and 1v:2h slope) in the gully like formation formed in between two embankment. Non concrete ditch of 900 mm width with 1:2 slopes is proposed on either side in the remaining part of alignment.

Tree plantation: no specific land is alloted for tree plantation. The land acquisition has been planned chainagewise to fit the cross section. Looking at the available RoW it is concluded that there is requirement of marginal land acquisition in the parallel section. This land acquisition is mainly for constructing the side drain and available space after constructing drain will be utilised for tree plantation. Suitable land will be identified for tree plantation during project implementation. There are possible options like planting trees on other available land of Railways near stations or other locations for bridging the gap between available and requisite land for tree plantation.

Fencing and barricading: provision in the design is made for appropriate fencing of platforms (about 9 km length) and no barricading is planned in open area.

Railway structure relocation: four major stations will require demolitions and reconstruction as given below:

Meerut Cant Station: The flush butt welding plant to be demolished

Sharanpur Station: Railway quarters and store to be demolished (relocated),

Khanna station: DFCCIL runs north side of Khanna Station requiring existing goods sidings removal and platform reconstruction.

Jagadhri workshop station: Clearance of special structures required.

As per ADB PPTA consultants estimate four each of station and goods facilities will require relocation, as well as remodelling 13 yards, and 7100 sq meter of service buildings.

Utilities shifting: The project of this magnitude will involve shifting of various common utilities like electrical lines (HTL/LTL), transformers, and water supply lines. The utilities to be shifted with detailed shifting plan for each of the utilities is under preparation for the project, which will be shifted in consultation with concerned stakeholders.

Physical cultural resources shifting*:* about 39 such structures are likely to be shifted due to the construction of EDFC. Details of the same are given in further sections.

Figure 3.3 : Earthwork Profile Double Independent Line (schematic diagram)

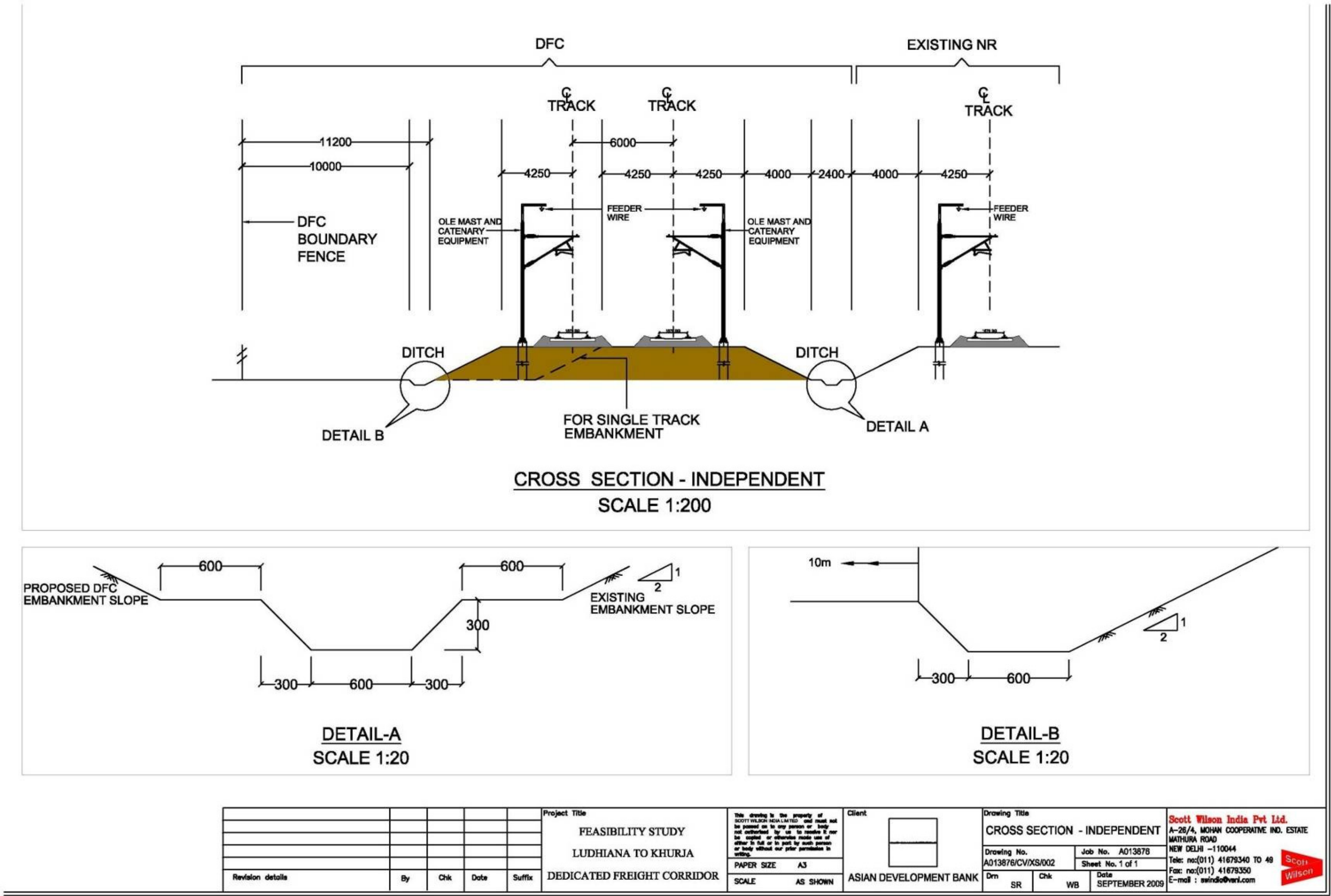
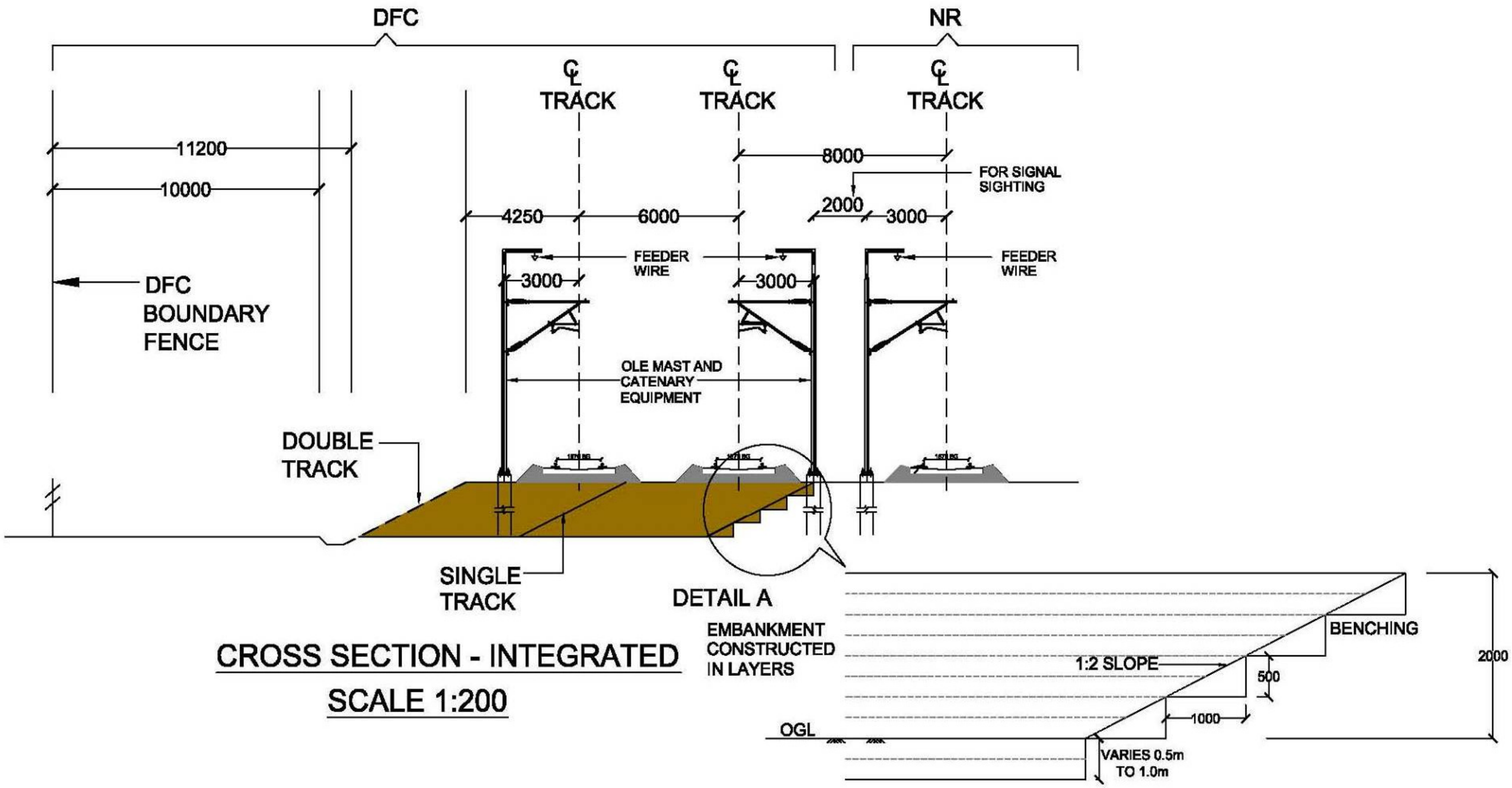


Figure 3.4 : Earthwork Profile Widening to Double Integrated line (schematic diagram)



3.3.8. Water Requirement

The water requirement for formation, other construction activities, and domestic purposes will be met from ground sources primarily. No specific water requirement details are yet available. However, as per estimate of earlier project of similar nature, about 3600 kL/day per km of water is required. The construction period is likely to spread for five years; the average per day water requirement is estimated to be of the order of 1000 kld per day at construction camp and construction sites. Since the alignment passes through over exploited, critical or semi critical area from ground water availability perspective, the prior permission from central ground water authority may be required.

3.3.9. Land Requirement

The EDFC will be constructed primarily on the available land along the existing track of ir. However, additional land 648.38 hectares will be acquired for the same. The private and Government land acquisition requirement is given below:

S. No.	Section	Private Land (Ha)	Government Land (Ha)	Total Land (Ha)
Total	Khurja-LDH	536.33	112.05	648.38

3.3.10. Junction and Crossing Stations

A junction station needs facilities of connecting tracks to/from feeder lines, auxiliary main tracks and sidings for such purpose, i.e. For trains to wait to adjust time, for crews and locomotives to change, to refuel and to uncouple/couple trains when trains corresponding to 1,500 m effective track length have to operate. The list of junctions and crossing stations are given in **Annexure- 3.2.**

Five junction stations are proposed at Khurja, Kalanaur, Rajpura and Sirhind. The purpose and interconnections proposed at these junctions are briefed at **Table 3.7.**

Table 3.7 : Junction Stations Location and Purpose

S. No.	Junction Station	Interconnections
1.	Khurja	A major Power Plant is coming up at Chola station (at about 15 kms West of Khurja Jn.). An arrangement for movement of rakes from DFC to Chola and vice versa had, therefore, to be planned. Hence it is proposed to provide a connection from DFC running from Khurja to Ludhiana just after crossing the main lines via a Fly Over at Khurja to Chola. This connection will, thus, be running on North side of the main line route.
2.	Kalanaur	The traffic to be transferred at Kalanaur consists of • Coal traffic to Yamunanagar powerhouse which is coming up on the side of the existing down line and return empties, for which number of trains of 25 tonne axle load wagons are 3 per day on an average. • Traffic to Chandigarh on Ambala-Kalka line, as the corridor takes a detour at Ambala and the return empties for which the traffic is about 1 train per day.
3.	Rajpura	The main traffic that has to be transferred from the

S. No.	Junction Station	Interconnections
		corridor here is for powerhouse and fertilizer coal to stations on Rajpura-Bhatinda section and food grains and BOXN empties in the reverse direction. The number of trains to be transferred is about 3.5 trains per day. The Rajpura-Bhatinda section is a single line section and takes off from the existing lines on the same side as that of corridor. Hence the single line corridor will be connected to the Rajpura-Bathinda line directly. Moreover, it has not been found possible to provide connectivity between the corridor and the existing lines at Sirhind. The traffic to Mandi-Gobindgarh is proposed to be transferred to the existing lines at Rajpura for onward movement.
4.	Sirhind	The traffic that has to be transferred from the corridor at Sirhind is Coal for Ropar powerhouse, Nangaldam fertilisers and on public account on Sirhind- Morinda-Una section, a single line section, and the number of trains to be transferred are about 4.5 trains per day. The corridor crosses the existing lines after Sirhind and will run along the existing lines on the Northern side, i.e. on the same side of the existing lines as is the Sirhind-Morinda-Una section. Hence there will be a direct connection from the corridor to the section. Therefore, it is recommended that the single line corridor may be connected to the existing line by a surface cross over.
5.	Sahnewal	The terminal station of DFCC is at Jaspalon i.e. about 13.29 Km, 21.11 Km &28.4 Km from Sahnewal, Dhandari Kalan & Ludhiana respectively.These are the major goods handling stations of Northern Railway in Punjab region. Thus, connection to Northern Railway is required. The nearest station to DFCC terminal is Sahnewal. A single line connection from Jaspalon terminal of DFCC to Sahnewal (Northern Railway) shall be constructed to despatch/receive goods traffic of IR. This line will further fetch services to Jammu (J&K), Amritsar, etc.

Crossing stations are provided to facilitate safe and smooth movement of train from both the direction. The crossing station of about 2000 m length is proposed to be provided at every 10 km of the alignment.

3.3.11. Grade separation/Rail over Rail Flyover

To eliminate flat junctions and to minimise the adjacent Indian Railways network operations impacting on those of the freight corridor and vice versa, rail over rail flyover at 6 locations are provided in Figure 3.5(a,b,c,d,e). The grade separator cum rail-over-rail flyovers is likely to be multi-span viaducts crossing not only other rail routes but other obstructions in close proximity such as nalas and highways. The details of the same are given below:

At Hapur, where the DFC passes over the Delhi to Moradabad stretch, the rail-over-rail flyover crosses main line and an adjacent nala approximately 2 km west of Hapur Junction.

At Meerut, to provide grade separation, to allow the corridor (rail-over-rail flyover) to cross the Delhi (Ghaziabad) to Meerut main line railway.

At Tapri, where the corridor (rail-over-rail flyover) crosses the Delhi to Tapri single line (branch line) railway.

At Ambala cantt, to allow the corridor (rail-over-rail flyover) to cross the Delhi to Ambala main line railway.

On the south approach to Rrajpura (rail-over-rail flyover), to allow the corridor to pass over National Highway NH1 and to cross the existing Delhi to Ludhiana rail line

Finally, at sirhind, the corridor (rail-over-rail flyover) passes over the existing rail branch line and main line.

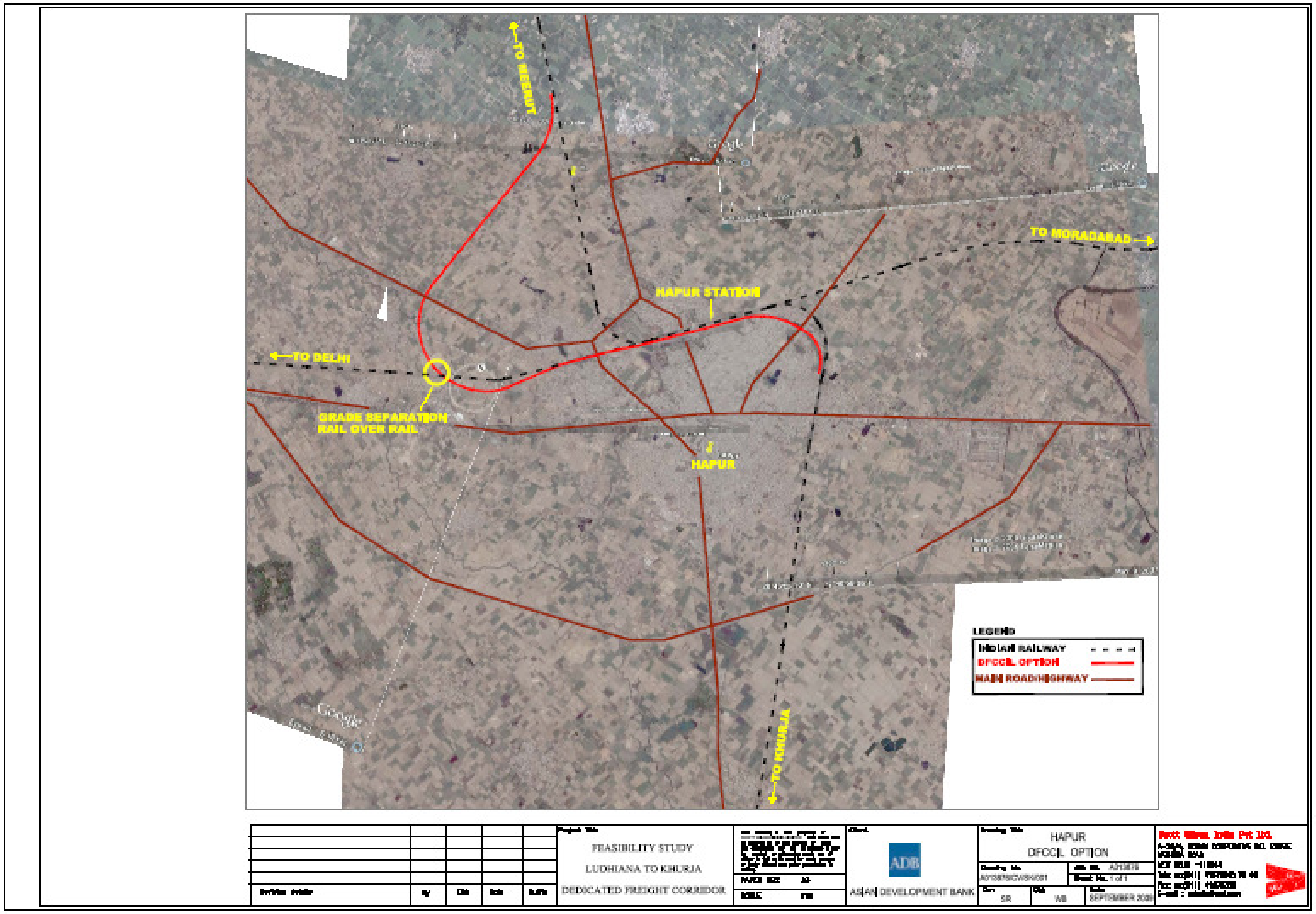


Figure 3.5 : (a) Grade Seperation / Rail Over Rail Flyover Locations at Hapur

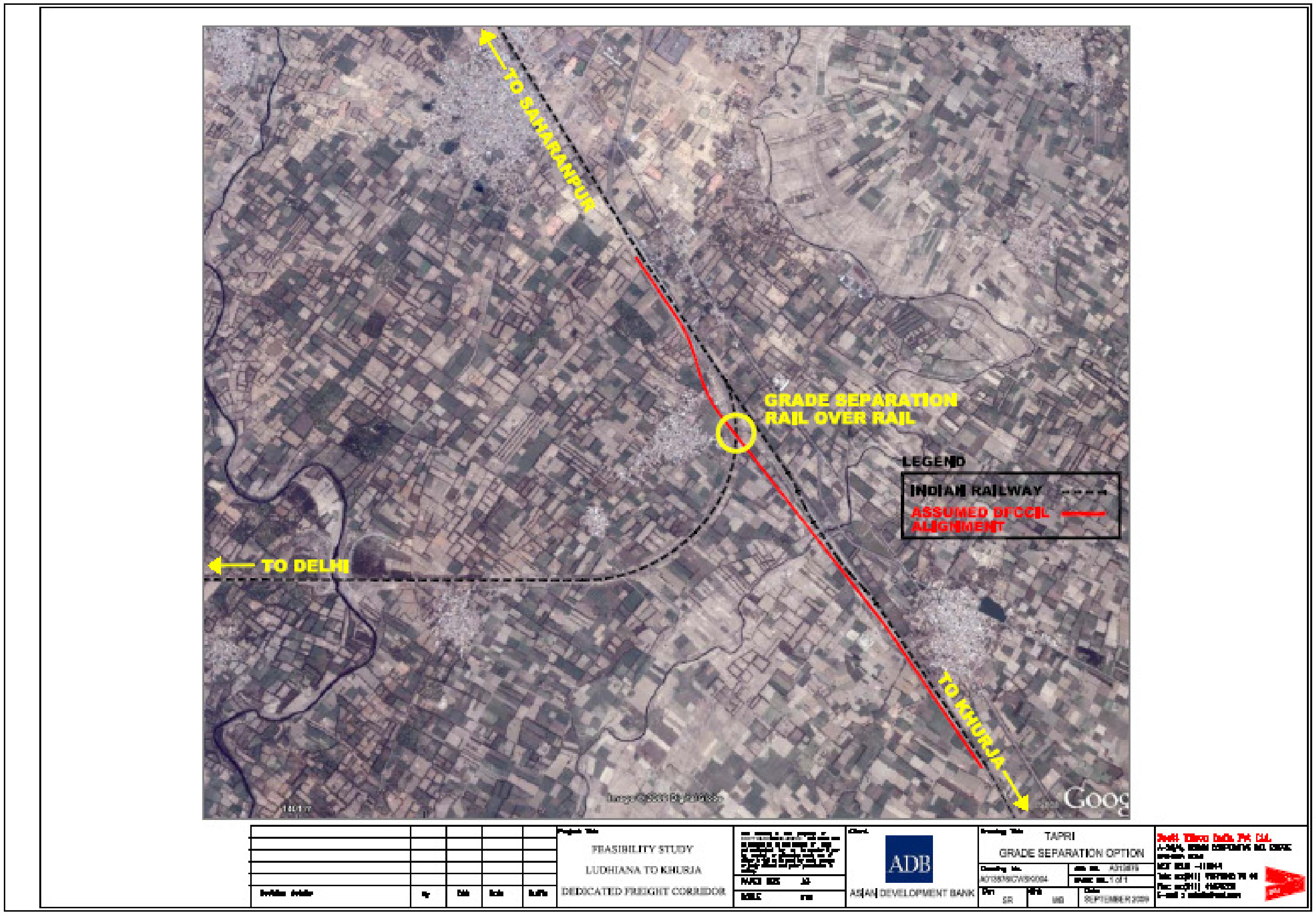


Figure 3.5: (B) Grade Seperation / Rail Over Rail Flyover Locations At Tapri

Figure 3.5: (C) Grade Seperation / Rail Over Rail Flyover Locations At Ambala

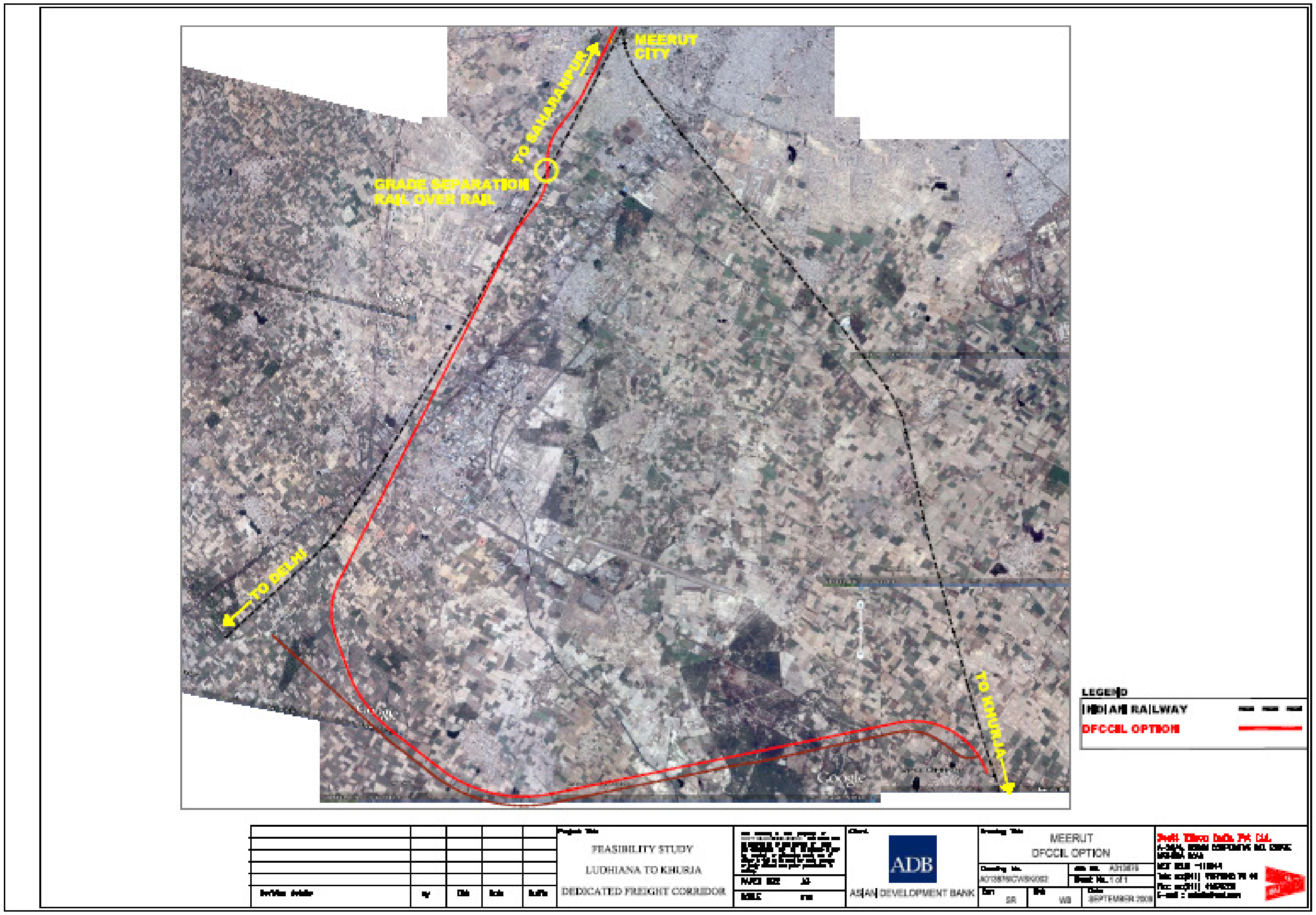


Figure 3.5: (D) Grade Separation / Rail Over Rail Flyover Locations At Meerut

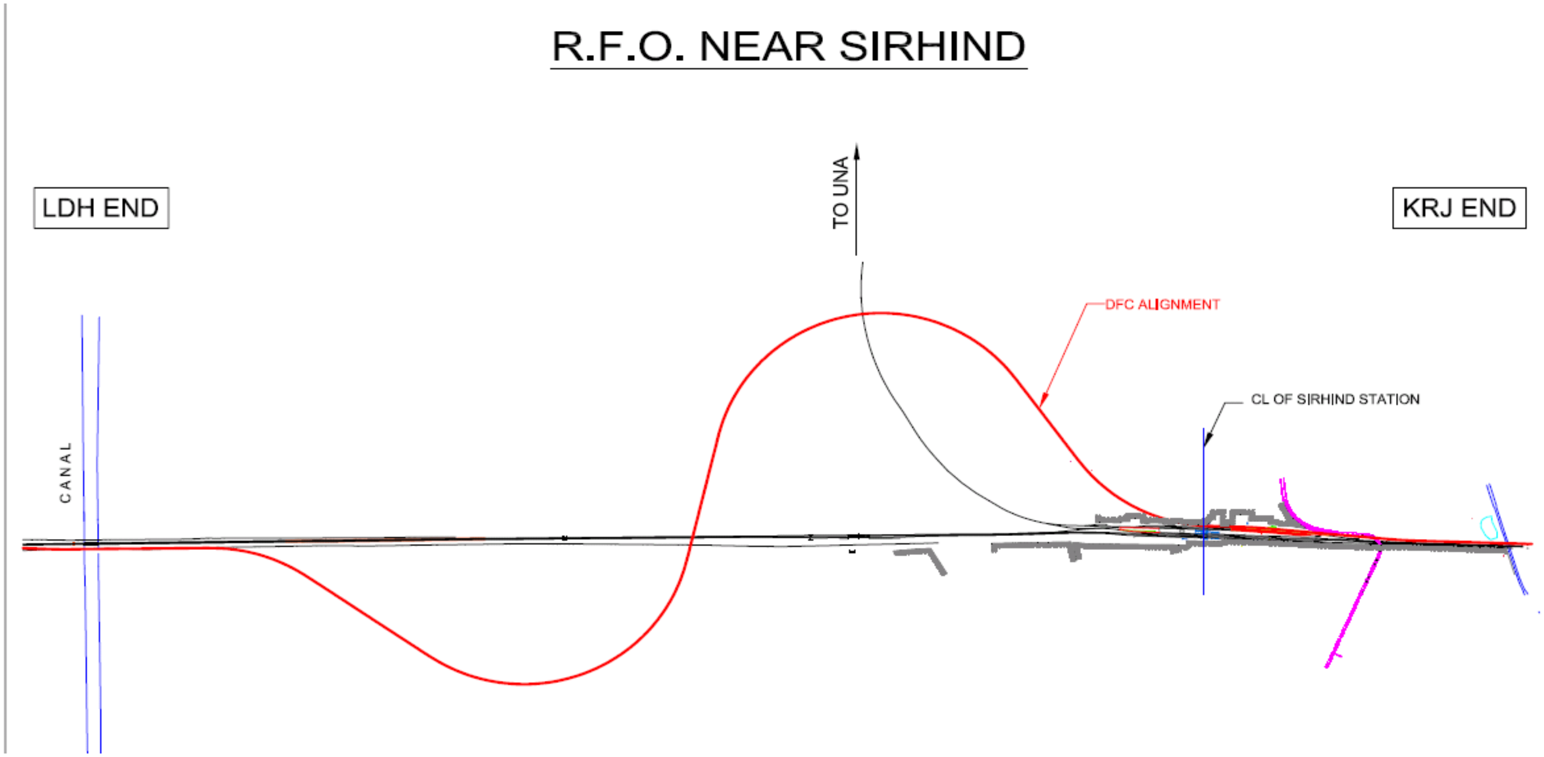


Figure 3.5: (E) Grade Seperation / Rail Over Rail Flyover Locations At Sirhind

3.3.12. Yards/Depots

The proposed locations for maintenance depots are km 80, km148, km 191, km 280 and km 346. However, it is recommended by consultants that further consideration is to be given to make the distances covered by depot uniform, as far possible, as the distance between the second and third depot is very short. The suggested locations are km 220, km 300 and km 346.

3.3.13. Crew Changing Points

At an average speed of 50 km per hour, a train can run 480 km in 10 hours on the double line. At the same time, as the trains mostly originate and terminate on the existing routes, the crew changing should cater to such movement. Crew changing also has to be arranged at the points where crew can be based or where running rooms are available or can be made available. Taking these factors into account, the crew originating/ changing points are proposed at Khurja and Kalanaur along this alignment.

3.3.14. Level Crossings

There are 196 level crossings in the entire section of the proposed corridor making it roughly one level crossing every 2 km. The location, chainage, tvus and type of crossings is given at appendix 3.3. The detours are planned such that no level crossing is required. High elevation of embankment and provision of underpasses has been proposed to eliminate the need of level crossings.

The existing guidelines of Indian Railways prescribe that a level crossing be replaced by a road over bridge (RoB) or a road under bridge (RuB) where traffic vehicle units (TVU's) are more than 100,000.

Some 76 level crossings are required to be upgraded to a higher classification based on the railway board's norms and existing tvus. There are 23 unmanned level crossings. In a high speed freight corridor route, keeping such unprotected level crossings is not desirable. These either have to be closed or manned and provided with other technological system to ensure safety and smooth operations. There are 11 level crossings with tvus of less than 1500, which could be considered for closure.

Of these, based on the criterion that any level crossing with more than 50,000 TVUS is to be replaced by a ROB or RUB, 97 level crossings are to be replaced. It will be necessary therefore for all of the existing level crossing gates to be planned for interlocking until formal replacement by RoB. The chainage wise locations of rail crossings have been given in **Annexure-3.3**.

3.3.15. Bridges Structures

Many important, major, minor bridges, rubs, robs, pedestrian underpasses, foot over bridges are required to be constructed for this section of EDFC. The summary of these requirements are given below:

Table 3.8 : Summary Bridges Structure Detail

Structure type	Number
Important Bridges	7
Minor Bridges	449
Major Bridges	61
ROBs	
a) ROBs under construction	15
b) ROBs required as per Norms	82
c) ROBs required at DFCCIL Stations	17
RUBs	45

Structure type	Number
Pedestrian underpasses	42
Footbridges	10
Existing ROB alterations	5

Source: Feasibility Report

Minor bridges: there are 449 minor bridges. Generally, all minor bridges are proposed of concrete box. As the bearing strata at shallow depths is weak and bearing capacity is low, this form of construction, spread footings should be adequate provided the hydraulic requirements are met when passing over a water course, river or canal. However, some of these minor bridges are currently pipes and the new works could be constructed of steel pipe of adequate diameter to meet the hydraulic requirements for each individual structure. This option would be quicker and easier to install.

Important and major bridges: there are 61 major structures and 7 important structures along the route. These structures are constructed in various forms: warren truss, plate girder and precast concrete beams. A number of the major bridges are flood relief spans and are located along the entire length of the route. The remainder span canals and river courses. The chainagewise locations of minor bridges, major bridges and important bridge structures on rivers (Yamuna, Markanda and Tangari) are given in **Annexures-3.4, 3.5 and 3.6** respectively.

Most civil structures on Indian Railways today carry the rail tracks directly on the superstructure otherwise known as direct fastening. It is a common practice internationally for the track to be supported on ballast over rail carrying structures to give a smoother ride, ease track maintenance and to reduce noise emanating from passing rail traffic.

RoB and RuBs: A total of 82 ROBs are required as per norms. 15 RoBs are already under construction. 17 ROBs are required at DFCCIL stations. About 5459 sq. M of land area is required for one ROB. 43 new RuBs are proposed, mostly at detours or grade separation approach. The chainage wise locations of RoBs and RUBs are given in **Annexures 3.7** and **3.8** respectively.

3.3.16. Signalling

Automatic block signalling with spacing of stations every 40 km for the double line portions (821 km) of the corridor between Khurja to Sonanagar. For the single line section, proposals are for three line crossings stations at every 10 km between Khurja and Sanehwal with absolute block working between the stations for train operations. The proposed signalling scheme is in conformity with the current practices of Indian Railways.

A standard signalling plan is prepared by DFCCIL for a three line crossing station with the following features:-

The signalling system caters to double distant signals as per the current policy followed by Indian Railways.

Universal simultaneous reception facilities on both sides of the loop line are proposed.

Two sidings 160.0m long, connected with a hot axle siding, should be provided on either side of the station.

The points between the siding and hot axle siding are proposed to be hand operated.

The proposed loop length is 695 m from starter to starter, 750 m from starter to fouling mark for main line and 750 m for loop lines.

The layout has considered extension of loop lines to 1500 m in the future to cater for longer length trains.

Block proving by axle counters has been included.

Electronic interlocking has been proposed with a distributed system.

Track circuiting of the station yard is proposed with aftc/axle counters.

Calling on signals are proposed on reception signals to receive trains in case the berthing tracks are occupied or due to failure of track circuits.

All level crossings are proposed to be power operated with facility for hand generator.

3.3.17. Traffic control system

DFCCIL has planned to provide Train Management System (TMS) in central location to monitor the movement of all the trains as well as monitor various maintenance parameters like equipment failure, drivers passing signal at danger, providing maintenance block. The centralised traffic control will have facility for computer based planning. Auxiliary Warning System is also proposed by adb ppta for the safety of train movement and driver’s safety. An overview of Traffic Control System is given at **Figure 3.6.**

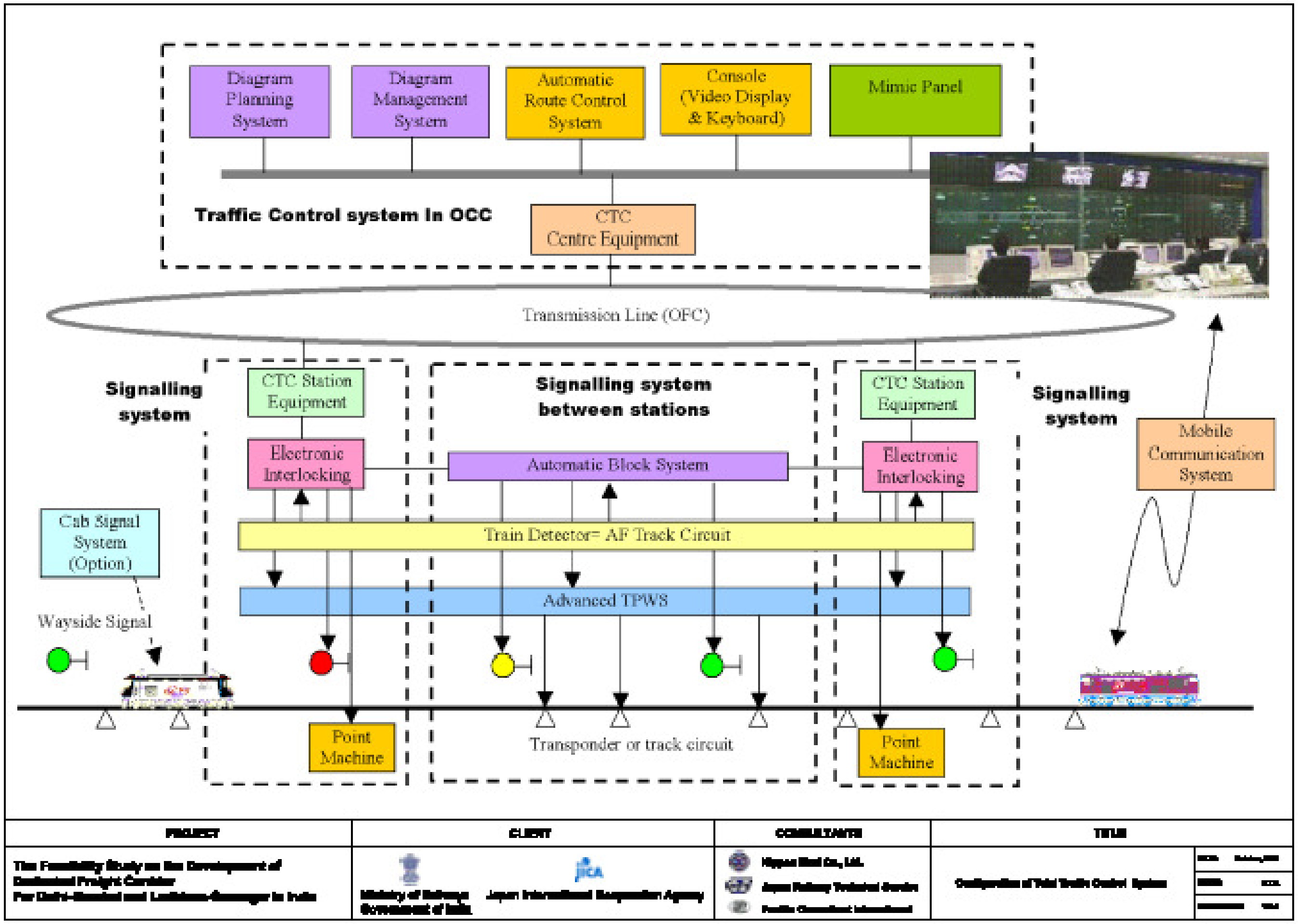


Figure 3.6 : Traffic Control System of the DFC

3.3.18. Telecommunication

Two 24 Fibers Optical Fibre Cables (OFC) as per Indian railway standards are proposed on either side of DFCCIL railway line. OFC is to be laid in HDPE pipe for better protection by the side of DFCCIL track. Along with OFC on one side, six quad communications should be laid. This can cater for provision of emergency socket at every kilometer and at every IC gate. It will also cater to gate telephone circuit connected to nearest station and from there to the CTC. A 2000 line telephone exchange at Ambala also proposed at control office.

3.3.19. Electrification

The electrification systems are proposed as per mor and dfccil orders. MoR has approved adoption of a 2x25 kV electric traction system with 60 mva transformers spaced at 60 km apart on dedicated freight corridors. The major ohe maintenance depot at every 60 km and minor depots at every 30 km are proposed. OHE will be basically the same as that of conventional system with return conductor. In 2x25 kV feeder wire runs through the entire length of the section on super mast in place of return conductor. The proposed design of OHE works are in line with standard practices. The system permits use of conventional locomotives designed for a 25 kV conventional system. It also permits easy crossover movement from the conventional 25 kV system to the 2x25 kV systems. Voltage profile ranges between 22.5 to 27.5 kV as against 18.4 kV to 29.99 kV on conventional 25 kV systems, average power factor is very high and specific energy consumption is much less. All power supply equipment is remote controlled from a centralised place in Indian railway through a supervisory control and data acquisition system.

Power supply for non- traction purposes: it is drawn from state power supply authorities or OHE. Local power supply connections will be taken from state electricity authorities and OHE supply for signalling through 25 kV/230 V single phase. Two auxiliary transformers will be installed at each station for colour lighting.

Maintenance infrastructure for electric locomotive: as per mor letter dated 25.09.06 no rolling stock maintenance facility is planned under DFC .

3.3.20. Residential Facilities and Labour Camps

The staff quarters are proposed to be constructed at each of crossing or junction stations itself.

The construction camps are likely to be set up at every major bridge construction location or on an average at each 50 km.

3.4. Construction Material Source

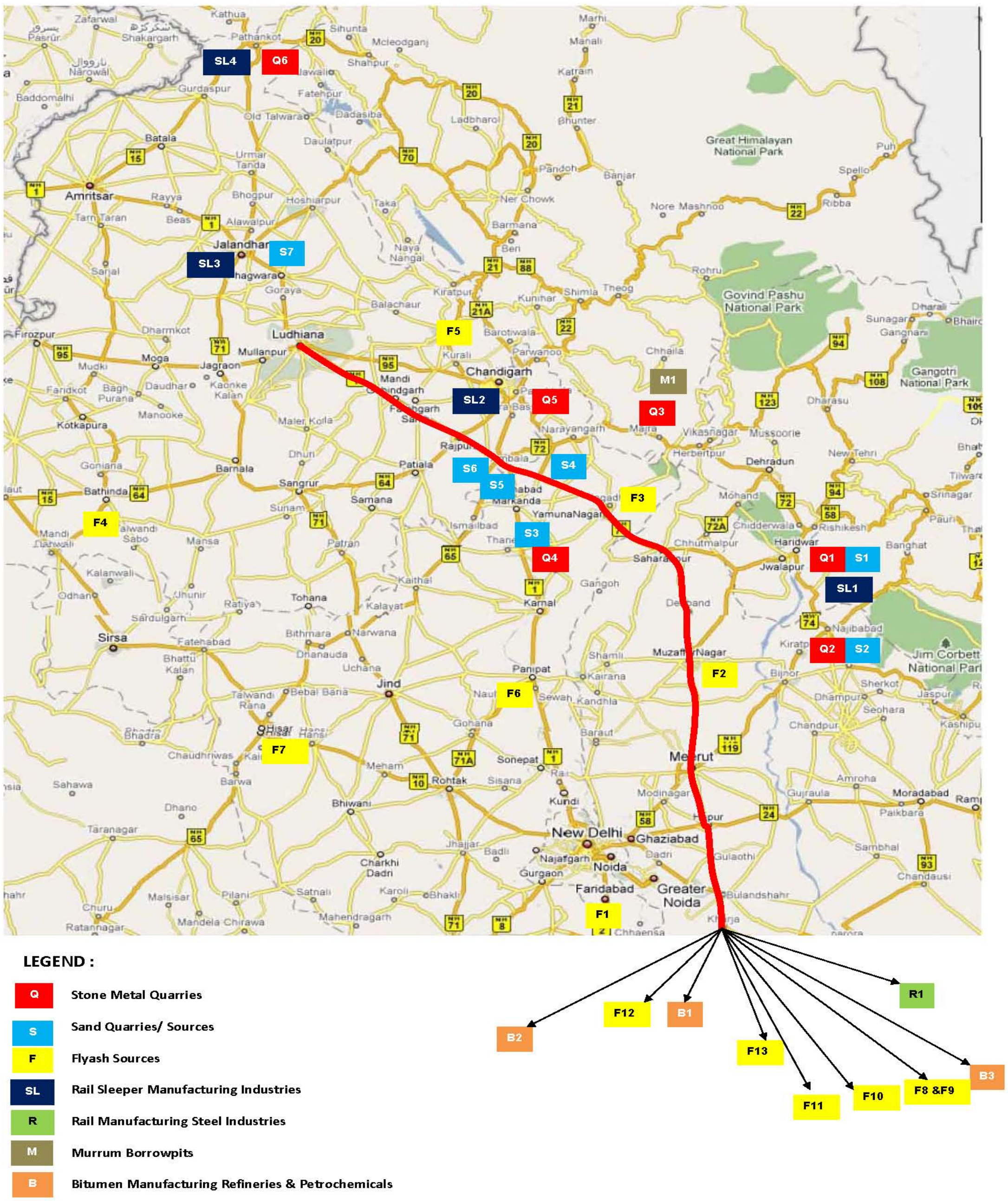
The main construction material required for the project is earth material, cement, ballast, stone chips and sand etc. Most of these materials are locally available. Earth will be borrowed preferably from government wasteland or private non-agricultural land. The availability of waste land is limited to the 15 km radius of entire stretch. Attempt has been made to identify the probable earth sources using GIS and ground truthing techniques and the same is detailed in chapter 5 of this report. Stone chips/ ballast will be procured from licensed quarries units nearby. Cement will be procured from suitable sources. These sources will be identified during the project implementation. Sand will be obtained from different river beds present along and nearby the project area. A list of construction materials sources with distance from railway line is given in **Annexure 3.1 and Figure 3.7**.

3.5. Project Implementation Schedule and Cost

The project is likely to be completed in about 4 year’s time.

Figure 3.7 : Key Map Showing Construction Material Sources

KEY MAP OF LUDHIANA TO KHURJA SHOWING MATERIAL SOURCES



Annexure- 3.1: Major construction Materials, its Source and Distance

S. No	Quarry / Source No.	Name of Quarries / Sources	DFC Chainage (Km)	Location	Lead Distance (Km)
		STONE METAL QUARRIES			
1.	Q 1	Haradwar Ganga River Stone Bouldary Source on RHS is located at a distance of 60.00 km from Project DFC	261.930	Ambala City	60.00
2.	Q 2	Nazizabad Ganga River Stone Bouldary Source on RHS is located at a distance of 110.00 km from Project DFC	180.790	Shaharanpur City	121.00
3	Q 3	Deodhar Stone Metal Quarry on RHS is located at a distance of 60.00 km from Project DFC	269.480	Ambala City	60.00
4.	Q 4	Jagadhari Stone Metal Quarry on LHS is located at a distance of 10.00 km from Project DFC	210.930	Jaghadhari Town	10.00
5.	Q 5	Ghaggar Stone Metal Quarry on RHS is located at a distance of 10.00 km from Project DFC	269.480	Ambala City	10.00
6.	Q 6	Patthankot Stone Metal Quarry on LHS is located at a distance of 171.00 km from Project DFC	375.560	Ludhiana City	171.00
		SAND SOURCES			
1.	S 1	Haradwar Ganga River Sand Source on RHS is located at a distance of 60.00 km from Project DFC	261.930	Ambala City	60.00
2.	S 2	Nazizabad Ganga River Sand Source on RHS is located at a distance of 110.00 km from Project DFC	180.790	Shaharanpur City	121.00
3.	S 3	YamunaNagar Yamuna River Sand Source on LHS is located at a distance of 2.00 km from Project DFC	204.560	Kalanoor City	2.00
4.	S 4	YamunaNagar Yamuna River Sand Source on LHS is located at a distance of 2.00 km from Project DFC	204.560	Kalanoor City	2.00
5.	S 5	Tandawal Markanda River Sand Source on LHS is located at a distance of 2.00 km from Project DFC	242.560	Tandwal City	2.00
6.	S 6	Dukheri Tangri River Sand Source on LHS is located at a distance of 2.00 km from Project DFC	254.450	Dukheri Town	2.00
7.	S 7	Ambala Ghaggar River Sand Source on LHS is located at a distance of 2.00 km from Project DFC	269.480	Ambala Town	2.00
8.	S 7	Sutlej River Sand Source on RHS is located at a distance of 30.00 km from Project DFC	375.560	Ludhiana	30.00

FLY ASH SOURCES					
1.	F 4	Fly Ash Producing Guru Nanak Thermal Power Plant, located near Bathinada, Punjab state	375.00 km	Ludhiana	146.00 km
2.	F 5	Fly Ash Producing 100 MW Thermal Power Plant, located near Rupar Town, RupaNagar District, Punjab state	289.840	Rajpura	80.00 km
3.	F 6	Fly Ash Producing Panipat Thermal Power Plant, located in village assan, jind road, Panipat, Haryana	269.480	Ambala	108.00
4.	F 7	Fly Ash Producing Rajiv Gandhi Thermal Power Plant, located in village Khedar, Hissar, Haryana	269.480	Ambala	196.00km
5.	F 3	Fly Ash Producing Dheenabandhu Choturam Thermal Power Plant, located on NH -73 – Kalanoor Road, Near YamunaNagar on RHS is located at a distance of 2.00 km from Project DFC	204.560	Kalanoor	2.00
RAIL SLEEPER MANUFACTURING INDUSTRY					
1.	SL 1	Rail Sleeper Manufacturing Industry at Haradwar City is located at a distance of 60.00 km from Project DFC	261.930	Ambala City	60.00
2.	SL 2	Rail Sleeper Manufacturing Industry at Chandigarh City is located at a distance of 36.00 km from Project DFC	289.840	Rajpura City	36.00
		Rail Sleeper Manufacturing Industry at Chandigarh City is located at a distance of 30.00 km from Project DFC	269.480	Ambala City	30.00
3.	SL 3	Rail Sleeper Manufacturing Industry at Jalandhar City is located at a distance of 60.00 km from Project DFC	375.650	Ludhiana City	60.00
4.	SL 4	Rail Sleeper Manufacturing Industry at Patthankot City is located at a distance of 171.00 km from Project DFC	375.650	Ludhiana City	171.00
RAIL MANUFACTURING STEEL INDUSTRIES					
1.	R 1	Bhilai Steel Plant (A subsidiary of SAIL), Bhilai, Chattishghad	375.650	Ludhiana	1500.00

Annexure- 3.2 : List of Junctions and TrainStations

		SL. NO.		DFCCIL PREFERRED CROSS STATION LOCATION START	DFCCIL END	LENGTH	SWR CHAINAGE START	SWR CHAINAGE END	INTERSTATIONS DISTANCES (Km) C-C	No.	PROPOSED 25KM CROSSING STATIONS CENTRE CHAINAGE START 2km only	PROPOSED 25KM CROSSING STATIONS CENTRE CHAINAGE END	INTERSTATIONS DISTANCES (Km) C-C	NAME OF STATIONS	BETWEEN EXISTING Rly. STATIONS	TYPE OF STATIONS
MEERUT		1	10.00	8.40	10.90	2.50	8.40	10.90		1	12.20	14.20			Khurja City - Maman	Crossing Station
		2	20.00	18.83	21.33	2.50	18.83	21.33	10.43				22.85		Maman- Bulandshahr	Crossing Station
		3	30.00	25.70	28.20	2.50	25.70	28.20	6.87	2	35.60	37.60			Bulandshahr- Baral	Crossing Station
		4	40.00	37.57	40.07	2.50	37.57	40.07	11.87				20.45		Chhaprawat Halt- Gulaothi	Crossing Station
		5	50.00	46.56	49.06	2.50	46.56	49.06	8.99	3	56.80	58.80			Hirdayapur Kurana Halt-	Crossing Station
		6	60.00	56.89	59.39	2.50	56.89	59.39	10.33				20.60		Hafizpur- Hapur Jn.	Crossing Station
		7	70.00	68.65	71.15	2.50	72.59	75.09	15.70						Hapur Jn. Kali	Crossing Station
		8	X'S ADDED ON MEERUT DETOUR	78.15	80.65	2.50	82.09	84.59	9.50	4	78.15	80.15			Meerut Detour	Crossing Station
			CHAINAGE AT MEERUT CITY CHANGES FROM Km. 92.75 TO Km. 67.17 TOWARDS SAHARANPUR													
		9	80.00	56.75	59.25	2.50	93.79	96.29	11.70				26.85		Gazibad - Meerut	Crossing Station
		10	90.00	68.00	70.50	2.50	105.04	107.54	11.25	5	105.00	107.00			Gazibad - Meerut	Crossing Station
		11	74.00	79.00	81.50	2.50	116.07	118.57	11.03				26.00		Meerut Cantt. - Pabli Khas	Crossing Station
		12	84.00	88.00	90.50	2.50	125.073	127.57	9.00						Daurala- Sakhoti Tanda	Crossing Station
		13	94.00	94.00	96.50	2.50	131.07	133.57	6.00	6	131.00	133.00			Sakhoti Tanda - Khatauli	Crossing Station
		14	104.00	105.95	108.45	2.50	143.02	145.52	11.95				22.20		Khatauli- Mansurpur	Crossing Station
		15	114.00	118.67	121.17	2.50	155.74	158.24	12.72	7	153.20	155.20			Mansurpur - Jarauda Nara	Crossing Station
		16	124.00	130.60	132.88	2.28	167.67	169.95	11.93				26.80		MuzaffarNagar - Baman Hari	Crossing Station
		17	134.00	138.95	140.98	2.03	176.02	178.05	8.35	8	180.00	182.00			Baman Hari- Rohana Kalan	Crossing Station
		18	144.00	148.06	150.12	2.06	185.13	187.19	9.11				25.00		Rohana Kalan - Deoband	Crossing Station
LUDHIANA	1	19	154.00	159.50	161.60	2.10	196.57	198.67	11.44						Deoband - Talheri Buzurg	Crossing Station
	2	20	164.00	168.90	171.10	2.20	205.97	208.17	9.40	9	205.00	207.00			Nangal - Tapri Jn.	Crossing Station
			174.00	NOT REQUIRED											Tapri Jn.- Saharanpur	Crossing Station
	3	21	184.00	183.00	185.15	2.15	220.07	222.22	13.15				23.00		Saharanpur - Pilkhani	Crossing Station
			188.40				225.47		3.25					Pilkhani Junction	Pilkhani	Junction Station
	4	22	194.00	190.85	193.35	2.50	227.92	230.42	6.95	10	228.00	230.00	12.00		Sarsawa - Kalanaur	Crossing Station
	5	23	204.56	203.10	205.00	1.90	240.17	242.07	11.00	11	240.00	242.00		Kalanaur		Junction Station & Crossing Station
	6	24	214.00	216.35	218.85	2.50	253.42	255.92	12.60				26.00		Jagadhri - Jagadhri Workshop	Crossing Station
	7	25	223.00	224.10	226.85	2.75	261.17	263.92	6.50	12	266.00	268.00			Darazpur - Mustafabad	Crossing Station
	8	26	233.00	233.35	235.85	2.50	270.42	272.92	7.75				26.20		Mustafabad - Barara	Crossing Station
	9	27	242.00	245.1	247.60	2.50	282.17	284.67	10.50						Barara - Tandwal	Crossing Station
	10	28	252.00	254.90	257.10	2.20	291.97	294.17	8.55	13	292.20	294.20	Move		Kesri - Dukheri	Crossing Station
		29	261.00												Dukheri- Ambala Cantt.	Crossing Station
	11	29	270.00	266.00	268.50	2.50	303.74	306.24	10.82				25.30		Ambala City - Sambhu	Crossing Station
	12	30	280.00	279.70	282.20	2.50	317.44	319.94	10.25	14	317.50	319.50			Sambhu - Rajpura	Crossing Station
	13	31	289.84	291.20	293.70	2.50	328.94	331.44	9.00				22.50	Rajpura		Junction Station & Crossing Station
			292.00											Rajpura Crossing	Rajpura	Crossing Station
			298.00							15	340.00	342.00			Rajpura- Sarai Banjara	Crossing Station
	14	32	306.00	307.00	309.10	2.10	344.74	346.84	13.30				24.60		Sarai Banjara - Sadhoogarh	Crossing Station
			311.00											Sirhind	Sirhind	Crossing Station
			315.22											Sirhind		Junction Station
	15	33	326.00	321.60	324.10	2.50	360.51	363.01	13.67	16	364.50	366.50			Mandi Gobindgarh - Khanna	Crossing Station
	16	34	336.00	336.60	339.08	2.48	375.51	377.97	12.50				23.50		Khanna - Chawapail	Crossing Station
	17	35	347.00	345.90	348.50	2.60	384.81	387.41	6.84	17	388.00	390.00			Chawapail - Doraha	Crossing Station
			357.00										10.00		Doraha-Sanehwal	Crossing Station
			360.54				398.54		11.13	18	398.00			Sanehwal	Sanehwal	Terminal Station

Annexure- 3.3 : Level Crossing Details

Khurja-Talheri Section

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
					Un-Man-ned	Man-ned	Inter-Locking		
1	2/C/E	3 /5-6	KHURJA Jn.	KHURJA City	UM			516	**RUB planned**
2	3/C/E	4/8-9	KHURJA Jn.	KHURJA City	UM			1464	
3	4/C/E	5/4-5	KHURJA Jn.	KHURJA City	UM			504	
4	5/B/T	7/1-2	KHURJA City	MAMAN		M	1	112176	
5	6/C/E	7/8-9	KHURJA City	MAMAN	UM			4620	
6	7/C/T	7/21-8/1	KHURJA City	MAMAN		M		11820	
7	8/A/E	11/2-3	KHURJA City	MAMAN		M	1	194590	
8	9/C/E	12/1-2	KHURJA City	MAMAN	UM			11580	
9	10/C/E	15/3-4	KHURJA City	MAMAN		M		11280	
10	11/C/E	18/4-5	KHURJA City	MAMAN		M		40800	
11	12/C/E	20/15-21/0	KHURJA City	MAMAN		M		1608	
12	13/B/T	23/0-1	BULANDSAHAR	BARAL		M	1	112518	
13	14/C/T	24/0-1	BULANDSAHAR	BARAL		M		27706	
14	15/A/E	24/10-11	BULANDSAHAR	BARAL		M	1	261436	
15	16/B/E	26/6-7	BULANDSAHAR	BARAL		M	1	56602	
16	17/C/E	28/3-4	BULANDSAHAR	BARAL		M		17990	
17	18/C/E	30/3-4	BULANDSAHAR	BARAL		M		20958	
18	19/C/E	31/2-3	BULANDSAHAR	BARAL		M		10416	

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
19	20/C/E	32/5-6	BULANDSAHAR	BARAL		M		14084	
20	21/C/T	35/10-11	BULANDSAHAR	BARAL		M		14322	
21	22/C/E	37/11-12	BARAL	GULAOTI	UM			2338	
22	23/C/E	39/10-11	BARAL	GULAOTI		M		43358	
23	24/C/E	41/6-7	BARAL	GULAOTI		M		21700	
24	25/C/T	44/10-11	GULAOTI YARD			M		24822	
25	26/B/T	45/5-6	GULAOTI	HAFIZPUR		M	1	80948	
26	27/C/E	46/13-14	GULAOTI	HAFIZPUR		M		16884	
27	28/C/E	48/5-6	GULAOTI	HAFIZPUR	UM			4200	
28	29/C/E	49/7-8	GULAOTI	HAFIZPUR		M		8260	
29	30/C/E	51/5-6	GULAOTI	HAFIZPUR		M		13440	
30	31/C/E	52/10-11	GULAOTI	HAFIZPUR	UM		NO	126	
31	32/C/T	53/7-8	GULAOTI	HAFIZPUR	UM			13384	
32	33/C/T	53/14-15	GULAOTI	HAFIZPUR		M		6860	
33	34/C/T	55/2-3	HAFIZPUR	HAPUR	UM			12540	
34	35/C/E	56/4-5	HAFIZPUR	HAPUR		M		15180	
35	36/C/E	58/11-12	HAFIZPUR	HAPUR	UM			1184	
36	37/C/E	59/11-12	HAFIZPUR	HAPUR		M		73730	
37	38/C/E	60/6-7	HAFIZPUR	HAPUR	UM			1713	
38	39/A/E	60/14-15	HAFIZPUR	HAPUR		M	1	673282	
39	40/C/T	62/3-4	HAFIZPUR	HAPUR		M		19297	

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
40	74/C/E-2	105/8-9	Hapur	Pilkhuva		M	1	687904	ROB under constructi on
41	75/C/E-2	105/20	Hapur	Pilkhuva		M		78680	RUB planned
42	44/C/E-2	70/6-7	HAPUR	KHARKHAUNDA		M		10183	
43	44/A/C/2-E	71/6-7	HAPUR	KHARKHAUNDA		M		11854	
44	45/C/E-2	72/12-13	HAPUR	KHARKHAUNDA		M		12357	
45	45/A/C/T-2	75/3-4	HAPUR	KHARKHAUNDA		M		17474	
46	46/C/T	75/9-10	HAPUR	MEERUT CITY	UM			1169	
47	47/C/T	76/1-2	HAPUR	MEERUT CITY		M	1	14869	
48	48/C/E	78/8-9	HAPUR	MEERUT CITY	UM			528	
49	49/C/E	80/6-7	HAPUR	MEERUT CITY		M		2288	
50	21/SPL/T	59/6-7	MOHDDINPUR	PARTAPUR		M		64092	ROB Exists
51	22/SPL/T	60/11-12	PARTAPUR	MEERUT CITY		M		53549	
52	23/SPL/E	62/13-14	PARTAPUR	MEERUT CITY		M		80501	RUB planned
53	24/B1/E	64/15	PARTAPUR	MEERUT CITY	UM			31339	RUB planned
54	25/SPL/T	66/7-8	PARTAPUR	MEERUT CITY		M		54221	ROB EXISTS
55	26/A/T	67/12-13	MEERUT CITY	MEERUT CANTT		M	1	285923	ROB under construc-tion
56	27/B/T	68/3-4	MEERUT CITY	MEERUT CANTT		M	1	177788	
57	28/B/T	69/9-10	MEERUT CITY	MEERUT CANTT		M		203019	
58	29/C/T	70/10-11	MEERUT CITY	MEERUT CANTT		M	1	57305	
59	29/A/C/T	71/0-1	MEERUT CITY	MEERUT CANTT		M	1	48908	

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
60	30/A/T	72/3-4	MEERUT CANTT	PABLI KHAS		M	1	275232	ROB under construc-tion
61	31/C/E	74/3-4	MEERUT CANTT	PABLI KHAS		M		9789	
62	31/A/A/T	74/11-12	MEERUT CANTT	PABLI KHAS		M		1320708	ROB under construc-tion (NHAI)
63	32/C/T	76/7-8	PABLI KHAS	DAURALA		M		67736	
64	32/A/E	77/11-12	PABLI KHAS	DAURALA		M		4018	
65	32B/CU/E	78/10-11	PABLI KHAS	DAURALA	UM			15728	
66	33/C/E	79/9-10	PABLI KHAS	DAURALA		M		23975	
67	34/C/T	82/7-8	PABLI KHAS	DAURALA		M		52627	
68	35/B/T	83/5-6	PABLI KHAS	DAURALA		M	1	467537	ROB under construc-tion
69	36/C/T	85/3-4	DAURALA	SAKHOTI TANDA		M		28428	
70	37/C/E	86/13-14	DAURALA	SAKHOTI TANDA	UM			4091	
71	38/C/E-2	88/4-5	DAURALA	SAKHOTI TANDA		M		19082	
72	39/C/T	90/1-2	DAURALA	SAKHOTI TANDA		M		37293	
73	40/B/T-2	91/8-9	SAKHOTI TANDA	KHATAULI		M	1	76447	ROB Exists
74	41/C/T-2	93/2-3	SAKHOTI TANDA	KHATAULI		M		64867	
75	42/C/E-2	96/8-9	SAKHOTI TANDA	KHATAULI		M		71226	
76	43/C/E-2	97/8-9	SAKHOTI TANDA	KHATAULI		M		43531	
77	43A/C/T-2	99/0-1	SAKHOTI TANDA	KHATAULI		M		69572	
78	44/B/T-2	100/7-8	KHATAULI	MANSURPUR		M	1	169178	ROB under construc-tion

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
79	45/C/T-2	101/8-9	KHATAULI	MANSURPUR		M	1	73231	
80	46/C/E-2	104/6-7	KHATAULI	MANSURPUR		M		58250	
81	47/C/T-2	108/9-10	KHATAULI	MANSURPUR		M		15782	
82	48/C/T-2	109/13-14	KHATAULI	MANSURPUR		M		50337	
83	49/C/T-2	111/10	MANSURPUR	JARUADA NARA	UM			17001	
84	50/C/T-2	114/10-11	MANSURPUR	JARUADA NARA		M		46095	
85	50A/C/E-2	117/17-18	JARUADA NARA	MUZAFFAR NAGAR		M	1	160521	ROB under construc-tion (NHAI)
86	51/C/E-2	118/10-11	JARUADA NARA	MUZAFFAR NAGAR		M		29405	
87	52/C/T-2	120/14-15	JARUADA NARA	MUZAFFAR NAGAR		M		28286	
88	53/C/T-2	122/1-2	JARUADA NARA	MUZAFFAR NAGAR		M	1	460790	ROB under construction
89	55/C/T-2	123/5-6	MUZAFFAR NAGAR	BAMAN HERI		M	1	233923	
90	56/C/T-2	124/6-7	MUZAFFAR NAGAR	BAMAN HERI		M		69287	
91	57/C/T-2	125/7-8	MUZAFFAR NAGAR	BAMAN HERI		M		21659	
92	60/C/E-2	130/9-10	BAMAN HERI	ROHANA KALAN		M		46409	
93	61/C/E-2	132/8-9	BAMAN HERI	ROHANA KALAN		M		29524	
94	62/C/T-2	134/8-9	ROHANA KALAN	DEOBAND		M		156306	
95	63/C/T-2	136/1-2	ROHANA KALAN	DEOBAND		M		21529	
96	64/C/E-2	137/8-9	ROHANA KALAN	DEOBAND		M		43487	
97	65/C/E-2	138/15	ROHANA KALAN	DEOBAND		M		25809	
98	66/C/E-2	140/14-15	ROHANA KALAN	DEOBAND		M		20050	

S. No	LC no. / Class/ Traffic/ Eng.	Location (Km)	BETWEEN STATION		Level Crossing			TVUs	REMARK
99	67/C/E-2	143/10-11	ROHANA KALAN	DEOBAND		M		17041	
100	68/A/T	145/8-9	ROHANA KALAN	DEOBAND		M		58729	
101	69/C/T-2	147/3-4	DEOBAND	TALHERI BUZURG		M	1	205065	
102	70/C/T-2	148/2-3	DEOBAND	TALHERI BUZURG		M		112634	
103	71/C/E-2	150/2-3	DEOBAND	TALHERI BUZURG		M		176340	
104	72/C/E	152/4-5	DEOBAND	TALHERI BUZURG		UM		1694	
105	74/C/E-2	153/10-11	DEOBAND	TALHERI BUZURG		M		18648	

Talheri to Ludhiana Section

New Line No.	S. No. old	LC no. / Class/ Traffic/ Eng.	Location (Km)	Converted to decimal chainages	BETWEEN STATION		Level Crossing			TVUs	Remarks
							Un- Man-ned	Manned	Inter Locking		
1	423	75/SPL/T	156/5-6	156.33	TALHERI BUZURG			M	1	55544	
2	424	76/A/E	159/5-6	159.33	TALHERI BUZURG	NAGAL		M		37047	
3	425	77/A/E	161/10-11	161.63	TALHERI BUZURG	NAGAL		M		45228	
4	426	78/SPL/T	163/13-14	163.81	NAGAL			M		101948	
5	427	79/SPL/T	165/4-5	165.25	NAGAL			M		60447	
6	428	80/C/E	167/4-5	167.25	NAGAL	TAPRI Jn.		M		2937	
7	429	81/C/E	168/14-15	168.88	NAGAL	TAPRI Jn.		M		6016	
8	430	82/A/E	171/2-3	171.13	NAGAL	TAPRI Jn.		M		37078	RUB on DFCC
9	431	83/SPL/T	173/8-9	173.50	NAGAL	TAPRI Jn.		M		215057	Rub By DFC
10	432	84/SPL/E	175/27-29	175.75	TAPRI Jn.	Saharanpur		M	1	279617	
11	435	84A/C/E	177/6-7	177.38	TAPRI Jn.	Saharanpur		M	1	322608	Requires upgrading
12	436	86/B/T	181/15-17	182.00	Saharanpur	Philakhni		M	1	787081	ROB under construction by State Government
13	437	88/C/E	185/1-3	185.06	Saharanpur	Philakhni		M	1	72286	Requires upgrading
14	438	89/C/E	186/15-17	187.00	Saharanpur	Philakhni		M		73884	
15	439	90A/C/T	189/13-15	189.81	Philakhni	Sarsawa		M	1	94940	
16	440	91/C/E	192/1-3	192.06	Philakhni	Sarsawa	UM			19380	Within DFCCI station, requires ROB
17	441	92/C/T	194/19-23	195.00	Sarsawa	Kalanaur		M	1	197910	ROB Sanctioned.
18	442	93/C/E	196/7-9	196.44	Sarsawa	Kalanaur		M		36210	Requires upgrading& Interlcoking
19	443	94/C/E	197/3-5	197.19	Sarsawa	Kalanaur		M		28390	Requires upgrading & Interlcoking
20	444	95/C/E	198/13-15	198.81	Sarsawa	Kalanaur		M		38976	Requires upgrading & Interlcoking
21	445	96/C/E	200/15-17	201.00	Sarsawa	Kalanaur		M	1	75240	Requires upgrading

22	446	97/C/E	208/21-23	209.00	Kalanaur	Jaghadri		M	1	533232	Requires upgrading
23	447	97A/C/T	210/23-25	211.00	Kalanaur	Jaghadri		M	1	53226	Requires upgrading
24	448	98/B/T	211/37-39	212.00	Jaghadri	Jaghadri Ws		M	1	336200	
25	449	99/C/E	213/15-17	214.00	Jaghadri	Jaghadri Ws		M	1	64534	Requires upgrading
26	450	100/C/T	215/27-29	216.00	Jaghadri Ws			M	1	116424	Requires upgrading
27	451	101/C/E	217/9-11	217.56	Jaghadri Ws	Darazpur		M		28056	Within DFCCI station, requires ROB
28	452	102/C/E	219/3-5	219.19	Jaghadri Ws	Darazpur		M		31504	Requires upgrading& Interlcoking
29	453	103/C/T	220/13-15	220.81	Darazpur			M	1	25200	Considered as B-1 being already interlocked
30	454	104/C/E	221/26-28	222.00	Darazpur	Mustafabad		M	1	28336	Requires upgrading
31	455	105/C/E	223/12-14	223.75	Darazpur	Mustafabad	UM			16800	
32	456	106/C/E	225/21-23	226.00	Darazpur	Mustafabad	UM			22680	Within DFCCI station, requires ROB
33	457	107/C/T	228/3-5	228.19	Mustafabad			M	1	59220	Requires upgrading
34	458	108/C/E	230/3-5	230.19	Mustafabad	Barara	UM			6568	
35	459	109/C/E	233/3-5	233.19	Mustafabad	Barara		M	1	178437	Requires upgrading
36	460	110/B/E	236/8-10	236.50	Mustafabad	Barara		M	1	361438	ROB in progress
37	461	111/C/T	236/18-20	237.00	Barara	Tandwal		M	1	452850	
38	462	112/C/E	237/33-35	238.00	Barara	Tandwal		M		66575	Requires upgrading
39	463	113/C/E	240/1-3	240.06	Barara	Tandwal		M		6959	
40	464	114/C/E	241/5-7	241.33	Barara	Tandwal		M		3063	
41	465	115/C/E	242/23-25	243.00	Barara	Tandwal		M		23536	Requires upgrading& Interlcoking
42	467	117/C/T	248/7-9	248.44	Tandwal	Kesri		M	1	232117	Considered as B-1 being already interlocked
43	468	118/C/E	250/9-11	250.56	Kesri	Dukheri		M		25471	
44	469	119/C/E	253/1-3	253.06	Kesri	Dukheri	UM			1245	
45	470	120/C/T	254/27-29	255.00	Dukheri	Ambala Cantt		M	1	45637	Within DFCCI station, requires ROB
46	471	121/C/E	258/3-5	258.19	Dukheri	Ambala Cantt		M		4695	

47	472	122/C/E	260/0-1	260.00	Dukheri	Ambala Cantt		M	1	130031	RUB by DFC
48	473	124/C/E	265/18-20	266.00	Ambala Cantt	Ambala City		M	1	119982	Requires upgrading
49	474	126/A/T	269/12-14	269.75	Ambala Cantt	Ambala City		M	1	480359	Requires upgrading
50	475	127C/T	270/26-28	271.00	Ambala City			M	1	96886	Requires upgrading
51	476	128/C/E	272/7-9	272.44	Ambala City	Sambu		M	1	170168	Requires upgrading
52	477	129/C/E	274/13-15	274.81	Ambala City	Sambu		M	1	70446	Requires upgrading
53	478	130/C/E	276/5-7	276.33	Ambala City	Sambu		M	1	155052	Requires upgrading
54	479	131/C/T	279/19-21	280.00	Sambu	Rajpura		M	1	299463	ROB in progress
55	480	132/C/E	282/5-7	282.33	Sambu	Rajpura		M	1	196868	Requires upgrading
56	481	133/C/E	283/31-284/1	284.00	Sambu	Rajpura		M	1	162336	Requires upgrading
57	482	134/C/E	287/3-5	287.19	Sambu	Rajpura		M	1	4032	Requires upgrading
58	483	134A/C/E	288/15-17	289.00	Sambu	Rajpura		M	1	251832	Requires upgrading
59	484	137/C/E	293/21-23	294.00	Rajpura	Sarai Banjara		M	1	50400	Requires upgrading
60	485	138/C/E	296/21-23	297.00	Rajpura	Sarai Banjara		M	1	110967	Requires upgrading
61	486	139/C/T	299/29-31	300.00	Rajpura	Sarai Banjara		M	1	190368	Requires upgrading
62	487	140/C/E	302/25-27	303.00	Sarai Banjara	Sadhoo Garh		M	1	74304	Requires upgrading
63	488	140A/C/E	304/5-7	304.33	Sarai Banjara	Sadhoo Garh		M	1	74166	Requires upgrading
64	489	141/C/T	306/23-25	307.00	Sarai Banjara	Sadhoo Garh		M	1	122670	Requires upgrading
65	490	142/C/E	309/5-7	309.33	Sadhoo Garh	Sirhind Jn.		M	1	33558	Considered as B-1 being already interlocked
66	491	143/C/E	311/15-17	312.00	Sadhoo Garh	Sirhind Jn.		M	1	132616	Considered as B-1 being already interlocked
67	492	144/C/E	312/27-29	313.00	Sadhoo Garh	Sirhind Jn.		M	1	1106931	Requires upgrading
68	493	145/B/T	314/15-17	314.00	Sadhoo Garh	Sirhind Jn.		M	1	1181142	ROB in progress
69	494	146/C/T	315/27-29	316.00	Sirhind Jn.	Mandi Govindgarh		M	1	35196	RUB on DFC Detour.
70	495	147/C/E	317/15-17	318.00	Sirhind Jn.	Mandi Govindgarh		M	1	474371	RUB on DFC Detour.
71	496	148/C/E	318/9-11	318.56	Sirhind Jn.	Mandi Govindgarh		M		9885	RUB on DFC Detour

72	497	150/C/E	321/17-19	322.00	Sirhind Jn.	Mandi Govindgarh		M		78800	Requires upgrading
73	498	151/C/T	325/3-5	325.19	Mandi Govindgarh	Khanna		M	1	500746	Requires upgrading
74	499	152/C/E	326/3-5	326.19	Mandi Govindgarh	Khanna		M	1	50160	RUB in Progress
75	500	153/C/E	327/9-11	327.56	Mandi Govindgarh	Khanna		M	1	372498	ROB Sanctioned
76	501	154/C/E	331/13-15	331.81	Mandi Govindgarh	Khanna		M	1	345530	Requires upgrading
77	502	155/B/T	332/17-19	333.00	Mandi Govindgarh	Khanna		M	1	708500	ROB in progress
78	503	157/C/E	336/21-23	337.00	Khanna	Chawapail		M		140553	Requires upgrading
79	504	158/C/E	337/29-338/1	338.00	Khanna	Chawapail		M		182952	Requires upgrading
80	505	159/C/E	341/7-9	341.44	Khanna	Chawapail		M		135154	Requires upgrading
81	506	160/C/E	342/13-15	342.81	Khanna	Chawapail		M	1	88020	Requires upgrading
82	507	161/C/T	343/15-17	344.00	Khanna	Chawapail		M	1	640134	ROB in progress
83	508	162/C/E	345/27-29	346.00	Chawapail	Doraha		M		78692	Requires upgrading
84	509	163/C/E	348/29-31	349.00	Chawapail	Doraha		M		119583	Requires upgrading
85	510	164/C/E	351/9-11	351.56	Chawapail	Doraha		M		35432	Requires upgrading& Interlcoking
86	511	164B/C/T	352/23-25	353.00	Chawapail	Doraha		M	1	50140	Requires upgrading
87	512	164A/B/E	353/35-354/1	354.00	Doraha	Sanehwal		M	1	602988	Requires upgrading
88	513	165/C/E	354/17-19	355.00	Doraha	Sanehwal		M		96480	Requires upgrading
89	514	166/C/E	356/19-21	357.00	Doraha	Sanehwal		M		1526	
90	515	167/C/E	357/21-23	358.00	Doraha	Sanehwal		M	1	191840	Requires upgrading
91	516	C168/C	359/5-7	359.33	Doraha	Sanehwal		M	1	112666	Requires upgrading
TOTAL						Total ROB's			**56**		
NOTES:											
1	**TVU'S ABOVE 50,000**				**62**						
2	**TVU'S ABOVE 25,000 BUT BELOW 50,000**				**15**						
3	**TVU'S BELOW 25,000**				**14**						
4	**Total Level Crossings**				**91**						

Annexure- 3.4: List of Minor Bridge Structures

Khurja-Talheri Section (0.0 km T0 189.9 km)
(Including Khurja Flyover)

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
KHURJA FLYOVER									
1					-6440	KRJ9	1	3	3
2					-5452.52	KRJ8	1	6	**3**
3					-5085.4	KRJ7	1	2	4
4					-4243.66	KRJ6	2	6	3
5					-4185.98	KRJ5	1	2	2
6					-3366.08	KRJ4	1	2	2
7					-2348.16	KRJ3	1	2	2
8					-1750.37	KRJ2	1	2	4
9					-800	KRJ1	1	3	3
KHURJA-HAPUR LINE									
10	3	3/2-3	1	3.66	0/083.952	3	1	4.00	1.20
11	4	3/13-14	2	0.61	0/613.338	4	2	1.20	1.20
12	5	3/14-15	1	0.30	0/737.500	5	1	1.20	1.20
13	6	4/6-7	1	0.61	1/165.550	6	1	1.20	1.20
14	7	5/8-9	1	0.61	2/312.500	7	1	1.20	2.00
15	8	5/11-12	1	3.66	2/497.500	8	1	4.00	2.00
16	9	5/14-15	1	1.83	2/747.900	9	1	2.00	1.20
17	10	6/0-1	1	3.05	2/850.00	10	1	4.00	1.20
18	12	7/1-2	1	3.66	3/871.638	12	1	4.00	2.00
19	13	7/3-4	1	0.46	3/970.000	13	1	1.20	1.20
20	14	7/3-4	1	0.61	4/012.180	14	1	1.20	1.20
21	15	8/1-2	1	0.46	4/890.182	15	1	1.20	1.20
22	16	8/4-5	1	0.92	5/140.380	16	1	1.20	1.20
23	17	8/9-10	1	0.61	5/342.500	17	1	1.20	1.20
24	18	8/15-9/0	2	0.92	5/835.545	18	2	1.20	1.20
25	19	9/2-3	1	0.61	6/006.774	19	1	1.20	1.20
26	20	9/14-15	1	6.10	6/792.500	20	2	4.00	2.00
27	21	11/1-2	2	1.83	7/904.315	21	2	2.00	3.00
28	22	11/9-10	1	0.46	8/387.932	22	1	1.20	1.20
29	23	12/4-5	1	1.83	9/092.463	23	1	2.00	1.20
30	24	12/5-6	1	0.30	9/128.124	24	1	1.20	1.20
31	25	12/9-10	1	0.30	9/375.713	25	1	1.20	1.20
32	26	12/10-11	1	3.66	9/487.500	26	1	4.00	2.00
33	27	12/15-13/1	1	0.61	9/780.607	27	1	1.20	1.20
34	28	13/4-5	1	0.92	10/074.963	28	1	1.20	1.20
35	29	13/6-7	1	0.61	10/216.084	29	1	1.20	1.20
36	30	13/11-12	1	3.05	10/538.744	30	1	4.00	3.00
37	31	14/04-05	1	0.92	11/182.500	31	1	1.20	2.00
38	33	14/8-14/9	2	1.22	11/527	33	2	1.20	2.00
39	34	14/13-14	1	0.92	11/795.001	34	1	1.20	2.00
40	35	15/2-3	1	0.92	12/105.016	35	1	1.20	2.00
41	36	16/2-3	1	5.41	13/037.463	36	1	6.00	3.00
42	37	16/6-7	1	0.46	13/257.500	37	1	1.20	1.20

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
43	38	16/12-13	1	3.66	13/690.00	38	1	4.00	3.00
44	39	17/02-03	1	0.61	13/970.000	39	1	1.20	1.20
45	40	17/03-04	1	0.61	14/032.463	40	1	1.20	1.20
46	41	17/04-05	1	0.61	14/126.846	41	1	1.20	2.00
47	42	17/09-10	1	0.83	14/422.046	42	1	2.00	2.00
48	43	17/12-13	1	0.38	14/679.470	43	1	1.20	1.20
49	44	18/04-05	1	3.66	15/089.962	44	1	4.00	2.00
50	45	18/04-05	1	0.61	15/135.000	45	1	1.20	1.20
51	46	18/09-10	1	0.61	15/482.500	46	1	1.20	2.00
52	47	19/03-04	1	0.38	16/030.837	47	1	1.20	2.00
53	48	19/06-07	1	0.46	16/202.500	48	1	1.20	1.20
54	49	19/10-11	1	3.66	16/497.500	49	1	4.00	2.00
55	50	19/14-15	1	0.30	16/707.500	50	1	1.20	1.20
56	51	20/05-06	1	0.61	17/105.001	51	1	1.20	2.00
57	52	20/12-13	1	1.83	17/652.500	52	1	2.00	2.00
58	53	21/03-04	1	0.61	18/034.962	53	1	1.20	1.20
59	54	21/09-10	1	0.61	18/425.000	54	1	1.20	1.20
60	55	21/11-12	1	0.61	18/575.000	55	1	1.20	1.20
61	56	22/0-1	1	1.83	18/817.500	56	1	2.00	1.20
62	57	22/3-4	1	6.10	19/053.459	57	2	4.00	2.00
63	58	22/16-23/1	1	1.83	19/832.500	58	1	2.00	1.20
64	59	23/1	1	0.92	19/870.000	59	1	1.20	1.20
65	60	23/08-09	1	6.10	20/374.190	60	2	4.00	3.00
66	61	24/1-2	1	0.61	20/840.00	61	1	1.20	1.20
67	62	24/6-7	1	0.61	21/150.00	62	1	1.20	1.20
68	63	24/8-9,	2	0.76	21/358.421	63	2	1.20	1.20
69	64	24/9-10	1	0.61	21/399.233	64	1	1.20	1.20
70	65	24/11-12	1	0.61	21/520.000	65	1	1.20	1.20
71	66	24/13-14,	1	0.61	21/562.500	66	1	1.20	1.20
72	67	25/1-2	1	0.61	21/875.00	67	1	1.20	1.20
73	68	25/6-7	1	0.61	22/205.00	68	1	1.20	1.20
74	69	25/10-11	1	0.92	22/415.618	69	1	1.20	2.00
75	70	25/15-16	1	0.61	22/701.446	70	1	1.20	2.00
76	71	26/3-4	1	0.61	22/962.500	71	1	1.20	2.00
77	72	26/8-9	1	1.22	23/325.00	72	1	2.00	2.00
78	73	26/10-11	1	1.52	23/475.00	73	1	2.00	2.00
79	74	27/3-4	1	3.05	24/007.462	74	2	2.00	4.00
80	75	28/13-14	1	3.66	25/677.500	75	1	4.00	3.00
81	76	29/8-9	1	1.83	26/340.004	76	1	2.00	2.00
82	77	29/15-30/1	1	0.61	26/792.498	77	1	1.20	1.20
83	78	30/4-5	1	0.61	27/35.545	78	1	1.20	1.20
84	79	30/6-7	1	0.46	27/226.447	79	1	1.20	1.20
85	80	30/13-14	1	3.66	27/712.500	80	1	4.00	3.00
86	81	31/6-7	2	3.66	28/227.500	81	2	4.00	3.00
87	82	31/11-12	1	1.83	28/560.000	82	1	2.00	2.00
88	83	32/7-8	2	0.92	29/305.806	83	2	1.20	2.00
89	84	32/13-14	1	0.30	29/756.4	84	1	1.20	1.20
90	86	34/5-6	2	3.66	31/202.500	86	2	4.00	4.00
91	87	35/8-9	1	0.61	32/480.000	87	1	1.20	1.20
92	88	36/8-9	1	0.61	33/442.500	88	1	1.20	1.20

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
93	89	37/3-4	1	0.30	34/425.000	89	1	1.20	1.20
94	90	38/9-10	1	0.30	35/470.000	90	1	1.20	1.20
95	91	38/14-15	1	0.61	35/830.000	91	1	1.20	1.20
96	92	39/10-11	1	0.91	36/540.000	92	1	1.20	1.20
97	93	40/2-3	1	0.61	37/039.962	93	1	1.20	2.00
98	94	40/14-15	1	0.61	37/802.500	94	1	1.20	2.00
99	95	41/1-2	1	0.30	37/982.492	95	1	1.20	1.20
100	96	41/5-6	1	0.30	38/232.500	96	1	1.20	1.20
101	97	41/10-11	1	0.61	38/538.500	97	1	1.20	1.20
102	98	42/1-2	1	0.30	39/10.8376	98	1	1.20	1.20
103	99	42/6-7	1	1.83	39/282.500	99	1	2.00	2.00
104	100	42/10-11	1	0.61	39/580.000	100	1	1.20	1.20
105	101	42/13-14	1	0.61	39/775.000	101	1	1.20	1.20
106	102	43/2-3	1	0.61	40/032.462	102	1	1.20	1.20
107	103	43/5-6	1	0.61	40/270.000	103	1	1.20	1.20
108	104	43/8-9	1	0.61	40/438.409	104	1	1.20	1.20
109	105	43/14-15	1	0.61	40/855.000	105	1	1.20	1.20
110	106	44/11-12	1	0.61	41/657.450	106	1	1.20	1.20
111	107	44/14-15	1	0.61	41/867.500	107	1	1.20	1.20
112	108	45/3-4	1	0.61	42/094.962	108	1	1.20	1.20
113	109	45/5-6	1	2.44	42/255.000	109	1	3.00	3.00
114	110	45/6-7	1	2.44	42/390.000	110	1	3.00	2.00
115	111	45/11-12	1	0.61	42/701.5	111	1	1.20	1.20
116	112	46/0-1	1	0.61	42/917.500	112	1	1.20	1.20
117	113	46/5-6	1	0.61	43/252.492	113	1	1.20	1.20
118	114	46/10-11	1	1.83	43/585.000	114	1	2.00	1.20
119	115	46/12-13	1	0.61	43/770.000	115	1	1.20	1.20
120	116	47/4-5	1	0.91	44/147.500	116	1	1.20	1.20
121	117	47/9-10	1	0.46	44/492.500	117	1	1.20	1.20
122	118	47/11-12	1	0.46	44/605.000	118	1	1.20	1.20
123	119	47/14-15	1	0.46	44/825.000	119	1	1.20	1.20
124	120	48/6-7	1	0.91	45/315.000	120	1	1.20	2.00
125	121	49/8-9	1	0.61	46/415.008	121	1	1.20	1.20
126	122	50/0-1	1	0.91	46/932.500	122	1	1.20	1.20
127	123	50/6-7	1	0.91	47/342.500	123	1	1.20	2.00
128	126	53/2-53/3	1	1.84	50/094.93	126	1	3.00	1.20
129	127	53/4-53/5	1	0.61	50225.74	127	1	1.20	1.20
130	128	53/7-53/8	1	0.39	50419	128	1	1.20	1.20
131	129	53/11-53/12	1	3.81	50725.93	129	1	4.00	3.00
132	130	55/4-55/5	1	1.83	52268.21	130	1	2.00	2.00
133	131	55/13-55/14	2	3.05	52846.3	131	2	4.00	3.00
134	133	56/0-56/1	1	3.66	53014.35	133	1	4.00	3.00
135	134	56/9-56/10	2	1.83	53662.27	134	2	2.00	2.00
136	135	56/10-56/11	1	0.30	53695.27	135	1	1.20	1.20
137	136	57/1-57/2	1	0.30	54062.56	136	1	1.20	1.20
138	136A	57/5-6	1	0.30	54349.3298		1	1.20	1.20
139	137	58/1-58/2	2	0.61	55100	137	2	1.20	1.20
140	138	58/10-58/11	1	0.76	55754.78	138	1	1.20	1.20
141	139	59/4-59/5	1	0.46	56200	139	1	1.20	1.20
142	140	59/12-59/13	1	0.91	56757.15	140	1	1.20	2.00

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
143	141	59/14-59/15	1	0.46	56862.44	141	1	1.20	1.20
144	142	60/2-60/3	1	0.61	57109.02	142	1	1.20	1.20
145	143	60/7-60/8	1	0.61	58328.71	143	1	1.20	1.20
DELHI-MURADABAD									
146	98	104/14-15	1	1.83	60863.91	98	1	2.00	1.20
147	100	106/3-4	1	0.30	62313.05	100	1	1.20	1.20
148	101	106/8-9	1	0.30	62684.75	101	1	1.20	1.20
149	102	106/12-13	1	0.30	62887.85	102	1	1.20	2.00
HAPUR-DETOUR									
150					65300.00	HPD1	1	1.2	2.00
151					66450.00	HPD2	1	1.2	2.00
152					67650.00	HPD3	1	1.2	2.00
HAPUR-MEERUT LINE									
153	159	67/9-67/10	1	0.41	67985.8	159	1	1.20	1.20
154	160	68/2-3	1	0.30	68500	160	1	1.20	1.20
155	161	69/2-3	1	0.30	69430.54	161	1	1.20	1.20
156	162	69/6-7	1	0.30	69694.45	162	1	1.20	1.20
157	163	69/12-13	1	0.30	70118.82	163	1	1.20	1.20
158	164	70/2-70/3	1	0.30	70421.38	164	1	1.20	1.20
159	165	70/4-70/5	1	0.30	71126.66	165	1	1.20	1.20
160	166	71/4-71/5	1	0.30	71609.55	166	1	1.20	1.20
161	167	72/0-72/1	1	0.30	72476.08	167	1	1.20	1.20
162	168	72/10-11	1	1.83	73086.08	168	1	2.00	1.20
163	169	74/9-10	1	1.83	74988.39	169	1	2.00	2.00
164	170	74/14-15	1	0.30	75330.88	170	1	1.20	1.20
165	171	75/11-75/12	1	2.44	76215.57	171	1	3.00	1.20
166	172	76/14-76/15	1	0.30	77376.62	172	1	1.20	1.20
167	173	77/1-77/2	1	1.83	77543.71	173	1	2.00	1.20
168	174	77/6-77/7	1	0.30	77893.04	174	1	1.20	1.20
169	175	79/0-79/1	1	6.10	79528.8	175	1	6.00	3.00
170	176	80/10-11	1	0.30	81239.15		1	1.20	1.20
MEERUT DETOUR									
171					83012.00	MTC1	1	1.20	1.20
172					83955.00	MTC2	1	1.20	1.20
173					85000.00	MTC3	1	1.20	1.20
174					87600.00	MTC4	1	1.20	2.00
175					88610.00	MTC5	1	1.20	1.20
176					89589.00	MTC6	1	4.00	2.00
177					91420.44	MTC7	1	6.00	2.00
DELHI-MEERUT LINE									
178	81	59/4-5	1	0.91	92162	81	1	1.20	1.20
179	82	59/6-7	1	1.83	93347.81	82	1	2.00	1.20
180	83	59/12-13	1	3.05	93783.9	83	1	3.00	1.20
181	84	60/8-9	1	3.05	94456.61	84	1	3.00	1.20
182	85	61/10-11	1	6.10	95568.04	85	1	6.00	3.00
183	86	63/11-12	1	0.91	97700	86	1	1.20	2.00
184	87	64/3-4	1	3.05	98200	87	1	3.00	3.00

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
185	88	64/4-5	1	2.82	98300	88	1	3.00	3.00
186	89	64/6-7	1	3.05	98400	89	1	3.00	3.00
187	90	64/9-10	1	0.61	98654.44	90	1	1.20	1.20
188	91	65/08-09	1	1.20	99472.9	91	1	1.20	1.20
189	92	65/14-15	1	1.20	99915.500	92	1	1.20	1.20
190	93	66/06-07	1	1.20	100349.27	93	1	1.20	1.20
MEERUT - LUDHIANA LINE									
191	96	67/10-11	1	0.91	101548.5	96	1	1.20	1.20
192	97	67/14-15	1	0.91	101819.73	97	1	1.20	1.20
193	98	67/16-17	1	0.91	101924.29	98	1	1.20	1.20
194	100	69/09-10	1	0.91	103577.87	100	1	1.20	1.20
195	101	70/12-13	1	2.44	104655.78	101	1	3.00	1.20
196	102	71/1-3	1	7.40	105050	102	2	4.00	3.00
197	103	73/4-5	1	1.52	107303.75	103	1	2.00	2.00
198	104	74/1-2	1	0.61	108014.2	104	1	1.20	1.20
199	105	74/4-5	1	0.61	108403.48	105	1	1.20	1.20
200	106	74/8-9	1	0.61	108525.204	106	1	1.20	1.20
201	108	74/13-14	1	0.91	108867.25	108	1	1.20	1.20
202	109	75/6-7	1	0.61	109419.926	109	1	1.20	1.20
203	110	76/14-15	1	3.05	110969.17	110	1	3.00	2.00
204	111	78/8-9	2	1.52	112554.22	111	2	2.00	2.00
205	112	79/4-5	1	0.46	113264.15	112	1	1.20	1.20
206	113	79/6-7	1	0.61	113380.51	113	1	1.20	1.20
207	114	79/14-15	1	3.05	113908.44	114	1	3.00	2.00
208	115	80/9-10	1	0.30	114654.53	115	1	1.20	1.20
209	116	80/12-13	1	0.91	114820.65	116	1	1.20	1.20
210	117	81/1-2	1	0.30	115084.88	117	1	1.20	1.20
211	118	81/8-9	2	0.61	115503.43	118	2	1.20	1.20
212	119	81/12-13	1	0.91	115773.78	119	1	1.20	1.20
213	120	82/6-7	1	3.05	116391.29	120	1	3.00	1.20
214	121	82/13-14	2	0.91	116828.74	121	2	1.20	1.20
215	122	82/15-16	1	0.61	116900	122	1	1.20	1.20
216	123	83/7-8	2	0.91	117429	123	1	3.00	1.20
217	124	83/11-12	1	0.91	117875	124	1	1.20	1.20
218	125	84/8-9	1	0.91	118529.39	125	1	1.20	2.00
219	127	84/9-10	1	0.91	118590	127	1	1.20	1.20
220	128	84/10-11	1	1.52	118646.03	128	1	2.00	2.00
221	129	85/0-1	1	3.05	119026.1	129	1	3.00	2.00
222	130	85/7-8	1	1.52	119507.09	130	1	2.00	2.00
223	131	85/10-11	1	0.61	119622.94	131	1	1.20	1.20
224	132	86/1-2	1	0.61	120061.29	132	1	1.20	1.20
225	133	86/9-10	1	0.30	120609	133	1	1.20	1.20
226	134	86/14-15	1	0.91	120926.82	134	1	1.20	1.20
227	135	88/10-11	2	0.91	122/686.6	135	2	1.20	1.20
228	136	89/9-10	1	0.61	123/616.6	136	1	1.20	1.20
229	137	90/6-7	1	0.91	124/431.1	137	1	1.20	1.20
230	140	91/12-13	1	0.61	125/849.5	140	1	1.20	1.20
231	141	92/4-5	1	0.40	126/243.00	141	1	1.20	1.20
232	142	92/7-8	1	0.61	126/503.7	142	1	1.20	1.20
233	143	92/11-12	1	0.46	126/717.2	143	1	1.20	1.20

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
234	144	94/8-9	1	0.52	128/621.520	144	1	3.00	1.20
235	145	95/3-4	1	3.05	129/160.2	145	1	3.00	3.00
236	146	95/13-14	2	1.60	129/898.5	146	2	2.00	1.20
237	147	96/2-3	1	0.61	130/150.6	147	1	1.20	1.20
238	148	96/15-97/0	1	0.61	130/981.4	148	1	1.20	1.20
239	149	97/10-11	1	0.61	131/639.9	149	1	1.20	1.20
240	150	98/14-15	1	4.80	132/951.400	150	1	6.00	2.00
241	151	99/6-7	1	0.61	133/445.2	151	1	1.20	1.20
242	152	99/10-11	1	0.61	133/669.1	152	1	1.20	1.20
243	153	99/14-15	1	0.61	133/912	153	1	1.20	1.20
244	155	103/11-12	1	7.77	137/769.6	155	2	4.00	4.00
245	156	104/13-14	1	0.91	38/904.274	156	1	1.20	1.20
246	157	105/10-11	1	0.91	139/664.085	157	1	1.20	1.20
247	158	106/3-4	1	0.61	140/179.123	158	1	1.20	1.20
248	159	106/13-14	1	0.91	140/817.049	159	1	1.20	1.20
249	160	107/0-1	1	7.08	141/034.734	160	2	4.00	2.00
250	161	108/2-3	1	1.83	142/145.548	161	1	2.00	2.00
251	162	108/5-6	1	1.83	142/293.616	162	1	2.00	2.00
252	163	110/13-14	1	1.22	144/853.957	163	1	1.20	1.20
253	164	111/2-3	1	4.57	145/138.856	164	1	6.00	2.00
254	165	111/14-15	1	0.61	145/964.344	165	1	1.20	1.20
255	167	114/13-14	1	0.91	148/859.267	167	1	1.20	1.20
256	168	115/12-13	2	0.45	149/965.202	168	2	1.20	1.20
257	169	117/3-4	1	0.61	151/100	169	1	1.20	1.20
258	170	117/12-13	2	3.05	151/682.348	170	2	3.00	3.00
259	171	118/3	1	1.52	152/119.922	171	1	2.00	1.20
260	172	118/12-13	1	0.60	152/816.966	172	1	1.20	1.20
261	173	119/2-3	1	2.86	153/114.37	173	1	3.00	2.00
262	174	119/14-120/0	1	0.61	153/854.64	174	1	1.20	1.20
263	175	120/11-12	1	0.90	154/604.462	175	1	1.20	1.20
264	178	121/9-10	1	0.58	155/533.23	178	1	1.20	1.20
265	179	121/13-14	1	0.60	155/815.89	179	1	1.20	1.20
266	180	122/1-2	1	0.91	155/983.46	180	1	1.20	1.20
267	181	123/8-9	1	0.61	157/390	181	1	1.20	1.20
268	182	124/8-9	1	0.91	158/845.021	182	1	1.20	1.20
269	183	125/3-4	1	0.20	160/005.062	183	1	1.20	1.20
270	184	126/1-2	1	0.30	160/155.765	184	1	1.20	1.20
271	185	126/3-4	1	0.61	160/328.076	185	1	1.20	1.20
272	186	126/15-127/0	2	0.91	160/897.413	186	2	1.20	1.20
273	187	127/13-14	1	1.57	162/086.957	187	1	2.00	2.00
274	188	128/1-2	1	1.86	162/192.702	188	1	2.00	1.20
275	190	132/4-5	1	1..52	166/227.554	190	1	2.00	1.20
276	191	135/14-15	1	0.61	169/896.199	191	1	1.20	1.20
277	192	136/13-14	2	1.83	170/780.417	192	2	2.00	2.00
278	193	137/9-10	2	1.83	171/596.041	193	2	2.00	1.20
279	194	143/5-6	1	3.05	177/246.443	194	1	3.00	2.00
280	195	145/1-2	3	0.61	178/998.593	195	1	2.00	1.20
281	196	146/2-3	2	3.05	180/122.366	196	2	3.00	2.00

S. No.	EXG. BR.No.	EXG.CH.	EXG. SPAN		PROP.CH.	PROP. BR.No.	No.SPAN		
			No. SPAN	WIDTH			No. SPAN	WIDTH	HEIGHT
282	197	147/9-10	1	1.52	181/535.183	197	1	2.00	1.20
283	198	148/3-4	2	3.05	182/170.327	198	2	3.00	3.00
284	199	149/0-1	2	3.05	82/972.388	199	2	3.00	3.00
285	199A	149/7-8	1	0.61	183/381.84	199A	1	1.20	1.20
286	200	149/12-13	2	3.05	183/756.715	200	2	3.00	2.00
287	201	153/8-9	2	4.57	187/435.276	201	4	3.00	3.00
288	201B	153/8-9	4	2.40	187/462.276	201B	4	3.00	3.00
289	201A	153/15-154/0	1	5.94	187/971.657	201A	1	6.00	3.00
290	202	154/3-4	1	6.10	188/136.788	202	1	6.00	2.00

Total water way :- 645.8m

Talheri- Ludhiana Section

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
1	203	156/3-4	1	1.52	Minor	RCC Slab
2	204	157/13-14	1	3.05	Minor	RCC Slab
3	205	159/0-1	2	1.16	Minor	RCC Box
4	206	160/13-14	1	3.05	Minor	RCC Slab
5	207	162/13-14	1	3.05	Minor	Hume pipe
6	208	167/10-11	2	3.05	Minor	RCC Slab
7	209	169/3-4	1	1.52	Minor	RCC Slab
8	211	172/900-173/00		1x6x4	Minor	Box
9	212	175/00-100		1x1.2x1.2	Minor	Box
10	213	175/5-6	1	1.2	Minor	RCC Slab
11	214	175/8-9	1	0.46	Minor	Hume pipe
12	215	176/3-4	1	0.61	Minor	Hume pipe
13	216	178/2-3	1	1.5	Minor	Hume pipe
14	217	17/30-32		1x6.1	Minor	Slab
15	218	179/4-5	1	0.92	Minor	RCC Slab
16	220	180/7-8	1	1.2	Minor	GIRDER
17	221	182/0-1	1	1.5	Minor	GIRDER
18	221A	182/8-9	1	-	Minor	BARREL
19	223	182/27-28	1	2.74	Minor	Arch
20	225	183/9-11	1	0.9	Minor	Girder Skew
21	226	183/27-29	1	2.06	Minor	TROUGH
22	227A	184/19-21	1	1.51	Minor	Arch
23	228	185/5-7	1	1.51	Minor	GIRDER
24	229	186/1-3	1	1.52	Minor	Arch
25	231	186/17-19		1x6.1	Minor	Slab
26	232	186/21-23	1	3.05	Minor	RCC Slab
27	233	187/21-23	1	3.05	Minor	RCC Slab
28	234	189/11-13	1	0.91	Minor	RCC Slab
29	235	189/13-15	1	3.66	Minor	RCC Slab
30	236	189/15-17	1	0.6	Minor	RCC Slab
31	237	190/11-13		1x6.1	Minor	Slab
32	238	193/13-15	3	3.05	Minor	Arch
33	239	194/1	1	0.45	Minor	RCC Slab
34	240	195/10-11	1	3.04	Minor	RCC Slab
35	243	198/21-23	1	3.05	Minor	GIRDER

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
36	244	200/2-3	1	3.05	Minor	GIRDER
37	246	204/31-34	1	5.9	Minor	RCC Slab
38	247	207/3-5	4	1.18	Minor	TRINGULAT
39	248	207/3-5		1x6.00x2.761	Minor	RCC Box
40	249	209/5-7	1	3.04	Minor	Hume pipe
41	250	210/15-16	2	3.05	Minor	PRC SLAB
42	252	210/12-13	1	0.61	Minor	Arch
43	252-A	211/4-5	1	0.61	Minor	TRINGULAT
44	252-B	211/37-39		1x6.00x2.761	Minor	RCC Box
45	253	212/33-35		2x4.00x2.177	Minor	RCC Box
46	253-B	213/4-5	1	1	Minor	GIRDER
47	254	213/7-9	2	3.04	Minor	RCC HUME PIPE
48	256	216/3-4		2x6.00x1.200	Minor	RCC Slab
49	257	216/6-7	1	3.69	Minor	GIRDER
50	258	218/9-11		2x6.00x1.200	Minor	RCC Slab
51	261	221/9-11	1	2.52	Minor	GIRDER
52	264	225/5-7		1x6.00x2.449	Minor	RCC Box
53	270	230/19-21		2x4.00x2.986	Minor	RCC Box
54	271	231/1-3		2x6.00x2.518	Minor	RCC Slab
55	272	232/19-21	1	0.62	Minor	GIRDER
56	273	233/7-9		2x6.00x1.460	Minor	RCC Slab
57	274	233/21-23	1	0.6	Minor	Hume pipe
58	275	235/2-3		1x6.00x1.425	Minor	RCC Slab
59	277	236/5-6		1x6.00x1.596	Minor	RCC Slab
60	278	237/9-10	1	1.98	Minor	PRC SLAB
61	279	238/15-17	1	3.04	Minor	GIRDER
62	284	245/9-11	1	3.66	Minor	PSC SLAB
63	285	247/11-13	2	0.9	Minor	TRINGULAT
64	287	248/7-8	2	1.83	Minor	Arch
65	292	254/2-3	1	3.05	Minor	GIRDER
66	1-D-2	---		1x3x3	Minor	Box
67	1-D-6	---		1x3x3	Minor	Box
68	1-D-7	---		1x2x2	Minor	Box
69	1-D-8	---		1x4x4	Minor	Box
70	301	264/9-10		2x6.1	Minor	PSC Slab
71	301	264/33-36		2x6.1	Minor	Slab
72	303	267/6-7	1	1.52	Minor	PSC SLAB
73	305	268/21-23	1	2.44	Minor	Arch
74	306	268/23-25	1	1.14	Minor	RCC Slab
75	308	269/5-6	2	0.91	Minor	TROUGH PL.
76	309	269/35-37	1	0.91	Minor	Arch
77	310	270/5-7	1	3.05	Minor	GIRDER
78	311	270/27-29	1	3.05	Minor	RCC
79	311-B	271/5-7		1x1	Minor	Hume Pipe
80	311-A	270/13-14	1	1.83	Minor	RCC Slab
81	312	271/20-22	1	2.44	Minor	Arch
82	317	278/14-16	1	3.05	Minor	PRC SLAB
83	318	280/12-14	1	1.52	Minor	PRC SLAB
84	319	280/18-20	1	1.21	Minor	RCC Slab
85	320	281/2-4	1	1.52	Minor	Arch
86	321	281/14-16	2	0.91	Minor	Hume pipe
87	322	282/27-29	2	2.67	Minor	Arch
88	323	285/13-15	2	3.05	Minor	Arch

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
89	2-D-1	---		1x3.05	Minor	Slab
90	324	285/26-28		1x3.05	Minor	Slab
91	2-D-2	---		1x3.05	Minor	Slab
92	2-D-5	---		1x6x4	Minor	Box
93	324A	287/5-8		1x6x4	Minor	Box
94	324B	287/11-14		1x6x4	Minor	Box
95	2-D-6	---		1x6x4	Minor	Box
96	325-B	289/8-10	1	1.22	Minor	PSC SLAB
97	325-A	291/4-8		1x1.2x1.2	Minor	Box
98	326	291/15-17	1	3.05	Minor	COMP GIRDER
99	327	291/27-25	2	3.05	Minor	GIRDER
100	328	291/31-34		2x9.15	Minor	Slab
101	329	293/13-15	4	3.05	Minor	BOX CUL
102	330	294/3-5	3	2.9	Minor	RCC T-BEAM SLAB
103	332	295/7-9	1	3.05	Minor	PRC SLAB
104	333	295/14-16	2	3.05	Minor	PRC SLAB
105	333-A	295/13-15	1	0.6	Minor	BOX CUL
106	334	297/21-24		4x3.05	Minor	Slab
107	335	298/33-35	2	3.04	Minor	Hume pipe
108	335-A	298/34-36	1	0.6	Minor	RCC BOX CULVERT
109	336	299/31-33	2	3.04	Minor	Hume pipe
110	337	300/7-9	2	3.04	Minor	Hume pipe
111	340	301/27-30		2x9.15	Minor	Slab
112	341	302/13-15	5	3.04	Minor	PRC SLAB
113	342	303/11-13	2	3.05	Minor	RCC T-BEAM SLAB
114	343	303/25-27	2	3.04	Minor	Arch
115	344-A	304/5-7	1	0.46	Minor	PRC SLAB
116	345	304/9-11	2	3.04	Minor	PRC SLAB
117	346	304/17-19	1	3.04	Minor	Hume pipe
118	347	305/4-5	1	3.04	Minor	BOX CUL
119	349	305/21-23	2	3.04	Minor	PRC SLAB
120	350	306/3-5	2	3.04	Minor	RCC T-BEAM SLAB
121	352	307/5-7	1	3.04	Minor	BOX CUL
122	353	307/24-26	2	3.04	Minor	PRC SLAB
123	353-A	309/2-4	1	0.91	Minor	PRC SLAB
124	354	309/17-19	1	3.04	Minor	PRC SLAB
125	355	310/8-5	2	1.52	Minor	PRC SLAB
126	355-A	310/21-23	1	2.44	Minor	PRC SLAB
127	356	311/15-17	1	3.04	Minor	Arch
128	356-A	312/5-7	1	1.2	Minor	BOX CUL
129	357	312/27	1	2.45	Minor	BOX CUL
130	358	313/19-21	1	1.52	Minor	Hume pipe
131	358-A	313/27-29	1	0.53	Minor	RCC Slab
132	362	320/25-27	2	3.04	Minor	RCC BOX
133	363	321/27-29	1	0.6	Minor	PRC SLAB
134	364	323/23-25	1	3.04	Minor	PRC SLAB
135	365	325/25-27	1	0.61	Minor	Arch
136	365-A	326/1-3	1	0.8	Minor	PRC SLAB
137	366	328/15-17	2	3.04	Minor	Arch

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
138	366A	328/1-3		2x3.00x1.37	Minor	Box Culvert
139	367	332/1-3	1	0.6	Minor	BOX CUL
140	368	332/15-17	1	0.61	Minor	BOX CUL
141	369-A	334/17-19	1	0.46	Minor	TROUGH
142	369-A1	334/16-18	1	0.46	Minor	TROUGH
143	370	336/23-25	1	3.04	Minor	CI Pipe
144	371	338/3-5	1	3.04	Minor	PRC SLAB
145	372	340/7-9	1	3.04	Minor	PRC SLAB
146	373	340/17-19	1	3.04	Minor	PRC SLAB
147	374	341/3-5	1	0.45	Minor	PRC SLAB
148	375	341/13-15	1	3.04	Minor	BOX CUL
149	376	343/25-27	1	0.6	Minor	TROUGH
150	376-A	345/4-6	1	0.6	Minor	RCC Slab
151	377	348/25-27	1	0.6	Minor	Arch
152	378	348/31to349/1	1	1.1	Minor	GIRDER
153	379	349/15-17		1x0.3	Minor	Hume Pipe
154	380	350/19-21	1	0.6	Minor	RCC HUME PIPE
155	381	351/1-3	1	0.91	Minor	Hume pipe
156	382	351/15-17	1	0.61	Minor	Hume pipe
157	383	352/21-23	1	0.91	Minor	Hume pipe
158	384	353/33-35	1	3.05	Minor	TROUGH
159	386	359/23-26		3x2	Minor	Box

Annexure- 3.5: List of Major Bridge Structures

Khurja-Talheri Section (0 km To 189.90 km)

Sr. No.	Ex Br No.	Ex Ch	Existing Span		Prop. Br.No.	Prop.Ch	Proposed Span	
			No.of Span	Width			No.of Span	Width
KHURJA-HAPUR LINE								
1	11	6/35-7/0	3	5.35	11	3/822.500	3	6
2	32&32A	14/6-14/7	6x18.3+1x61		32	11/304.121	6x18.3+2x30.5	
3	85	33/10-11	3	6.1	85	30/488.513	3	6
4	124	50/12-50/13	4	12.19	124	47/757.500	4	12.2
5	125A	52/2-52/4	5	12.19	125A	49067.163	5	12.2
6	132	55/14-55/15	3	12.19	132	52931.4	3	12.2
DELHI-MURADABAD								
7	99	105/12-13	**1**	**11.9**	99	61810.87	1	12.2
HAPUR DETOUR								
8					2	63449.442	1	18.3
9					3	64548.520	1	18.3
MEERUT DETOUR								
10					4	86366.504	1	12.2
GZB-SRE LINE								
11	107	74/10-11	1	7.92	107	108663.77	1	12.20
12	154	102/14-15	3	30.5	154	136/911.4	3	30.5
13	166	113/15-16	3	18.3	166	147/920	3	18.3
14	189	129/13-14	3	24.4	189	163/740	3	24.4

Talheri- Ludhiana Section

SN	Bridge No.	Locat -ion	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
1	210	172/3-4		4x30.5	Major	PSC Box Girder		
2	219	179/31-33	3	22.86	Major	GIRDER	OPEN	DHAMOLA
3	227	184/15-17	1	21.9	Major	GIRDER	WELL	
4	241	196/29-01	1 up	22.86	Major	GIRDER		KALA NALA
5	242	197/22-35	2+1 up	12.2+25.8	Major	GIRDER	WELL	BUDHI YAMUNA
6	251	210/21-23	1 up	60.9	Major	TRINGULAT	WELL	WESTERN YAMUNA CANAL
7	255	214/21-23	2	7.62	Major	PRC SLAB		
8	259	219/17-19	1 up	22.86	Major	GIRDER	WELL	RAKSHI NALA
9	260	221/5-7	3 up	12.04	Major	GIRDER	WELL	LUNDA NALA
10	263	224/9-11	3 up	12.19	Major	GIRDER	WELL	CHATANG NALA

SN	Bridge No.	Locat -ion	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
11	265	226/17-19	1+2 up	6.09+7.93	Major	GIRDER	OPEN	TEEN DARA
12	266	227/1-2	16 up		Major	PRC SLAB	OPEN	SOLAN DARA
13	267	227/23-25	10 up	2.52	Major	RCC SLAB	OPEN	
14	268	228/25-27	2 up	22.88	Major	GIRDER	WELL	SARASWATI NALA
15	269	229/23-27	15 up	6.09	Major	PRC SLAB	OPEN	DAULAT PUR BR.
16	276	235/28-32	15 up	6.1	Major	PRC SLAB	OPEN	
17	280	238/25-27	6 up	5.94	Major	PSC SLAB	OPEN	
18	281	239/19-21	4 up	5.94	Major	PSC SLAB	OPEN	
19	282	243/9-11	3	5.94	Major	PSC SLAB		
20	286	247/11-13	3 up	6.1	Major	PSC SLAB	OPEN	
21	289	251/5-7	5 up	6.1	Major	PSC SLAB	OPEN	
22	290	253/1-3	1 up	22.86	Major	GIRDER	OPEN	
23	291	253/12-13	1 up	22.86	Major	GIRDER	OPEN	MG FLOORING
24	293	256/5-7	1 up	30.48	Major	TRINGULAT GR.	OPEN	CHOWA NALA
25	299	263/21-23	6 up	2.58	Major	RCC SLAB	OPEN	
26	300	264/6-7	3 up	6.1	Major	PSC SLAB	OPEN	
27	302	266/10-11	4+3+2 up	4X6.10+3X1.895+2X3.00	Major	PSC SLAB+BOX	OPEN	
28	304	267/25-27	3 up	6.1	Major	RCC SLAB	OPEN	
29	312 New	271/19-21		3x4x2	Major	Box		
30	313	273/22-30	8 up	22.86	Major	GIRDER	WELL	
31	314	275/8-10	5+2+1+3 up	6.10+3.25+1.966+3.25	Major	PRC SLAB	OPEN	
32	314A	275/1-8		8x(2x4x2)	Major	Box		
33	314B	275/11-18		8x(2x4x2)	Major	Box		
34	315	277/8-10	4 up	6.1	Major	PRC SLAB	OPEN	
35	316	278/4-6	4 up	6.1	Major	PRC SLAB	OPEN	
36	322-A	283/11-13	4 up	2X18.3+2X12.20	Major	GIRDER	OPEN	
37	2-D-7	---		4x30.5	Major	Through Type Steel Truss		

SN	Bridge No.	Locat -ion	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
38	325	287/1 6-20	8+5	8X8.23+5X 12.20	Major	GIRDER	OPEN	
39	331	294/1 3-17	15 up	6.09	Major	PRC SLAB	OPEN	
40	338	300/1 7-19	8 up	6.09	Major	PRC SLAB	OPEN	RE-BUILT-1988
41	339	301/1 9-21	8 up	6.09	Major	PRC SLAB	OPEN	
42	344	304/1-3	8 up	6.09	Major	PRC SLAB	OPEN	REPL/10-92
43	348	305/1 5-17	2	7.92	Major	RCC Slab		
44	351	306/1 1-13	5 up	6.09	Major	PRC SLAB	OPEN	REPL/8-91
45	3-D-4	---		4x18.3	Major	PSC Girder		
46	361-A	319/2 5-27	6 up	6.09	Major	PRC SLAB	OPEN	REP/05-93
47	385	354/0-1	2+2+ 2 up	2X24.23+2 X21.34+2X 24.08	Major	GIRDER	WELL	SIRHIND CANAL

Annexure- 3.6 : List of Important Bridge Structures

Bridge No.	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Remarks
245	7	60.96	Important	TRUSS WELL	YAMUNA RIVER
262	14	6.1	Important	PRC SLAB	CHAUDAH DARA
283	4	45.72	Important	TRUSS WELL	MARKHANDA RIVER
294	4	45.72	Important	TRUSS WELL	TAGRI RIVER

Annexure- 3.7: List of RoBs

Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
LX 75/B/T	156/5-6			ROB			
LX 76/C/E	159/5-6			ROB			
LX 77/C/E	161/10-11			ROB			
LX 78/C/T	163/13-14			ROB			
LX 79/C/T	165/4-5			ROB			
LX 84/C/E	175/12-13			ROB			
LX 84A/C/E	177/6-7			ROB			
LX 86/B/T	181/15-17			ROB			ROB Under Construction
LX 88/C/E	185/1-3			ROB			
LX 89/C/E	186/15—17			ROB			
LX 90A/C/T	189/13-15			ROB			
LX 93/C/E	196/7-9			ROB			
LX 94/C/E	197/3-5			ROB			
LX 95/C/E	198/13-15			ROB			
LX 96/C/E	200/15-17			ROB			
LX 97/C/E	208/21-23			ROB			
LX 97A/C/T	210/25A-25B			ROB			
LX 99/C/E	213/15-17			ROB			
LX 100/C/T	215/27-29			ROB			
LX 101/C/E	217/9-11			ROB			
LX 102/C/E	219/3-5			ROB			
LX 103/C/E	220/13-15			ROB			
LX 104/C/E	221/26-28			ROB			
LX 107/C/T	228/3-5			ROB			
LX 109/C/E	233/3-5			ROB			
LX 110/C/E	236/8-10			ROB			ROB

Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
LX 111/C/T	236/18-20			ROB			
LX 112/C/E	237/33-35			ROB			
LX 117/C/T	248/7-9			ROB			
LX 118/C/E	250/9-11			ROB			
LX 120/C/T	254/27-29			ROB	Within a DFCCIL & SW Crossing Station	CLOSE?	
LX 124/C/E	265/18-20			ROB			
LX 126/A/T	269/12-14			ROB			
LX 127C/T	270/26-28			ROB			
LX 128/C/E	272/7-9			ROB			
LX 129/C/E	274/13-15			ROB			
LX 130/C/E	276/5-7			ROB			
LX 131/CE	279/20-22			ROB			ROB under Construction.
LX 132/C/E	282/5-7			ROB			
LX 133/C/E	284/0-1			ROB			
LX 134A/C/E	288/15-17			ROB			
LX 137/C/E	293/21-23			ROB			
LX 138/C/E	296/21-23			ROB			
LX 139/C/T	299/29-31			ROB			
LX 140/C/E	302/25-27			ROB			
LX 140A/C/E	304/5-7			ROB			
LX 141/C/T	306/23-25			ROB			
LX 142/C/E	309/5-7			ROB			
143/C/E	311/15-17			ROB			
LX 144/C/E	312/27-29			ROB			

Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
LX 145/B	314/13-15			ROB			ROB under Construction.
LX 150/C/E	321/17-19			ROB			
LX 151/C/T	325/3-5			ROB			
LX 154/C/E	331/13-15			ROB			
LX 155/B	332/17-19			ROB			ROB Sanctioned.
LX 157/C/E	336/21-23			ROB			
LX 158/C/E	337/29-338/1			ROB			
LX 159/C/E	341/7-9			ROB			
LX 160/C/E	342/13-15			ROB			
LX 161/C/E	343/15-17			ROB			ROB Under Construction
LX 162/C/E	345/27-29			ROB			
LX 163/C/E	348/29-31			ROB			
LX 164/C/E	351/9-11			ROB			
LX 164/B	352/23-25			ROB			
LX 164A/B/E	353/35-354/1			ROB			
LX 165/C/E	354/17-19			ROB			
LX 167/C/E	357/21-23			ROB			
LX 168/C/E	359/5-7			ROB			
LX 17/C/E	28/3-4			ROB??			Move crossing station 100m - 200m South
				ROB Alterations		Within a DFCCIL Crossing Station	NH 24 Hapur By-pass
				ROB Alterations	Meerut Detour	On NH119 bridge at Junction	
	180/2			ROB Alterations			
	182/21			ROB Alterations			
	262/33-35			ROB Alternations			

Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comment	Remarks
	289/13-15			ROB Alterations			
	291/7			ROB Alterations			
	213/6-7			ROB Alternations			
	314/18			ROB Alternations			

Annexure- 3.8: List of RuBs

Khurja-Talheri Section

S. No.	Chainage	Br.No.	Proposed Span			Remark
			No.	Width	Height	
KHURJA-HAPUR LINE						
KHURJA FLYOVER						
1	KRJ RUB1	-1483.39	1	5.5	4.5	
2	KRJ RUB2	-2048.31	1	5.5	4.5	
3	KRJ RUB3	-2495.37	1	5.5	3.5	
4	KRJ RUB4	-2793.19	1	5.5	4.5	
5	KRJ RUB5	-2952.87	1	5.5	3.5	
6	KRJ RUB6	-4252.5	1	5.5	3.5	
7	KRJ RUB7	-4807.51	1	5.5	4.5	
8	KRJ RUB8	-5391.32	1	5.5	3.5	
9	KRJ RUB9	-5457.4	1	5.5	4.5	
10	KRJ RUB10	-5719.52	1	5.5	4.5	
11	KRJ RUB11	-6208.24	1	5.5	3.5	
KHURJA-HAPUR LINE						
12	141.263	1	1	5.5	3.5	L-xing N0.2
DELHI - MORADABAD LINE						
13	62140.63	2	1	5.5	4.5	L-xing N0.75
HAPUR DETOUR						
16	62147.50	HPRUB1	1	5.50	4.5	
17	64898.80	HPRUB2	2	5.50	4.5	
18	65811.62	HPRUB3	1	5.50	3.5	
19	66541.14	HPRUB4	1	5.50	3.5	
MEERUT DETOUR						
20	82335.73	MTRUB1	1	5.50	3.5	
21	82765.33	MTRUB2	1	5.50	3.5	
22	84171.21	MTRUB3	1	5.50	3.5	
23	84552.00	MTRUB4	1	5.50	4.5	
24	86233.70	MTRUB5	1	5.50	3.5	
25	87522.49	MTRUB6	1	5.50	3.5	
26	88010.32	MTRUB7	1	5.50	3.5	
27	88722.32	MTRUB8	1	5.50	3.5	
28	89184.55	MTRUB9	1	5.50	3.5	
29	90393.25	MTRUB10	1	5.50	3.5	
GZB-SRE LINE						
14	96769.265	3	1	5.5	3.5	L-xing

S. No.	Chainage	Br.No.	Proposed Span			Remark
			No.	Width	Height	
						N0.23
15	98937.96	4	1	5.5	3.5	L-xing N0.24

Talheri-Ludhiana Section

Sr.No.	Chainage	Br.No.	Proposed Span			Remark
			No.	Width	Height	
1	171/4-5					On LC No. 82
2	173/700-800					On LC No. 83
3	260/0-1					On LC No. 122
4	287/4-6					On LC No. 134CE
5	315/27-29					On LC No. 146/C/T
6	317/15-17					On LC No. 147/C/E
7	318/9-11					On LC No. 148/C/E
8	124983					On Detour Portion
9	124587					On Detour Portion
10	97950					On Detour Portion
11	69900					On Detour Portion.
12	68595					On Detour Portion.
13	13000					On Detour Portion.

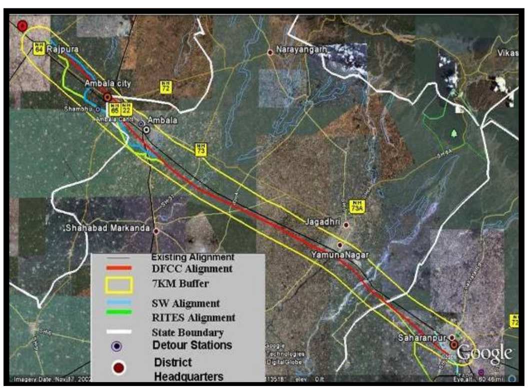
Chapter 4. Baseline Environmental Profile

4.1. Baseline

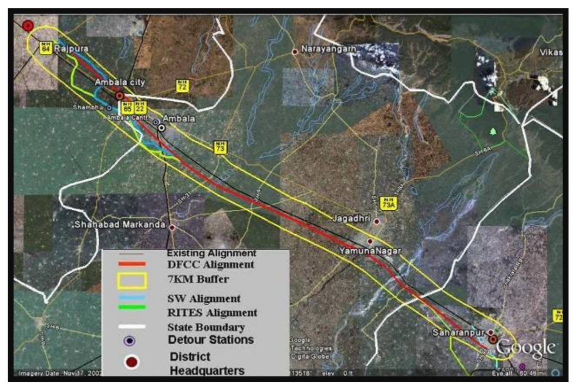
The natural environment, commonly referred as the environment, is a term that encompasses all living and non-living things occurring naturally on earth or some region thereof. The concept of the natural environment can be broken down into a few key components like physical, which includes physical phenomena like air, water, soil, noise and climate, biological, which comprises of ecological units that function as natural systems and socio-economic scenario.

The natural environment is sensitive to even the minute activities carried out by humans unless it is kept under a certain limited level. This level depends on the specific context, and changes in different areas and contexts. Thus, it is imperative to study the existing environmental conditions not only to establish the present physical, biological and socio-economic scenario but also in order to predict future impacts owing to construction and operation of the project.

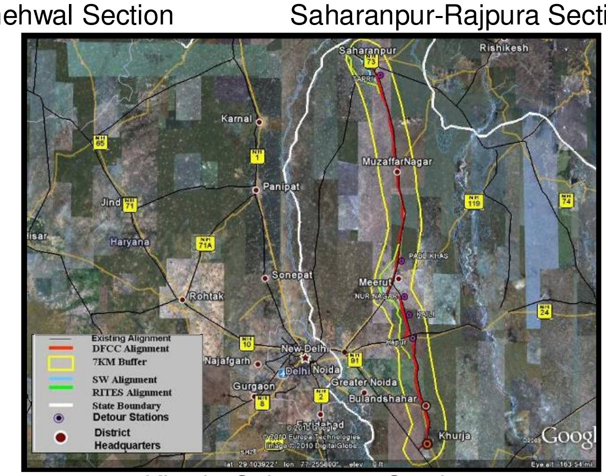
The proposed alignment is passing through three major states of India i.e. Uttar Pradesh, Haryana & Punjab covering a total length of 404.098 km (**Figure 4.1**). The chapter assesses the relevant physical, biological and socio-economic components of the environment along the proposed EDFCsection. The data related to the study area has been assembled from various secondary sources and primary environmental surveys on ambient air quality, noise and vibration levels, water and soil quality, aquatic and terrestrial ecology.



Rajpura-Sanehwal Section



Saharanpur-Rajpura Section



Khurja-Saharanpur Section

Figure 4.1 : Study Area Map

To study the environmental parameters effectively the entire alignment has been divided into four stretches in both the core zone (within 100 m) and buffer zone (7 km radius) namely:

Ch. 0.00 to Ch. 100 km and Ch. 101 to Ch. 200 in U.P. (two stretches),
Ch. 201 to Ch. 300 km in Haryana (one stretch),
Ch. 301 to 389 km in Punjab (one stretch)

The sampling of physical environment namely- air quality, water, soil, noise & vibration was done at various locations to estimate the baseline status in both the core and buffer zone along the finalized alignment. The sampling locations were chosen considering their sensitivity during construction and operation phases of the project. A detailed study of the ecology in the study area - terrestrial and aquatic including wild life movement, tree cover, endangered species, biodiversity etc., was also conducted. The land-use land-cover and drainage maps using the recent satellite imageries have been used to identify the material sourcing and drainage pattern for the project. The summary of key environmental features is given in **Table 4.1** below.

Table 4.1 : Summary of Environmental Features

S. No.	Environmental Features	Within 100 m core zone	Within 7 km buffer zone
1.	Ecological		
	a. Presence of Wildlife Sanctuary/ National Park	None	None
	b. Reserved Forests	None	None
	c. Protected Forests	All area along both sides of the existing track is plantation has been categorised as protected forest	Kalanaur and small stretch in Meerut (Gangol)
	d. Wetland	None	None
	e. Migratory route for wild animals	None	None
	f. Migratory routes for birds	None	None
	g. Migratory routes for fishes	None	None
	h. Presence of schedule 1 animal including rivers	None	None except Gyps Bengalensis (Bird)
	i. Tree cover	Poplar, Eucalyptus, Mango, Neem and Shisam are the most dominant species observed. Approximately **16723** trees need to cut.	Mango in U.P., Poplar in Haryana and Punjab are the most dominant.
	j. Birds Nesting	Cattle Egret, House Crow, common Myna, Weaver bird commonly sighted.	Same
2.	Archaeological Monuments	None falls within 300 m of proposed track	Yes. The list is enclosed in **Section 4.4.7**
3.	Water Bodies	**Crossing Rivers** – Yamuna, Markanda, Tangri and Ghaghhar **Crossing Canals** – Upper Ganga, Western Yamuna Canal	Rivers within 7 km – Kali, Yamuna, Markanda, Tangri and Ghaghhar Canals – Upper Ganga, Western Yamuna Canal, Eastern Yamuna Canal, Bhakhra canal, Sirhind canal.
4.	Ground water	The alignment passes through **Over exploited** blocks of	Same as in core zone

S. No.	Environmental Features	Within 100 m core zone	Within 7 km buffer zone
		Jagadhari, mustafabad, Rajpura, Sirhind and Khanna. **Critical** blocks of Barara and Doraha. **Semi-critical** blocks of Khatauli, Deoband and Gulaothi.	
5.	Land-use	Primarily agricultural (62%) followed by settlement area (17.3%), water bodies (0.7%), open land (18%), vegetation (1.8%), barren land (0.2%).	Primarily agricultural (77%) followed by settlement area (11.3%), water bodies (0.7%), open land (10.0%), vegetation (0.3%), barren land (0.2%).
6.	Physically sensitive receptors	**Physical-Cultural resources getting affected** – 39	On the similar pattern.
7.	Social	**Poverty** – highest in U.P. followed by Haryana and least in Punjab **Indigenous** – none **HIV/AIDS** – none	On the similar pattern.

4.2. Physical Environment

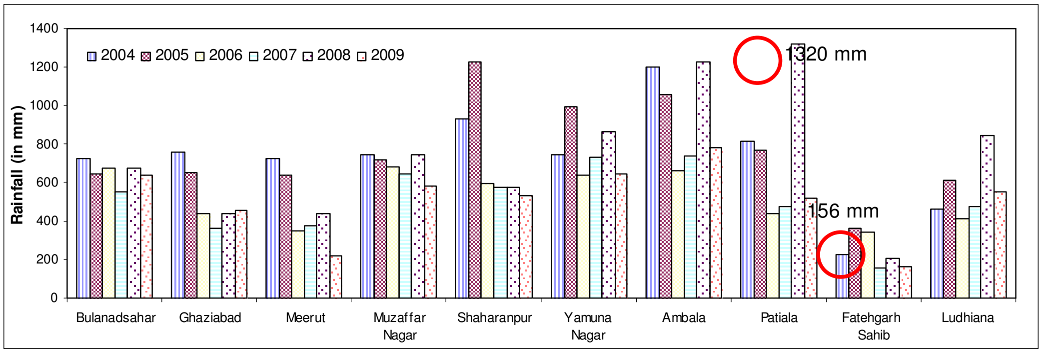
4.2.1. Meteorology and Climate

The entire stretch from Khurja (Uttar Pradesh) to Sanehwal (Ludhiana) passess through ten Districts namely Bulandshahar, Ghaziabad, Meerut, Muzaffarnagar, Saharanpur (Uttar Pradesh), Yamunanagar, Ambala (Haryana), Fatehgarh Sahib, Patiala and Ludhiana (Punjab). To establish the meteorological features of the project area, data has been collected from India meteorological department (IMD) Delhi. It is found that the project alignment has predominantly four seasons namely – summer (mid-March to June), monsoon (July to mid-September), post-monsoon (mid-September to November) and winter (December to February). It has a subtropical climate characterized by high temperature, low humidity, and medium to scanty rainfall. The details of the parameters studied for the project area are shown in Table 4.2

Table 4.2 : Details of Meteorological Data Collected for the Project Area

Parameter	Stations	Duration	Source
Rainfall	1. Bulandshahar 2. Ghaziabad 3. Meerut 4. Muzaffarnagar 5. Saharanpur 6. Yamunanagar 7. Ambala 8. Fatehgarh Sahib 9. Patiala 10. Ludhiana	Last five years (2005 – 2010)	India Meteorological Department, Delhi
Wind Speed and Direction Temperature Humidity	1. Aligarh 2. Meerut 3. Ambala 4. Patiala 5. Ludhiana	June 2009 to May 2010	India Meteorological Department, Delhi

Rainfall: the rainfall distribution pattern in the entire project area is uneven. The maximum annual rainfall recorded during the last five years was in Patiala (1320.4 mm in 2008). The minimum annual rainfall was observed in Fatehgarh Sahib (156 mm in 2007). The average annual rainfall of Fatehgarh Sahib District among others is found to be the lowest. The annual rainfall pattern in the project district is shown in figure 4.2

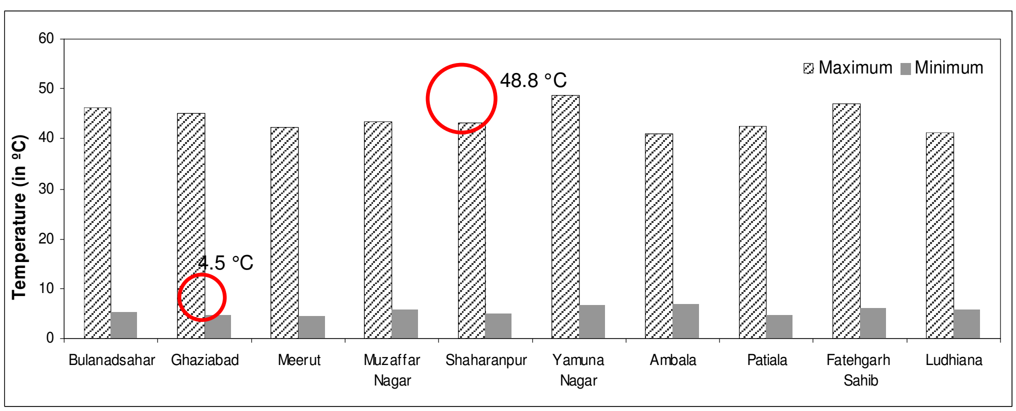


Source: India Meteorological Department (IMD), Delhi

Figure 4.2 : Average Annual Rainfall in the study area (2004-2009)

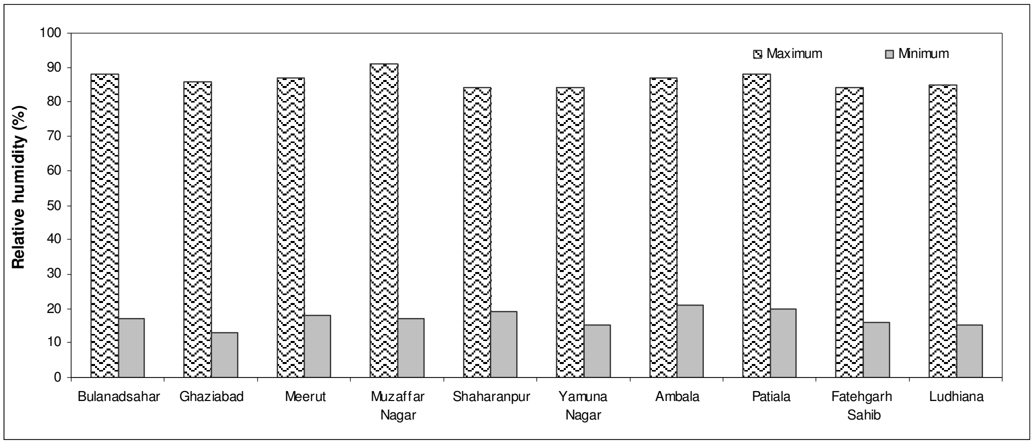
Wind: The wind speed & direction in the project districts is found to be varying at different locations in each season. The wind data for Aligarh, Meerut, Ambala and Ludhiana indicate winds are mostly low (< 8 km/hr). The predominant wind direction in the project area is during the year 2009-10 are west, north-west and south-west. Wind speed is relatively high during the summer months of April and May and during the monsoon months. During the post-monsoon and winter, the wind speed is relatively low (mean speed = 2 – 6 km/h). The maximum average wind speed was observed in May and June 2009 at all the stations, while, November and December was comparatively calm.

Temperature & humidity: The maximum annual average temperature in the study area is found in Yamunanagar district (48.8ºc) while the lowest is observed in Patiala district (4.5 ºc) during the period 2008-09. The annual average humidity is very low in the entire project area. The relative humidity ranges from 13 to 88% in the study area. The temperature and humidity of the project area are shown in figure 4.3 & figure 4.4.



Source: India Meteorological Department, Delhi

Figure 4.3 : Annual Average Temperature in the Study Area 2008-09



Source: India Meteorological Department, Delhi

Figure 4.4 : Annual Average Relative Humidity in the Study Area in 2008-10

The conclusions of the above analysis are shown in **Table 4.3** below. The table reveals that the range of temperature and humidity is almost same in the entire project area. However, the parameters, wind and rainfall vary in different sections of the alignment. The maximum rainfall was recorded in the last stretch but wind speed is found to be lowest. Generally, the wind blows in the north-west direction in the entire project area.

Table 4.3 : Summary of Meteorological Variations in Different Sections

Parameters	Ch. 00 – 100 km (Aligarh and Meerut)	Ch. 101 – 200 km (Meerut)	Ch. 201 – 300 km (Ambala)	Ch. 301 – 400 km (Ludhiana)
Rainfall (range in mm)	221 – 754	532 – 1226	637 – 1228	156 – 1320
Wind Speed (range in kmph)	4 – 9	4 – 9	5 – 8	2 – 5
Wind Direction (16 point compass)	W and NW	W and NW	SE and NW	SE and NW
Temperature (°C)	6.1 – 41.9	6.1 – 41.9	6.1 – 39.6	6.2 – 40.3
Humidity (%)	23 – 85	23 – 85	26 – 84	26 – 84

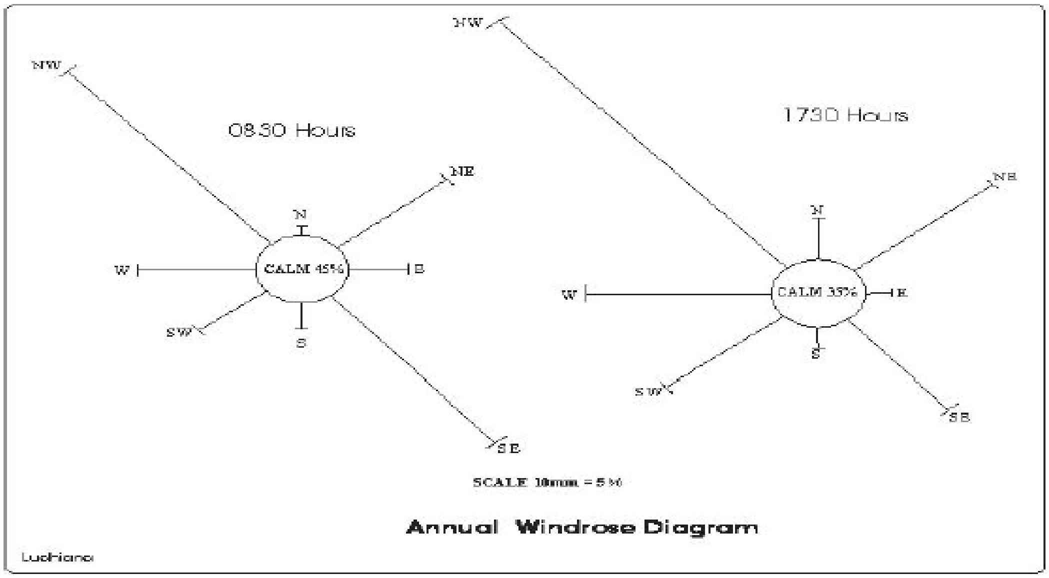


Figure 5.1: Wind Rose Diagram for Ludhiana IMD Observatory

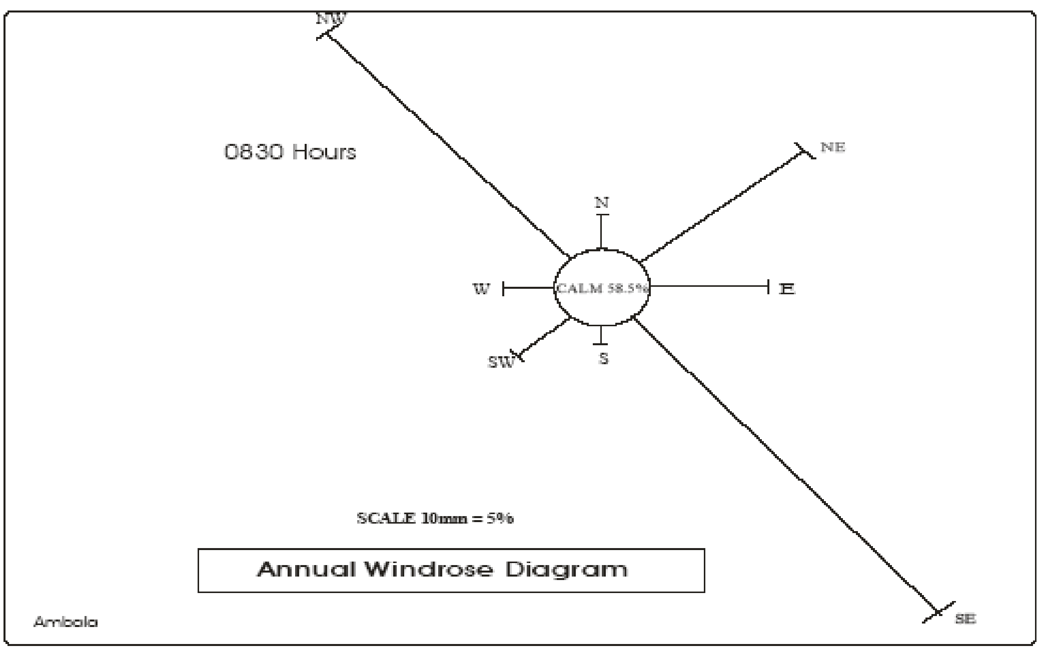


Figure 5.2: Wind Rose Diagram for Ambala (8.30 AM) IMD Observatory

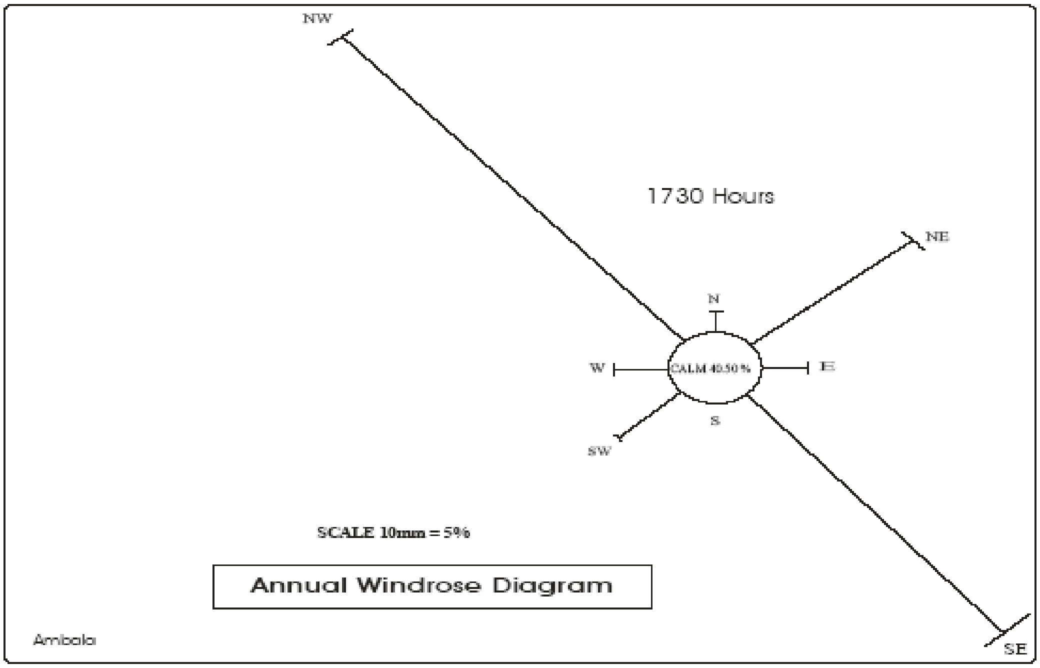


Figure 5.3: Wind Rose Diagram for Ambala (5.30 PM) IMD Observatory

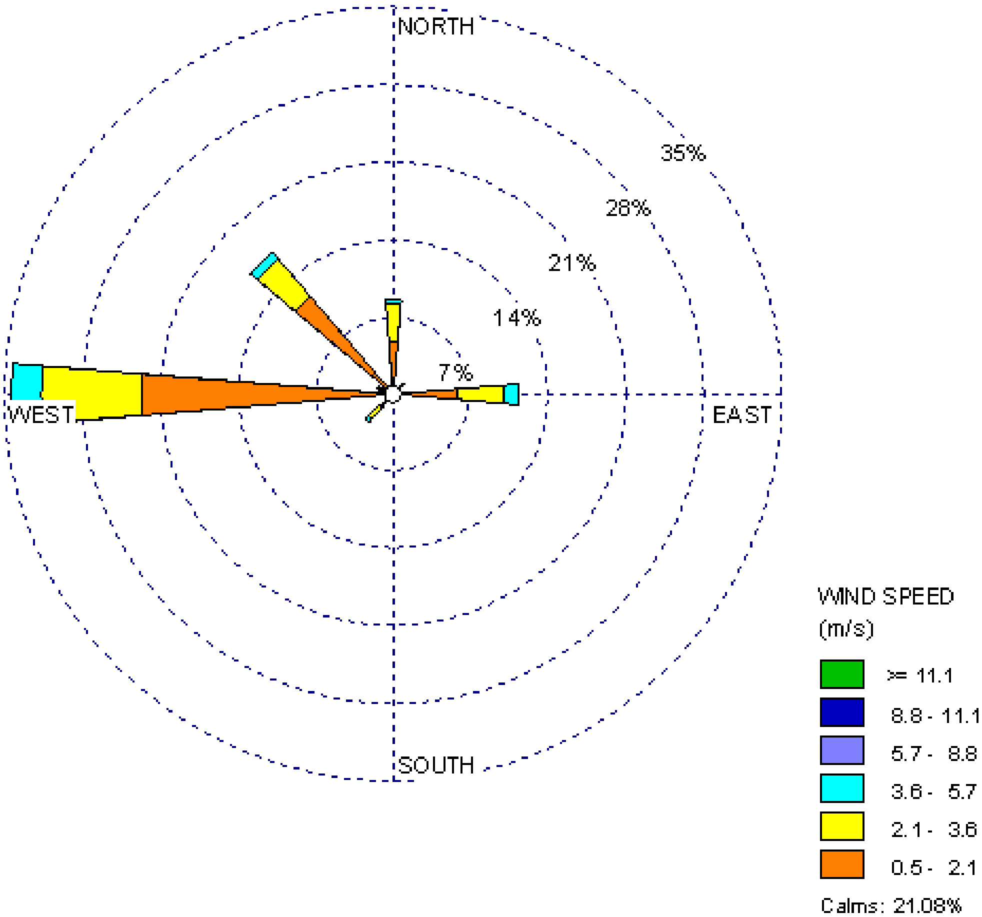


Figure 4.5 : Aligarh (December 2008 to February 2009)

4.2.2. Air Quality

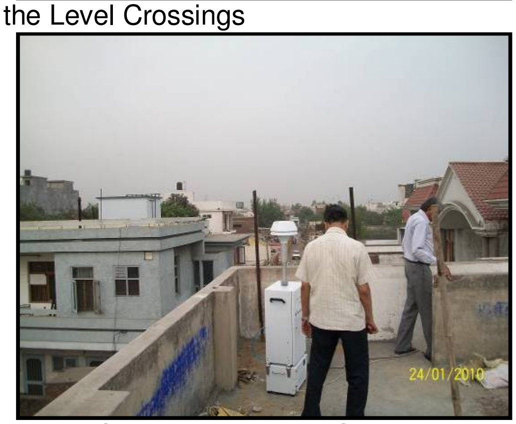
The ambient air quality level in the study area was determined by monitoring of criteria pollutants namely suspended particulate matter (SPM), particulate matter (PM2.5), respirable suspended particulate matter (RSPM i.e. PM10), sulphur dioxide (SO_2) and oxides of nitrogen (NOx). The monitoring was conducted for winter season covering the period from December 2009 to February 2010. The ambient air quality monitoring has been conducted at different locations covering 44 locations spread across the entire length. The locations of monitoring are true representatives of study area. These cover rural, residential, commercial, and industrial. The monitoring has been done in core zone and buffer zone. The air quality sampling was also assessed at detour locations. All the major habitations have been bypassed. The methodology followed for AAQ measurements is described at **Annexure -4.1**.

The air quality results reveal that except the particulate matter (SPM and PM10) all other pollutants are well within the prescribed standards. The dust levels (SPM and RSPM) are found to be quite high at locations like Meerut, Khatauli, Saharanpur, Mandi Gobindgarh etc., due to heavy traffic movement and presence of industries like sugar, iron and steel.The gaseous pollutants are observed to be within limits at all the locations. The concentrations of SPM, RSPM, PM2.5, SO_2 and NO_x are in the range 541-189 µg/m^3, 162-118 µg/m^3, 45-18 µg/m^3, 23-10 µg/m^3 and 18-8 µg/m^3 respectively, in the project area. The photographs of ambient monitoring of some sites are presented below:

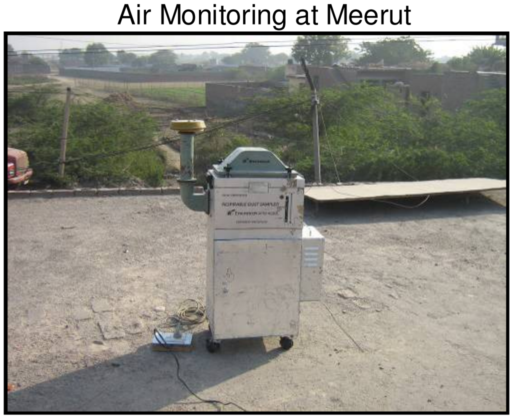
Industries along the Alignment

Traffic Congestion At the Level Crossings

Air Monitoring at Meerut



Air Sampling at Mandi Gobindgarh



Air Monitoring at Bulandshahar

Air monitoring at Sirhind

A summary of the ambient air quality is shown in **Table 4.4** below. The table shows that air quality along the entire project sections is above the prescribed standards for the particulates and is particularly poor along ch. 101 – 200 km and ch. 301 – 400 km sections. Location wise and date wise detailed results presented in **Annexure-4.2**.

Table 4.4 : Summary of Air Quality Variations during Winter Season

Parameters	**Ch. 00 – 100 km (Khurja- Meerut)**	**Ch. 101 – 200 km (Meerut-Talheri Bujurg)**	**Ch. 201 – 300 km (Talheri Bujurg-Ambala)**	**Ch. 301 – 400 km (Ambala-Ludhiana)**
SPM (ug/m^3)	186 – 362	228 – 376	200 – 356	225 – 421
PM2.5 (ug/m^3)	19 - 42	21 – 37	21 – 33	21 – 45
RSPM (PM10) (ug/m^3)	117 – 222	177 – 257	134 – 222	118 – 250
SO_2 (ug/m^3)	11 – 35	21 – 37	12 – 28	12 – 53
NO_X (ug/m^3)	12 – 32	11 – 34	10 – 25	13 – 33

4.2.3. Noise and Vibration

The project being associated with Railways is expected to generate considerable noise and ground vibrations, especially, in the immediate vicinity of the tracks. In order to evaluate the noise and vibration levels due to new freight trains, it was necessary to collect data on unit level of the railway noise and vibration with respect to the features such as train categories, railway track characteristics, structural characteristics, attenuation patterns with distance/train speed, etc., especially along the densely populated areas. For this purpose, ambient noise and ground vibration levels (hereafter referred to as vibrations) were measured at various locations along the alignment to ascertain their current levels and identify the hotspots. These were also measured at sensitive locations like temples, schools, hospitals etc.

Railway noise - as for railway noise level, sound pressure level (Leq) and equivalent continuous a-weighted sound pressure level (Leq) of passing trains was measured. The standardized method of ambient noise measurement was applied. Methodology for noise and vibration study is described in **Annexure- 4.3**. The schematic layout for noise and vibration measurements has been shown in **Figure-4.6.**.

Railway vibration - as for railway vibration levels, peak level (lpeak) of vibration was measured. In general vertical vibration may directly affect human body while horizontal vibration may affect stability of structures like trembling and cracking of walls. In India, the method of vibration measurement is based upon the iso procedure which measures both vertical and horizontal vibration. One of the reasons why the above procedure is applied is that structural instability of buildings results in collapse and cracking of structure walls in India. In this survey, Japanese standard (JIS Z 8735) was used for vibration measurement.

The variation of noise and vibration along the proposed alignment is shown in **Figure 4.7**. Railway noise and vibration measurements were carried out simultaneously using` noise and vibration level meters at at distance of points at 12.5 m, 25 m and 50 m (3 point measurement at each monitoring location) from the centre of the nearest railway track. The noise levels recorded are shown in **Table 4.5** for each passing train in one direction. The figure reveals that the noise levels exceed the prescribed standards both during day and night-time at several locations. It is sufficiently high in populated areas due to vehicular flow and other commercial activities. The levels are found to be within limits in residential areas.

Ambient Sensitive Receptors

Source: JICA Study Report

Figure 4.6 : Schematic Layout of Noise and Vibration Measurement Sites

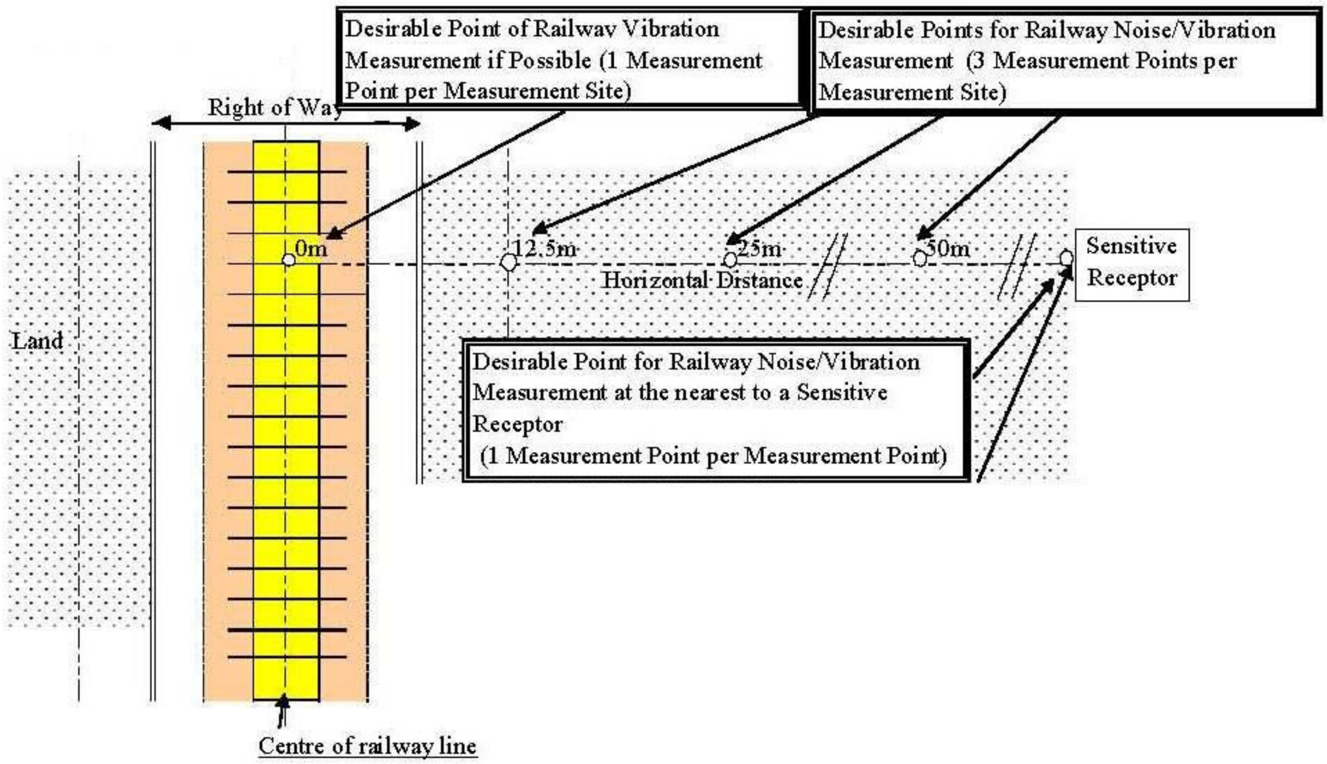


Table 4.5 Ambient Noise Level along the Corridor

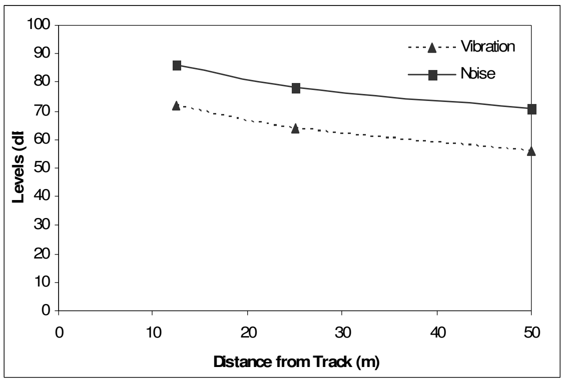
S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
1.	Acharya Industries Nizampur, Bulandshahar	Core	Industrial	60.8	50.3	69	55	Due to heavy Industrial activities as well as road and train traffic the noise level is very high
2.	Dharpa Dadupur	Buffer	Rural	53.9	42.3	69	39	Noise level is within the prescribed limit of CPCB
3.	Bulandshahar Station	Core	Commercial	61	48	65	34	Due to heavy commercial activities as well as road and train traffic the noise level is very high
4.	Bedmani Hospital , Bulandshahar	Core	Commercial	62.8	45	71	39	Daytime noise level is little high due to commercial activity and train/road traffic
5.	Primary School, Murshidpur Near Hafizpur Station	Core	Silent	52.1	42.1	55.8	31.5	Noise level is within the prescribed limit of CPCB
6.	Rampur, Near Hapur	Buffer	Rural	51.5	43.2	79.3	29.7	Noise level is within the prescribed limit of CPCB
7.	Pal Hara	Buffer	Rural	49.2	38.6	78.9	28.3	Noise level is within the prescribed limit of CPCB
8.	Gagaul	Buffer	Rural	42.3	38.9	54	37	Noise level is within the prescribed limit of CPCB
9.	Adarsh Siksha Jr. High School Kharkhauda	Core	Silent	54.7	42.5	69	32.5	Noise level is within the prescribed limit of CPCB
10.	Sundra, Partapur	Buffer	Residential	54.3	42.5	68	49	Noise level is within the prescribed limit of CPCB
11.	Rathani, Partapur	Buffer	Rural	51.3	42.5	85	29.5	Noise level is within the prescribed limit of CPCB
12.	NH119 Crossing, Meerut	Core	Commercial	68.1	57.2	83	38	Due to heavy commercial activities as well as road and train traffic the noise level is very high
13.	Gulauti Station	Core	Commercial	64.1	42.2	75	51	Due to heavy commercial activities as well as road and train traffic the noise level is very high
14.	Meerut City	Core	Commercial	70.2	58.7	83.3	34.5	Due to heavy commercial activities as

S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
								well as road and train traffic the noise level is very high
15.	Walidpur, Meerut	Buffer	Residential	53.9	32.5	92.8	29.5	Noise level is within the prescribed limit of CPCB
16.	Naula	Buffer	Residential	68.3	40.5	81.4	35.2	Noise level is within the prescribed limit of CPCB
17.	Sardar Ballav Bhai Patel University of Agri. & Tech. Pabli Khas	Core	Silent	49.9	32.7	78	27.5	Noise level is within the prescribed limit of CPCB
18.	Hitkari Kissan Inter College Sakhauti	Core	Silent	58.6	42.7	71	33	Daytime noise is a little high due to train movement
19.	Muzaffar Nagar	Core	Commercial	70	51	81.3	31	Due to heavy commercial activities as well as road and train traffic the noise level is very high
20.	Rohana	Buffer	Rural	46	37.5	68.2	31.2	Noise level is within the prescribed limit of CPCB
21.	Deoband Industrial Area	Core	Industrial	73	56	78.3	42	Due to heavy Industrial activities as well as road and train traffic the noise level is very high
22.	Talheri Buzurg	Core	Silent	47	33.2	69	28.5	Noise level is within the prescribed limit of CPCB
23.	Ranakhandi Near Talheri Buzurg	Buffer	Rural	49.5	35.2	69	31.5	Noise level is within the prescribed limit of CPCB
24.	Tapri	Buffer	Rural	65	62.5	84.2	50.2	Noise level is high since the NH 73 is passing across the village parallel to railway track
25.	Saharanpur City	Buffer	Commercial	67	60.2	92.1	51	Due to heavy commercial activities as well as road traffic the noise level is very high
26.	Jaihind Public School, Sheikhpura. Saharanpur	Core	Residential	53.3	42.2	70	50.9	Noise level is within the prescribed limit of CPCB
27.	Saharan pur Public School	Core	Silent	62.5	47	79	44.2	Noise level is high due to road traffic

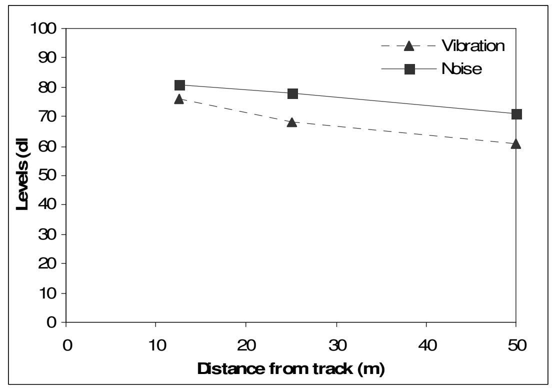
S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
28.	Janata Inter College, Sarsawa	Buffer	Commercial	51	42	81	49	Noise level is within the prescribed limit of CPCB
29.	KLG Public School, Saharanpur	Core	Sensitive	69	60.5	82.8	41	Noise level is high due to road & railway traffic
30.	Pilkhani	Buffer	Rural	47.3	34.5	72	44.3	Noise level is within the prescribed limit of CPCB
31.	Asian Group of College, Darazpur	Core	Residential	51.9	39.2	78	41.2	Noise level is within the prescribed limit of CPCB
32.	High School, Mustafabad (Chainage-269km)	Core	Commercial	68.6	60.7	71	49	High due to commercial activities and road & railway traffic
33.	Barara	Buffer	Rural	49	41.3	77	50.1	Noise level is within the prescribed limit of CPCB
34.	Kesri Railway Station	Core	Rural	54	49	72	35	Noise level is within the prescribed limit of CPCB
35.	Angel's Public School, Ambala	Core	Urban	78	60.3	78.2	49.1	Due to heavy commercial activities as well as road & train traffic the noise level is very high
36.	Pashupati Kusht Ashram Society, Ambala	Core	Commercial	77	57	81	46.3	Due to heavy commercial activities as well as road & train traffic the noise level is very high
37.	Primary School , Ambala	Core	Residential	69.3	54	71	45	Due to heavy commercial activities as well as road & train traffic the noise level is very high
38.	Rajpura	Buffer	Commercial	69.9	45	79	47.8	Due to heavy commercial activities as well as road traffic the day noise level is very high
39.	Sirhind Station	Core	Residential	67.9	59.3	75	41.9	Due to heavy commercial activities as well as road traffic the noise level is very high
40.	Om Prakash Bansal School, Mandi Gobindgarh	Core	Sensitive	48.3	33.5	76.7	29.3	Noise level is within the prescribed limit of CPCB
41.	Robin Model School, Khanna	Core	Commercial	71	59	78.9	51.2	Noise level is very high due to heavy train traffic and commercial activities since the school campus is adjacent

S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
								to existing railway track
42.	Sanjivani Group of Institutes, Chawa Pail	Core	Sensitive	57	43	82	32.5	Daytime noise level is high due to heavy train traffic
43.	Primary School Chawa Pail	Core	Sensitive	48	32.7	80.1	28.5	Noise level is within the prescribed limit of CPCB
44.	Sultanpur, Doraha	Buffer	Residential	47.5	34.5	66.2	28.5	Noise level is within the prescribed limit of CPCB
45.	Near Aryaputri Senior Sec. School, Doraha	Core	Silent	58	43.5	65	34.8	Daytime noise level is little high due to heavy train traffic

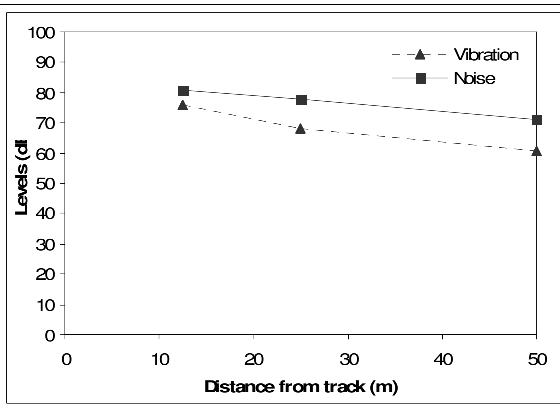
The train movement is also associated with significant ground vibrations which depend on the speed and type of the train, ground conditions and weather conditions especially humidity. The vibrations and noise level (impulse noise) during different train movements near rail-track were recorded from different types of trains and of varying speed along the proposed alignment as shown in **Figure 4.7**. The monitoring at 40 different locations divided into four different chainages groups was conducted as per the japanese standard (JIS Z 8735). These 40 locations are spread in the entire length of corridor. The monitoring results and methodology for noise and vibration is given at **Annexures 4.3 and 4.4**). The maximum value of vibration is found to be mainly close to the track which decreases with increasing distances from the track. It is also noticeable that both noise and vibration levels are almost same near the track however, dampening of vibration is faster than noise with increasing distance.



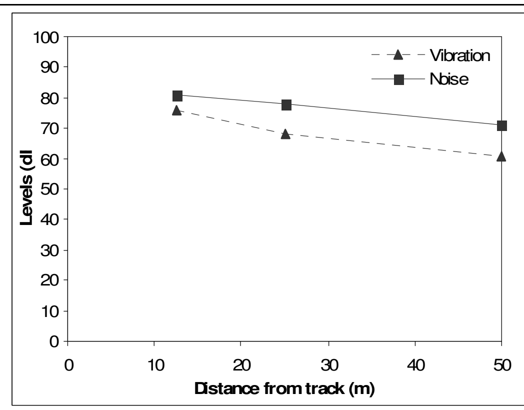
Chainage 00 km-100 km Group



Chainage 101 km -200 km Group



Chainage 201-300 km Group



Chainage 301-389 km Group

Source: Field Monitoring

Figure 4.7 : Attenuation Pattern of Noise & Vibration along the Alignment

The vibration isopleths from the centre of the track due to train movement along the alignment can be seen in **Figure 4.8**. The figure reveals that the levels are higher than the Japanese standards (70dB) within 10 m from the centre of the track. The variation in the vibration levels are due to different train movements, background vibrations due to road traffic, soil and moisture levels at the time of measurement. Measureable difference in vibration levels were observed at rural/urban and rob setup. However, the vibrations were not found to be significant close to the sensitive receptors which were located more than 25 m from the track. The vibration monitoring data has been given in **Table-4.6.**

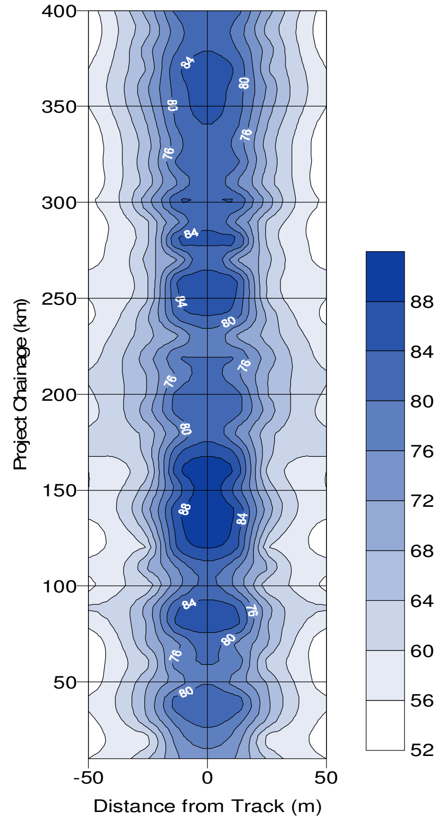


Figure 4.8 : Isopleths of Ground Vibration from the Centre of Track

Vibration Monitoring Along the Alignment

Table 4.6 : Vibration Monitoring Data

S. No.	Location	Classification	Set-up	Towards	Type of Train	Duration of passage (in Sec)	Length of the bogies (in m)	No. of Bogies	Speed (in km/hr)	Max. LdB at 5m	Max. LdB at 12.5 m	Max. LdB at 25m
1	**Khurja**	Semi-urban	Near Temple (Ch. 4.6 km)	Meerut	Passenger	35	20	10	20.6	68	66.1	60.6
2	**Bulands-hahar**	Urban	Bedmani hospital (Ch. 22.6 km)	Hapur	Passenger/ Freight/ Express	14,62,15	13,10,20	10,17,12	33.4,9.9, 57.6	71.2	71	65.5
3	**Hapur**	Semi-urban	Near Open area (Ch. 51.5 km)	Meerut	Express-Freight	18, 43	20,20	8,18	32,30.1	74.3	66	60.5
4		Urban	Residential Location near LX39/A/E	Dehradun	Express-Freight-Shatabdi	23, 28, 13	17,20,20	11,32,12	29.3,82. 2,66.5	83.2	78.3	72.8
5		Urban	Near commercial location (Ch. 61.8 km)	Jammu	Express-Freight-Shatabdi	14, 38, 14	17,20,20	11,32,12	29.3,82. 2,66.5	84.2	80.3	74.8
6	**Meerut**	Urban	Proposed ROB near Lx29/B/T	Jammu	Freight	60	13	32	25.0	72	70.2	64.7
7		Rural	Near Temple (Ch. 106.2 km)	Jammu	Passenger	8	20	9	81.0	57	55.4	49.9
8		Rural	Near Railway Bridge near Lx 35/B/T	Jammu/Delhi	Freight	44	18	61	89.8	68	62.6	57.1
9		Rural	Near Bric kiln (Ch. 109.4 km)	Jammu	Passenger	6	20	9	108.0	69	66.6	61.1
10	**Muzaffar nagar**	Rural	Near Muzaffarnagar Station (Ch. 161 km)	Delhi	Only Engine	2	20	1	36.0	68	67.1	61.6

S. No.	Location	Classification	Set-up	Towards	Type of Train	Duration of passage (in Sec)	Length of the bogies (in m)	No. of Bogies	Speed (in km/hr)	Max. LdB at 5m	Max. LdB at 12.5 m	Max. LdB at 25m
11	**Saharan pur**	Urban	Near Railway station crossing Lx88/C/E	Dehradun	Freight	32	20	42	94.5	62	60.1	54.6
12		Urban	Near Mosque 219.9 km	Jammu	Freight	46	15	50	58.7	69	67.3	61.8
13		Urban	Near Temple at 224.2 km	Delhi	Passenger	18	20	30	120.0	68	65.2	59.9
14		Semi-urban	Near Yamuna Bridge at Lx96/C/E	Jammu	Freight & Passenger	6	15	11	99.0	70	67.2	61.9
15	**Jagadhri**	Urban	Near Lx100C/T	Jammu	Paschim Express Amritsar Banda	15	20	20	96.0	60	57.2	51.9
16	**Barara**	Urban	Residential Location at Ch. 286 km	Jammu	Freight	65	18	44	43.9	70	67.2	61.9
17	**Ambala**	Urban	Temple near Ch. 306.3 km	Jammu	Passenger	10	20	11	79.2	60	57.2	51.9
18		Urban	At Lx126/A/T near NH 65	Delhi	Passenger	16	20	22	99.0	66	63.2	57.9
19		Semi-urban	At Lx129/C/E near proposed work access points	Meerut	Passenger	17	20	22	93.2	71	68.2	62.9
20		Rural	Near NH 1	Jammu	Freight	33	13	62	87.9	66.9	64.1	58.8
21		Rural	At Lx133/C/E near Ghagghar Sarai village	Jammu	Passenger	9	20	9	72.0	62.1	59.3	54

S. No.	Location	Classification	Set-up	Towards	Type of Train	Duration of passage (in Sec)	Length of the bogies (in m)	No. of Bogies	Speed (in km/hr)	Max. LdB at 5m	Max. LdB at 12.5 m	Max. LdB at 25m
22		Semi-urban	Near proposed new flyover at Ch. 327.2 km	Meerut	freight	32	15	61	102.9	61.5	58.7	53.4
23	**Rajpura**	Urban	Near Railway station	Jammu	Passenger	12	20	19	114.0	60.8	58	52.7
24		Semi-urban	At Lx137/C/E	Jammu	Engine	2	20	1	36.0	58.2	55.4	50.1
25		Semi-urban	Near temporary construction site at Ch. 337.5	Delhi	Passenger	15	20	20	96.0	59.4	56.6	51.3
26		Rural	Near Briklins at Lx139/C/T	Delhi	Passenger	15	20	19	91.2	60.6	57.8	52.5
27		Rural	Near Sadhugarh railway station	Meerut	Freight	46	15	52	61.0	57.9	55.1	49.8
28	**Sirhind**	Rural	Near Temple at Km 356.3	Jammu	Passenger	5	20	6	86.4	57.8	55	49.7
29		Rural	Near Bhakhra Canal at Lx150/C/E crossing	Jammu	Engine	2	20	1	36.0	54.8	52	46.7
30	**Mandigo-bindgarh**	Urban	Temple at Ch. 367.5 km	Delhi	Passenger	22	20	25	81.8	62.9	60.1	54.8
31		Urban	Temple at Ch. 368 km	Delhi	Passenger	13	20	17	94.2	62.8	60	54.7
32		Semi-urban	Open area at Lx153/C/E	Jammu	Freight	35	15	61	94.1	65.9	63.1	57.8
33	**Khanna**	Semi-urban	Near Mosque and School	Jammu	Passenger	13	20	12	66.5	62.6	59.8	54.5

S. No.	Location	Classification	Set-up	Towards	Type of Train	Duration of passage (in Sec)	Length of the bogies (in m)	No. of Bogies	Speed (in km/hr)	Max. LdB at 5m	Max. LdB at 12.5 m	Max. LdB at 25m
			at Ch. 374.5 km									
34		Semi-urban	Near Gurudwara at Ch. 37.4 km	Rajpura	Passenger	13	20	20	110.8	73.4	70.6	65.3
35		Rural	Near Ch. 383 km	Ambala	Passenger	8	20	9	81.0	68.8	66	60.7
36	**Between Doraha & Chawa Pail**	Rural	Temple at Ch. 389 km	Rajpura	Freight	35	15	60	92.6	74.7	71.9	66.6
37	**Between Doraha & Chawa Pail**	Rural	Gurudwara at Ch. 390 km	Ambala	Passenger	13	20	27	149.5	57.8	55	49.7
38	**Between Doraha & Chawa Pail**	Semi-urban	Near temporary construction at Ch. 391.2 km	Ambala	Passenger	13	20	12	66.5	54.8	52	46.7
39	**Doraha**	Semi-urban	Aryaputri School at Ch. 393 km	Rajpura	Passenger	20	20	20	72.0	54.8	52	46.7
40	**Sanehwal**	Semi-urban	Near Cremation ground at Ch. 398.5 km	Ambala	Passenger	24	20	22	66.0	60.3	57.5	52.2
									Max.	**84.2**	**80.3**	**74.8**
									Min.	**54.8**	**52**	**46.7**
									Average	**65.4**	**62.6**	**57.2**

4.2.4. Topography and Geomorphology

The great Indian sedimentary basin, drained by the Indus-Ganges-Brahmaputra river system, is one of the largest and most productive groundwater provinces of the world. The great Himalaya in the north and the Deccan shield in the south flank it. The basin runs over a length of 2400 km from Punjab in the west to Assam in the east (**Figure 4.9**). Its width is variable, the maximum being over 400 km and the minimum as small as 25 km. The basin is filled with four distinct sedimentary units designated as the siwalik, bhabar, terai and alluvial formations, which are disposed in a nearly parallel fashion between them as well as with the himalayan range. Though, the major part of the SIWALIK formation is now present as the Siwalik Hills along the northern border of the basin and considered as a separate geologic system, from a tectonic angle it can be considered as an integral part of the great Indian sedimentary basin.

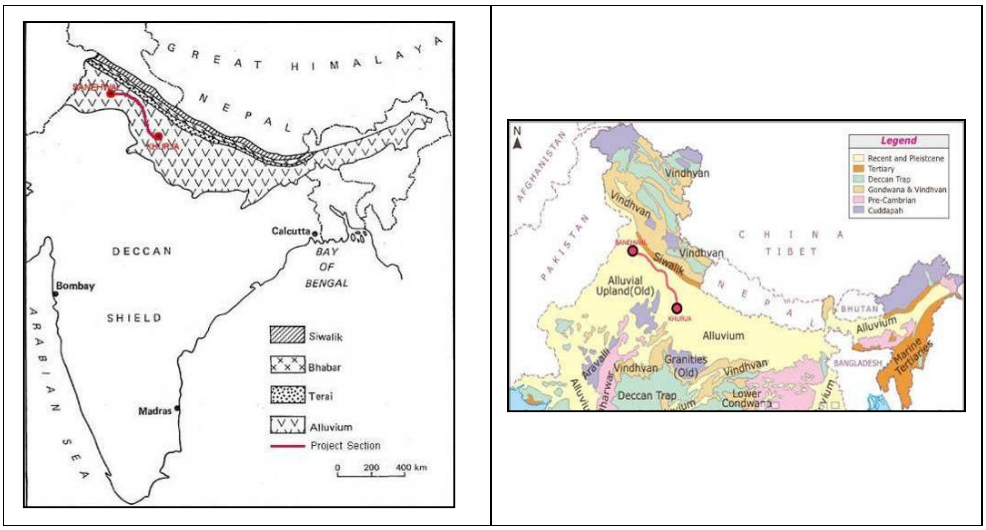


Figure 4.9 : Hydrogeologic Unit in Great Indian Sedimentary Basin

Siwalik System. It derived its name from the Siwalik Hills lying in the Hardwar region of uttaranchal. The siwaliks comprise consolidated and semi-consolidated rocks namely sandstones, grits, conglomerates, pseudoconglomerates, clays and silts. They have the character of deposits formed by torrential streams and floods in shallow and fresh-water basins. The Siwalik system is divided into three major divisions namely the lower, middle and upper siwaliks, ranging in age from middle miocene to lower pleistocene. While there are no marked unconformities within a system, there are indications that the upper siwaliks were deposited on the middle Siwaliks after severe tectonic disturbances resulted due to folding and uplifting of those tectonic plates .

Bhabhar formation: It comprises of boulders cobbles and gravels as piedmont deposits occur all along the southern slope of siwaliks as a distinct belt, varying in width between 3 and 24 km. The formation occurs as an accumulation of talus materials and coalescent alluvial cones built by the hill streams. The ground slope is high and towards the south in the range it descends 8 to 17 m per km.

Terai formation: Immediately following the bhabar belt on its south is the terai belt, composed of alternate layers of clay and sand-pebble beds. A spring line is usually seen to separate the bhabar from the terai. These sand beds, except the topmost one, usually form artesian aquifers, in which the piezometric level lies at 0.3 to 1.5 m above ground surface. The pressure head shows a tendency to decrease from the north to the south.

Alluvial plain formation: On Its South, the terai belt is followed by the vast alluvial plain comprising of sand and clay with kankar. The sand beds highly constitute rich aquifers. In the northern half of the plain, the aquifers maintain continuity in the n-s direction, whereas in the southern half E- W is exhibited. On a regional scale the aquifers are unconfined but subartesian conditions have developed.

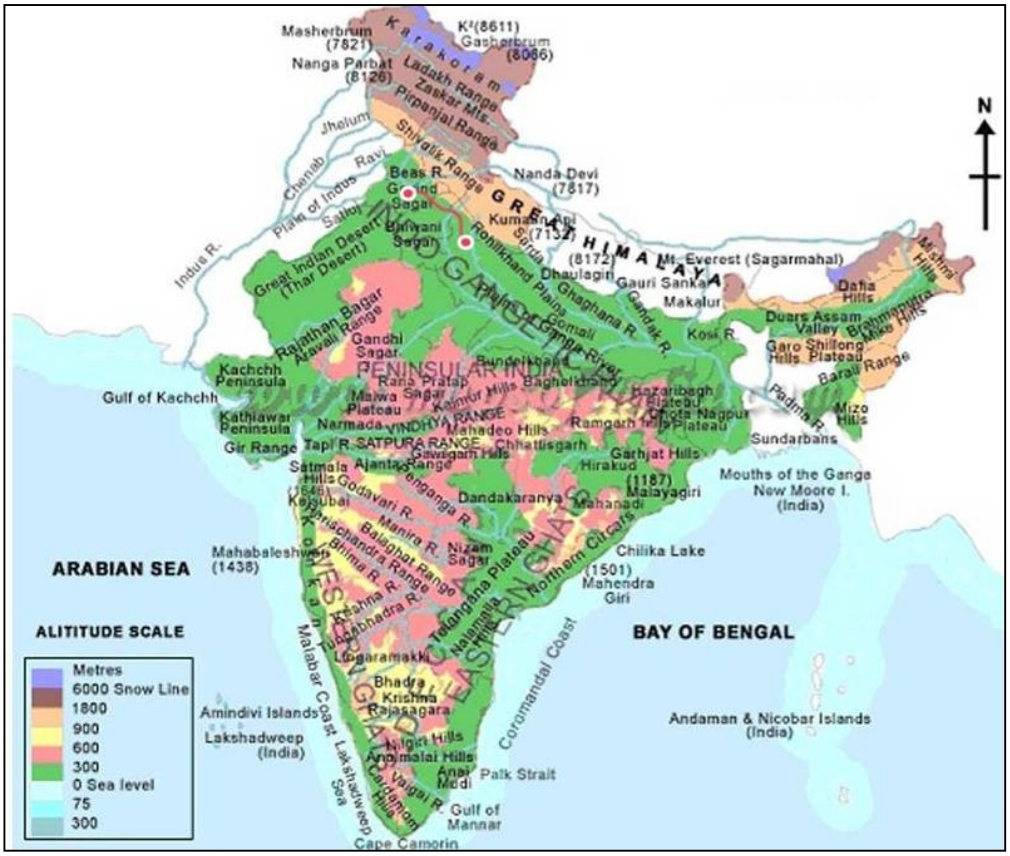


Figure 4.10 : Topographical Map of Indian Region

The proposed alignment passes through the above basin divided by indo-gangetic and Yamuna plains. The entire alignment is occupied by indo-gangetic alluvium of quaternary age. The topographic and geological features (**Figure 4.10**) of the alignment are as above:

The town of Khurja in Bulandshahar is situated on the right bank of the Kali River, a tributary of Ganga. The area represents a typically uniform plain ecosystem with a gradual slope from northwest to southeast. The general average slope of the area is about 0.29 m/km, i.e. Gentle.

Meerut district also falls in the alluvial plain (gangetic plain) and is more or less flat with an average elevation of 224 metres above mean sea level and having a gentle southerly and south-westerly slope. However about 2 km north-east of the meerut cantonment, a series of sand drives, trending nnw-sse occur in an echelon pattern. These drives rise to a maximum height of 1m above the general land surface. Kali River flows east of the area, which is traversed mostly by minor canals and their distributaries.

The Muzaffarnagar District and further (till Ludhiana) is occupied by indo-gangetic alluvium. Physiographically the area is flat terrain. However a little part in the extreme north-eastern area of the district is occupied by Siwalik hills, and falls in the zone of "dissected rolling plain". The area slopes towards southwest with an average gradient of 1.5m/km. The general elevation of the alignment varies between 245 m to 260 m above mean sea level (**Figure 4.11**)

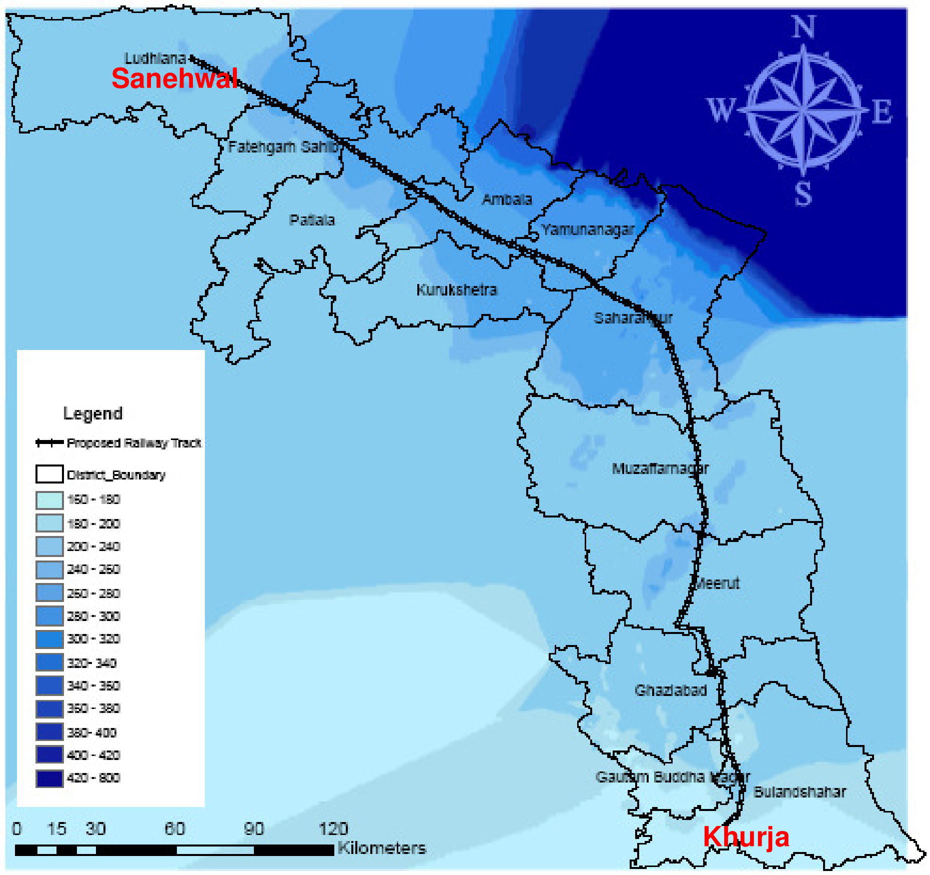


Figure 4.11 : Elevation Map of the Alignment of Khurja- Ludhiana

A summary of the elevation level in the core and buffer zone is given in **Table 4.7**. The table reveals that the topography of the entire alignment varies between 210 to 270 m at different chainages along the alignment for the core zone while ranges between 180 to 270 m in the rest of the project area. It also shows that ch. 201 to 400 is almost flat while there are in-homogeneities in the surface between the other two stretches.

Table 4.7 : Summary of elevation Levels in the core and buffer zone of the proposed alignment

Parameters	**Ch. 00 – 100 km (Khurja- Meerut)**	**Ch. 101 – 200 km (Meerut- Talheri-Bujurg)**	**Ch. 201 – 300 km (Talheri Bujurg-Ambala)**	**Ch. 301 – 400 km (Ambala- Ludhiana)**
Core Zone (in m)	210 – 240	210 – 240	270 – 270	270 – 270
Buffer Zone (in m)	180 – 240	210 – 270	210 – 360	180 – 270

4.2.5. Seismicity

As per the seismic zonal map of India, all the ten project districts are located in the zone iv as shown in **Figure 4.12**. This zone is categorized as high damaged risk zone.

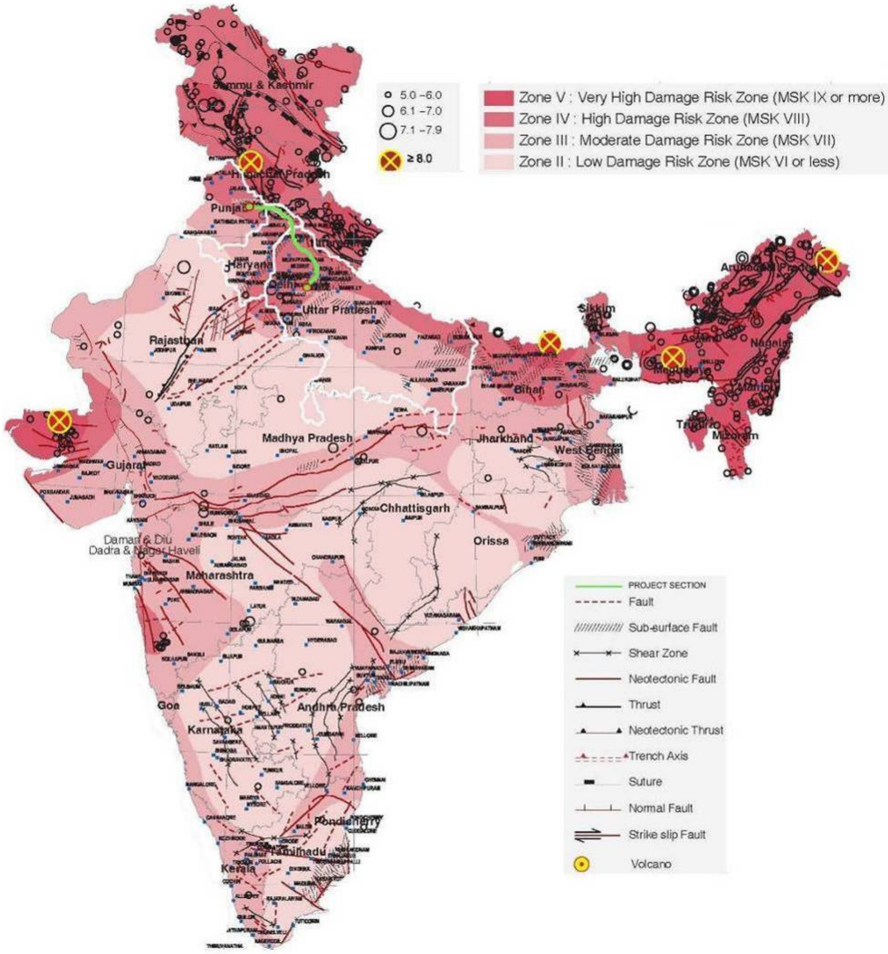


Figure 4.12 : Seismic Zoning Map of Indian Region

4.2.6. Water Hydrology and Drainage

4.2.6.1 Surface Water

The project area from Khurja to Sanehwal is a part of two different basins Gangaand Yamuna that contains the largest river system on the subcontinent comprising number of other rivers (**Figure 4.13**). The flow in the basin is largely contributed by the southwestenrly monsoon winds from July to September, as well as on the flow from melting himalayan snows in the hot season from April to June. TROPICAL CYCLONES originating between June and October in Bay of Bengal also contribute to water flows in the basin. The average annual rainfall varies from 712 mm at the eastern end (Khurja) of the basin to more than 1200 mm at the western end (Ludhiana).

The proposed alignment crosses many surface water bodies of the ganga-Yamuna basin. Some of the important rivers and canals crossing the alignment are: upper Gangacanal (at Khatauli, dist. Meerut), Hindon (at Tapri, Dist. Saharanpur), Yamuna (at Kalanaur in Yamunanagar), Tangri (Dukheri), Markanda (at Ambala), Chaudah Dhara and Ghaghhar. However, except upper Ganga canal and Yamuna all other rivers are found to be non-perennial.

4.2.6.2 Drainage

In the present study the drainage maps of survey of India (SOI) on 1: 50,000 scale is used as base map for the delineation of basin, sub-basin, watersheds and other permanent features such as rivers, canals, distributaries etc. Major drainages and drainage names are derived from topographical maps obtained from SOI. All maps have been digitized using ARCGIS 9.2 software. The final mapping is done using ERDAS 9.1 environment. The drainage map is shown in **Figures 4.13-4.14.**

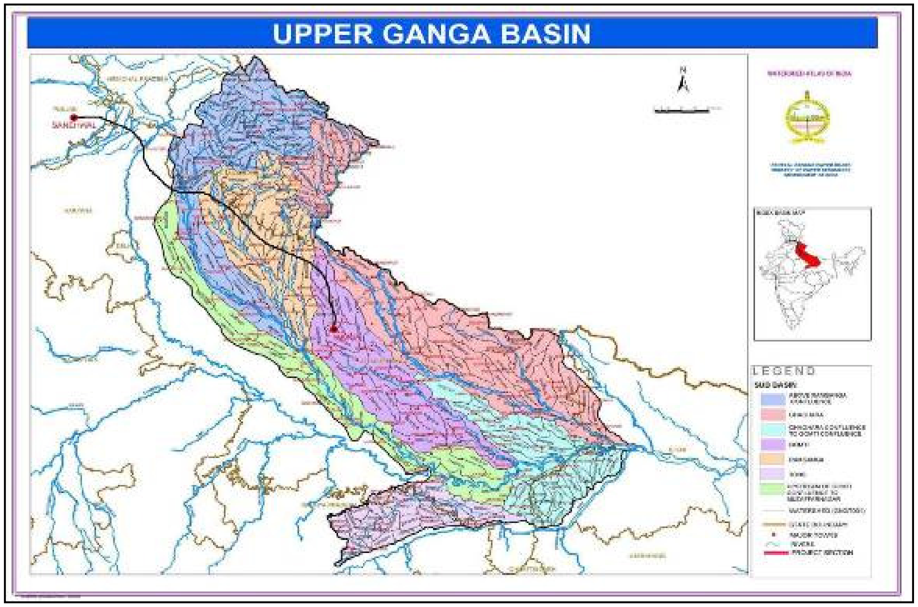
The summary about the major drainage and its flow direction is given in **Table 4.8.**

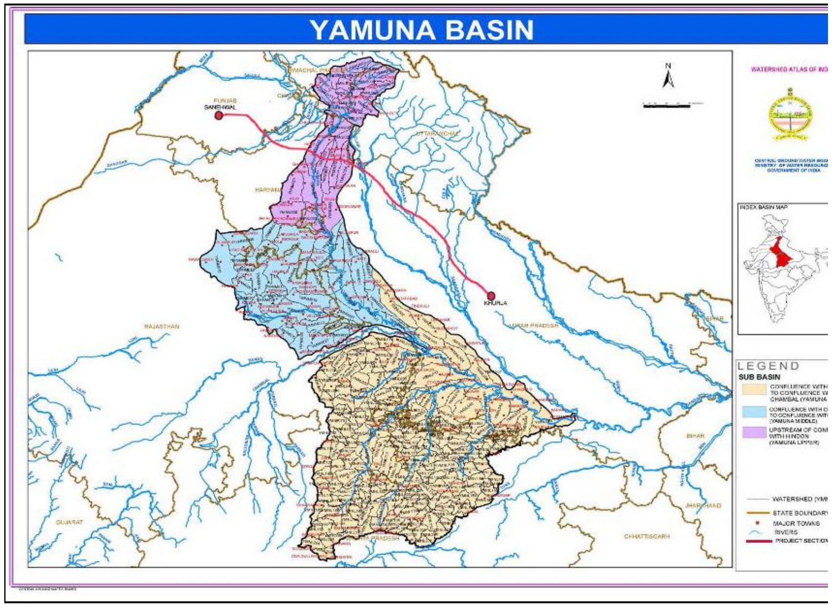
Table 4.8 : Summary of Drainage along the Proposed Alignment

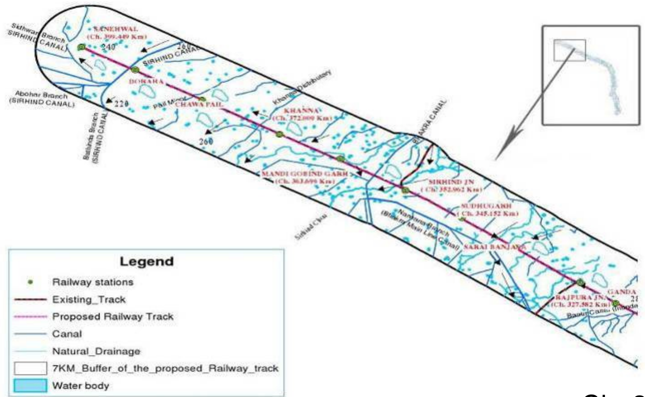
Parameters	Ch. 00 – 100 km	Ch. 101 – 200 km	Ch. 201 – 300 km	Ch. 301 – 400 km
Core Zone	NW – SW	NE – SW	NE – SW	NE – SW
	Major Drainage- Upper Ganga Canal	**Major Drainage**- Kali Nadi, Upper Ganga Canal, Hindan River	**Major Drainage**- Hindan River, Yamuna River, Markanda River	**Major Drainage-** Ghaghhar River, Sirhind Canal, Bhakhra Canal
Buffer Zone	○ N – S ○ NW – SW	○ NW – SW ○ NE – SW	○ NE – SW	○ NE – SW, NW – SW, E – W, SE- NW
	Major Drainage- Kali Nadi & Upper Ganga Canal	**Major Drainage**- Kali Nadi, Abu Nala, Upper Ganga Canal, Hindan River	**Major Drainage**- Hindan River, Eastern Yamuna Canal, Western Yamuna Canal, Markanda River, Tangri River	**Major Drainage-** Ghaghhar River, Sirhind Canal, Bhakhra Canal

None of the above drainage system will be affected during construction or operation of Ludhiana- Khurja portion of EDFC.

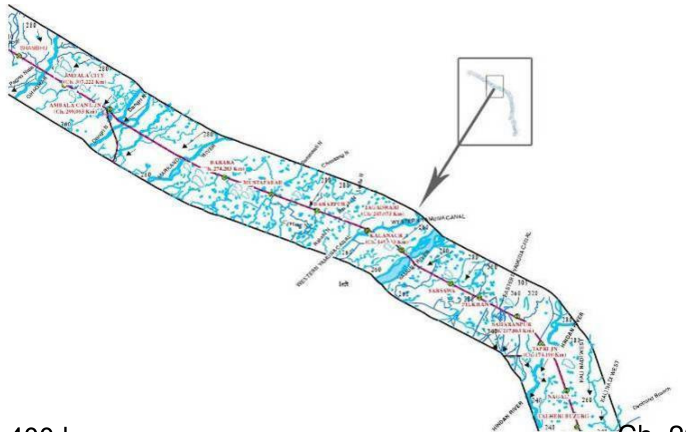
Figure 4.13 : Ganga-Yamuna Basin Map



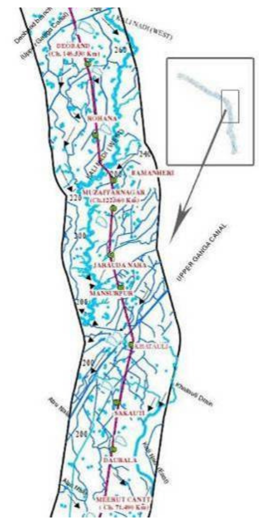




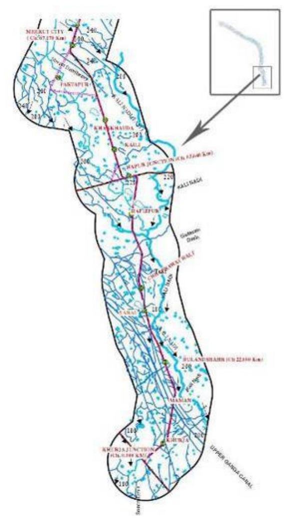
Ch. 301 – 400 km



Ch. 201 – 300 km



Ch. 101 – 200 km



Ch. 00 – 100 km

Figure 4.14 : Drainage Map of the Proposed Alignment

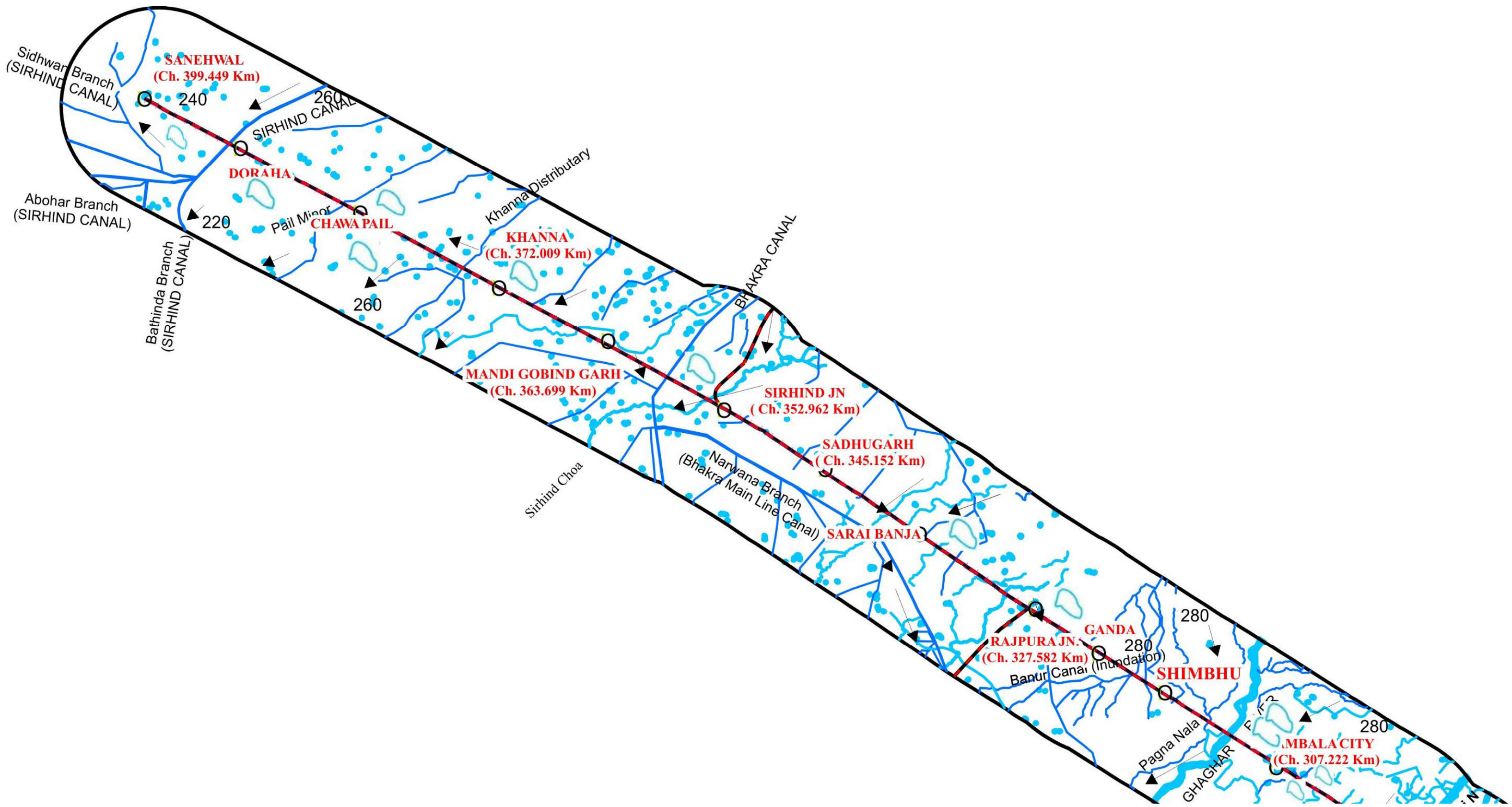


Figure 4.14 continued: Blow Up Drainage Map of Ch. 400 – 300 km

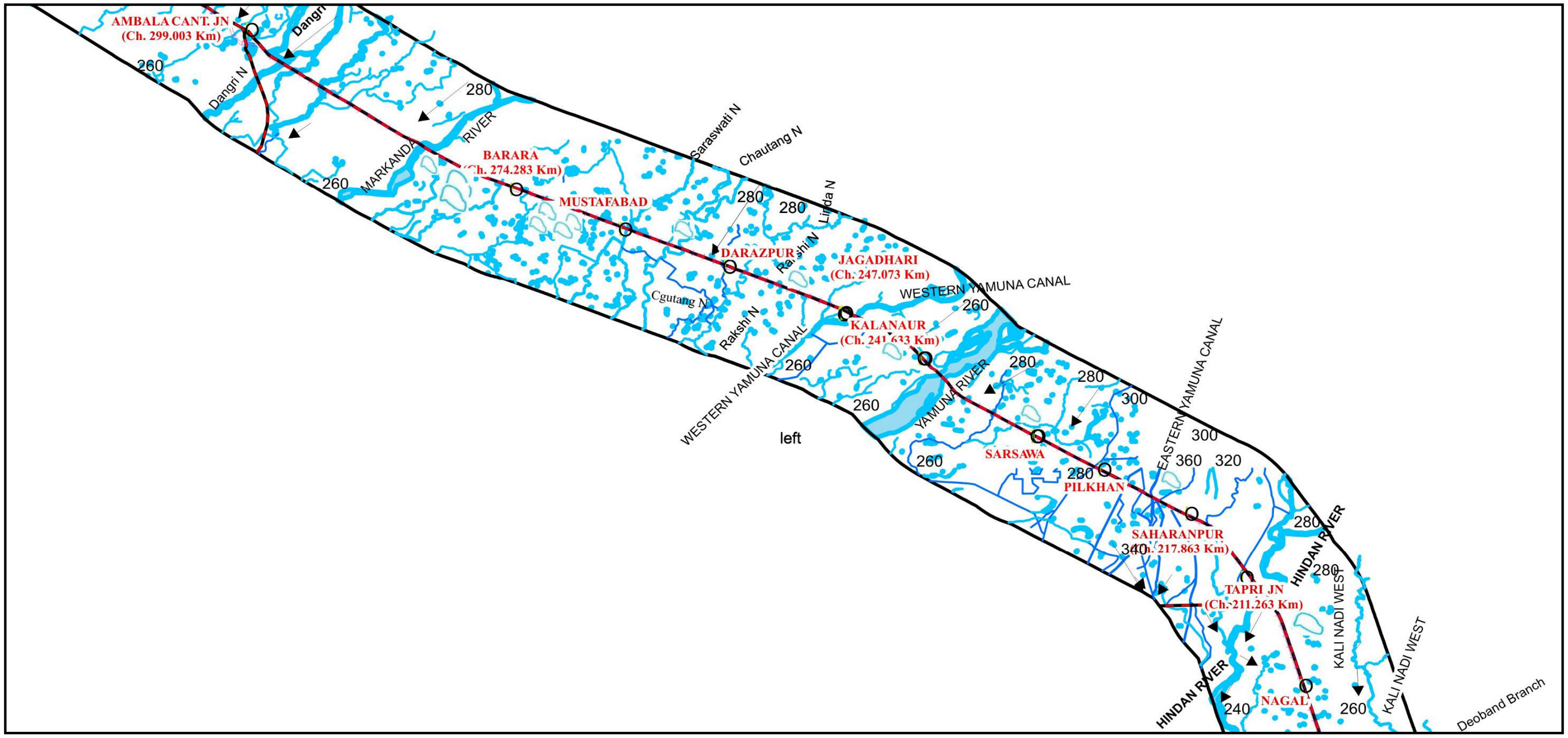


Figure 4.14 continued: Blow Up Drainage Map of Ch. 300 – 200 km

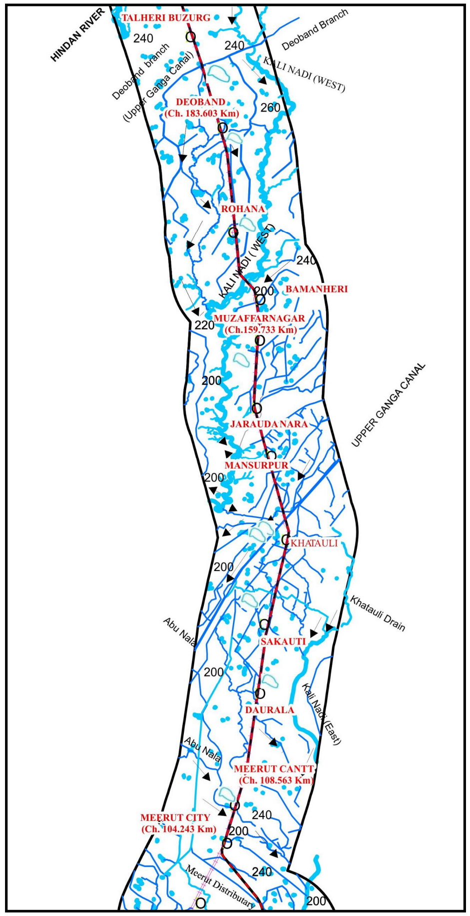


Figure 4.14 continued: Blow Up Drainage Map of Ch. 200 – 100 km

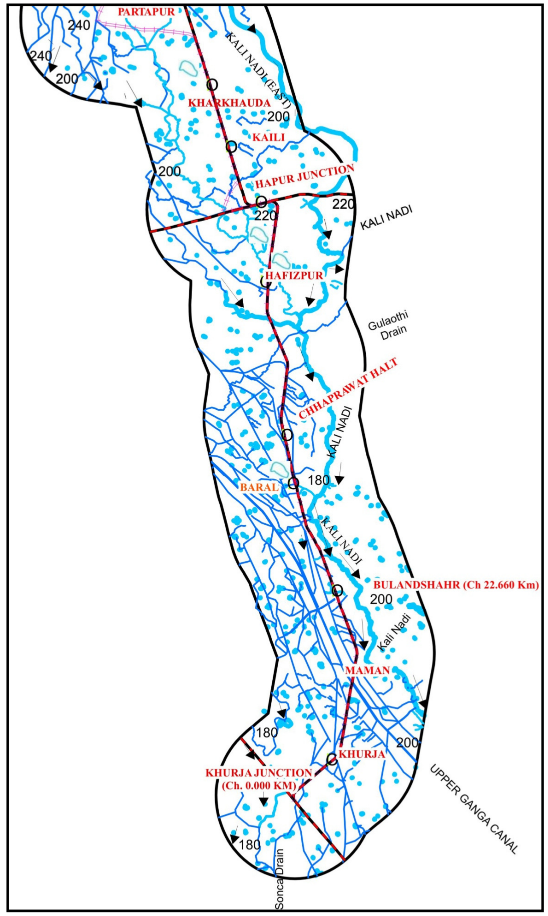


Figure 4.14 continued: Blow Up Drainage Map of Ch. 100 – 0 km

During construction as well as operational phases, it will be ensured that flow of water through existing watercourses is not restricted. This will be taken care at the design stage.

4.2.7. Water Quality

Surface Water Quality: The surface water samples are tested and analyzed as shown in **Table 4.9** to assess their quality as per the standards prescribed by standards for drinking water as per is: 10500-1993. The parameters are found to be well within the limits.the suspended particulate matters in Yamuna River were found at higher side (7900 mg/l)) which is probably due to the presence of waste material disposed to the river.

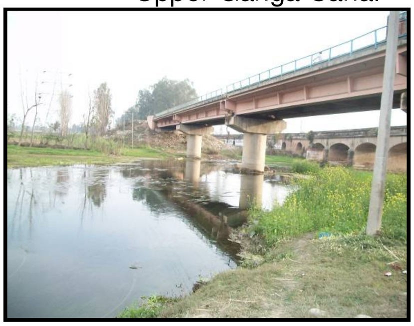
Table 4.9 : Surface Water Quality along the Proposed Alignment

Parameters	Desirable Limit	Permissible Limit	Western Yamuna Canal	Hindon River	Kali River	Upper Ganga Canal	Yamuna River
Colour (Hazen Units)	5	25	>5	>5	>5	>5	>5
Conductivity (μmhos/cm)	-	-	426	676	430	426	272
Turbidity (NTU)	5	10	3.1	16	4.2	3.4	16.3
pH value	6.5 to 8.5	6.5 to 8.5	8.2	7.6	8.6	7.9	7.4
Total Dissolved Solids (mg/liter)	500	2000	258	406	258	252	104
Total Suspened Solids	-	-	156	146	234	196	7900
Total Hardness (as $CaCO_3$) mg/liter	300	600	128	364	200	80	260
Chlorides (as Cl) mg/liter	250	1000	12	16	16	12	10
Sulphate (as SO_4) mg/liter	200	400	8	32	16	6	14
Nitrate (as NO_3) mg/liter	45	100	0.8	3.58	1.8	1.2	2
Phosphate (as PO_4) mg/liter	-	-	0.02	0.04	0.2	0.22	N.D
Fluoride (as F) mg/liter	1	1.5	N.D	0.2	0.2	N.D	0.5
Iron (as Fe) mg/liter	0.3	1	N.D	0.04	0.06	N.D	0.06
Lead (as Pb) mg/liter	0.05	0.05	N.D	N.D	N.D	N.D	N.D
Copper (as Cu) mg/liter	0.05	1.5	N.D	N.D	N.D	N.D	N.D
Nickel (as Ni) mg/liter	-	-	N.D	N.D	N.D	N.D	N.D
Zinc (as Zn) mg/liter	5	15	0.26	0.26	0.42	0.32	0.02
Total Chromium (as Cr) mg/liter	0.05	0.05	0.04	N.D	0.02	N.D	0.04
Manganese (as Mn) mg/liter	0.1	0.3	N.D	N.D	N.D	N.D	N.D
Oil & Grease (mg/liter)	-	-	N.D	N.D	N.D	N.D	8
Calcium (as Ca) mg/liter	75	200	38	94	48	22.4	65.6
Magnesium (as Mg) (mg/liter)	30	100	8	32	19	5.83	23.32
Ammonical Nitrogern (mg/liter)	-	-	N.D	N.D	N.D	N.D	N.D
Total Alkalinity (mg/liter)	200	600	18	32	24	14	22
Chemical Oxygen Demand (mg/liter)	-	-	12	N.D	16	N.D	142
Bio-chemical Oxygen Demand (mg/liter)	-	-	N.D	N.D	N.D	N.D	18
Dissolved Oxygen (mg/liter)	-	-	6.4	7.2	6.8	7.4	4.6

Source: Onsite Field Monitorin;g N.D. – Not Detectatable


Upper Ganga Canal


Hindon River


Western Yamuna Canal


Yamuna River

Groundwater quality: Groundwater is an important resource for meeting the water requirements for irrigation, domestic and industrial uses. It is an annually replenishable resource but its availability is non-uniform in space and time. The project area is underlined by thick pile of quaternary sediments which comprises sands of various grades, clays and *kankar*. The depth of ground water varied from 10-40 metre from the ground level as per the ground water survey report by central ground water authority (CGWA) conducted for different districts. The water table in Haryana and Punjab is lower than Uttar Pradesh districts along the EDFC alignment. As per the local enquiry during the consultations, ground water fluctuation is 1-1.5 m during monsoon and summer season.

To assess the suitability of ground water, sampling was conducted at several locations in both buffer and core zone. The ground water occurring at shallow depth is found to be satisfactory except at few locations where salinity has rendered the water unfit for drinking purposes. Most of the well water is suitable for irrigation. The water quality at few places in the district of Ambala, Yamuna Nagar and Ludhiana is found to be marginally alkaline in nature. Information about groundwater quality was also obtained from local people, railway staffs and passengers for different locations. The list of groundwater affected blocks along the alignment is given in table 4.10.

Table 4.10 : Groundwater Categorisation of Blocks along the Proposed Alignment

State	District	Semi-critical	Critical	Over-exploited
Haryana	Ambala	-	Barara	-
	Yamunanagar	-	-	Jagadhari Mustafabad
Punjab	Fatehgarh Sahib	-	-	Sirhind
	Ludhiana	-	Doraha	Khanna
	Patiala	-	-	Rajpura
Uttar Pradesh	Bulandshahar	Gulaoti	-	-
	Muzaffarnagar	Khatauli	-	-
	Saharanpur	Deoband	-	-

Source: Central Groundwater Authority

Physiochemical quality of ground water: the ground water quality largely conform the standards for drinking water as per is: 10500-1993 except total dissolved solids (874-564), hardness in Meerut (432) & iron in most of the sampling locations of the desirable limits. Withdrawal of ground water during construction and operation will depend on permission of concerned authoritity.The groundwater quality of the samples collected during field survey in the study area has been summarised in **Table 4.11**.

Table 4.11 Groundwater Quality in the Project Area

Parameters	*Desirable Limit*	Ch. 00 – 100 km			Ch. 101 – 200 km					Ch. 201 – 300 km				Ch. 301 – 400 km			
		Khurja station	**Gulaothi**	**Meerut Cant**	**Daurala**	**Jarauda Nara**	**Deoband**	**Tapir**	**Saharanpur**	**Sarsawa**	**Jagadhari**	**Barara**	**Dukheri**	**Shambhu**	**Sarai Banjara**	**Mandi Gobind Garh**	**Sanehwal**
Colour (Hazen Units)	*5*	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5
Conductivity (µmhos/cm)	-	1132	1143	1135	1127	1272	1234	1187	1163	1167	1156	1245	1276	1166	1145	1231	1166
Turbidity (NTU)	*5*	0.2	0.5	0.3	0.7	0.3	0.5	0.3	0.5	0.8	0.9	0.7	0.8	0.5	0.5	0.7	0.4
pH value	*6.5 to 8.5*	7.9	7.2	7.4	7.8	7.1	7.3	8.1	7.4	7.7	7.8	8.2	8.1	8.3	8.2	7.6	7.5
Total Dissolved Solids (mg/liter)	*500*	686	768	673	768	782	781	666	567	874	726	756	768	721	763	712	670
Total Hardness (as $CaCO_3$) mg/liter	*300*	432	231	213	234	245	256	276	231	245	255	266	255	278	244	255	240
Chlorides (as Cl) mg/liter	*250*	9.5	43	55	67	78	87	77	77	87	21	12	7.1	21	14.5	17.5	120
Sulphate (as SO_4) mg/liter	*200*	32	34	43	21	65	67	32	21	14	56	67	54	56	78	42	72
Nitrate (as NO_3) mg/liter	*45*	2.8	3.2	3.5	4.1	3.7	2.8	4.5	2.5	4.2	5.1	3.2	2.8	3.3	4.1	2.1	3.8
Fluoride (as F) mg/liter	*1*	0.5	0.3	0.4	0.2	0.4	0.2	0.1	0.5	0.2	0.4	0.5	0.6	0.2	0.3	0.5	0.4
Iron (as Fe) mg/liter	*0.3*	0.46	0.56	0.45	0.42	0.32	0.34	0.45	0.53	0.62	0.54	0.34	0.67	0.37	0.25	0.35	0.08
Lead (as Pb) mg/liter	*0.05*	N .D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Copper (as Cu) mg/litter	*0.05*	N.D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Zinc (as Zn) mg/liter	*5*	0.14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.36
Total Chromium (as Cr) mg/liter	*0.05*	N.D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N.D

Parameters	Desirable Limit	Ch. 00 – 100 km			Ch. 101 – 200 km					Ch. 201 – 300 km				Ch. 301 – 400 km			
		Khurja station	Gulaothi	Meerut Cant	Daurala	Jarauda Nara	Deoband	Tapir	Saharanpur	Sarsawa	Jagadhari	Barara	Dukheri	Shambhu	Sarai Banjara	Mandi Gobind Garh	Sanehwal
Manganese (as Mn) mg/litre	*0.1*	N.D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Calcium (as Ca) mg/liter	*75*	88	36	45	75	87	35	87	62	45	25	65	56	45	28	35	83.2
Magnesium (as Mg) (mg/liter)	*30*	51.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.76
Total Alkalinity (mg/liter)	*200*	200	145	75	85	75	55	57	80	65	125	45	120	135	110	75	72

Source: Analysis of Field Samples

4.2.8. Soil

In the proposed study soil quality are influenced to a very limited extent by the topography, vegetation and parent rock. However, the variations in soil profile are much more pronounced because of the regional climatic differences. The soil of this zone has developed under semi-arid conditions. The soil is sandy loam to clayey with normal reaction (pH from 7.8 to 8.5). The sub-surface geological formations of the buffer area (7 km radius) comprise of sand, silt, clay and kankar in various proportions . Its characteristics in the districts of Uttar Pradesh is part of Gangetic alluvium while in Yamuna Nagar, Ambala, Patiala and Ludhiana these are non-calcareous and sandy loam on the surface, and loam to clayey loam at depth and placed under the classification as udipsamments/udorthents. The soil texture characteristic and the erosion map of the proposed alignment is given in **Figure 4.14** and **Figure 4.15** respectively.

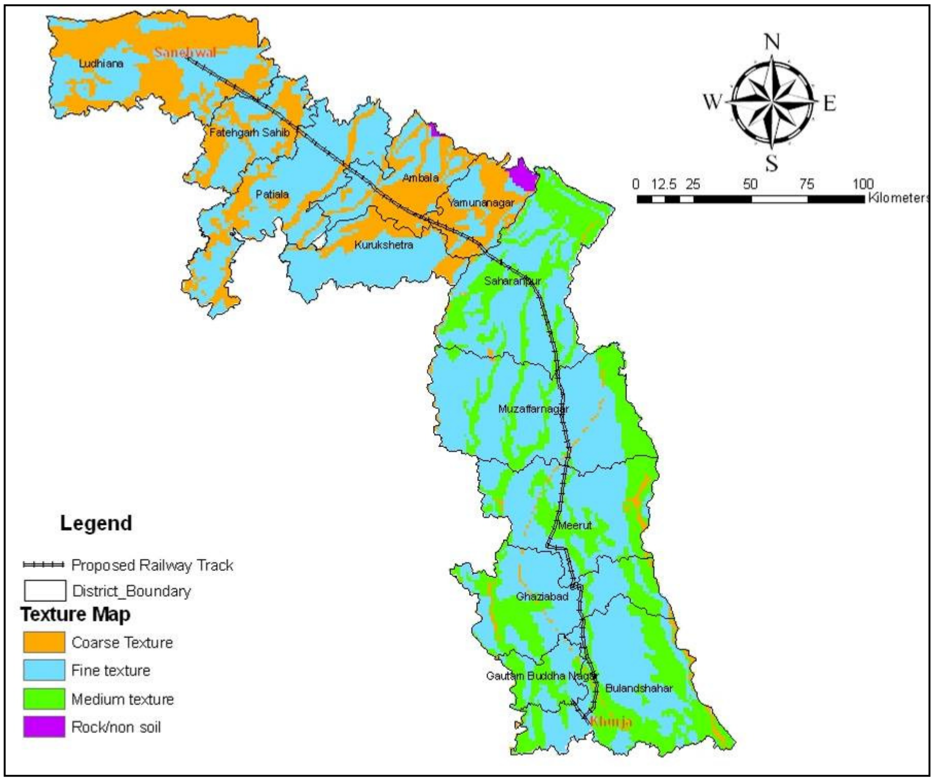


Figure 4.15 : Soil Texture Characteristic of the Proposed Alignment

To estimate the characteristics of soil in the core and buffer zone of the alignment sampling was carried out at 13 locations as shown in **Table 4.12**. The table indicates that the soil in the project area is good for agricultural and plantation purposes

Table 4.12 : Physico-Chemical Characteristics of Soil

Location	Parameters								
	pH	Conductivity	Cation Exchange Capacity	Sodium Absorption Ratio	Water Holding Capacity	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sodium (Na)
Ch. 00 – 100 km									
Khurja station	7.8	376	24	0.84	25.5	0.65	0.31	24	52
Baral	8.1	0.371	27	0.22	23.8	0.12	0.24	23	160.5
Hapur Detour	7.3	356	21	0.32	23.2	0.72	0.37	27	10
Meerut Cant station	8.1	365	25	0.36	24.2	0.65	0.41	31	13
Ch. 101 – 200 km									
Daurala station	7.1	321	25	0.56	23.0	0.65	0.36	35	52
Khatauli station	5.1	268	20	0.32	19.0	0.72	0.36	15	10
Mansurpur village	5.0	382	22	0.84	18.5	0.68	0.32	42	52
Deoband	5.7	339	21	0.58	21.7	0.66	0.30	41	50
Tapri Detour	7.3	356	21	0.32	23.2	0.72	0.37	27	10
Saharanpur	7.8	333	26	0.27	24.0	0.68	0.39	41	150.1
Ch. 201 – 300 km									
Kalanaur station	8.1	365	25	0.36	24.2	0.65	0.41	31	13
Jagadhari	8.0	340	21	0.23	28.1	0.591	0.35	56.0	76.4
Ambala Cant Detour	8.2	275	32	0.45	21	0.71	0.45	38	45
Ch. 301 – 400 km									
Sarai Banjara village	7.6	275	18	0.22	21	0.67	0.42	24	13
Sirhind Detour	7.4	256	21	0.42	23	0.56	0.34	14	17
Mandi Gobindgarh	5.1	242	10	0.36	24.9	0.42	0.28	18	14

Source: Analysis of field samples

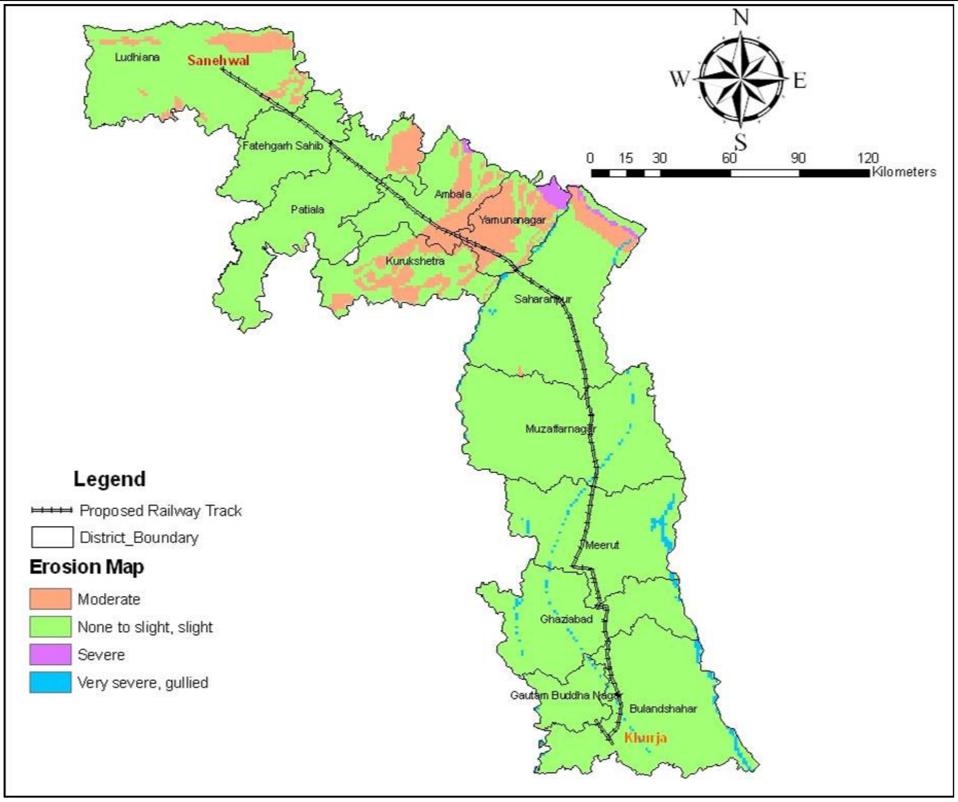


Figure 4.16 : Soil Erosion Map of the Proposed Alignment

Soil Sampling Along the Proposed Alignment

4.2.9. Land-Use

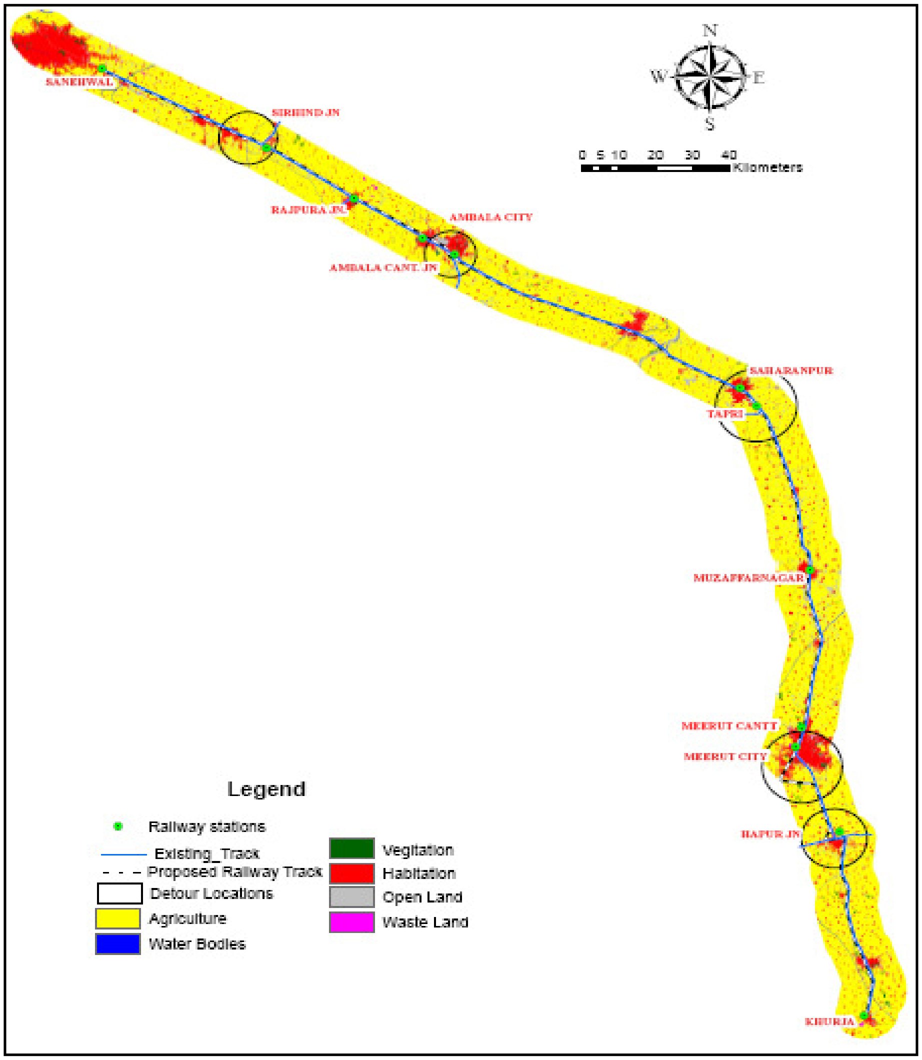
The land use study is of fundamental significance, as the land resources play a strategic role in the determination of economic, social and cultural progress of the region. Remote sensing data provides reliable accurate baseline information for carrying out the land use mapping. To delineate different land classes of the proposed EDFC alignment, a study was undertaken using Indian remote sensing satellite imagery (LISS 4 mx, year 2010) obtained from national remote sensing centre (NRSC), Hyderabad. A systematic digital image interpretation approach is used to delineate the land use classes using ERDAS 9.1 image processing software. The study was focused on demarcating boundaries of different land use/land cover units from an analysis of different types of colour registrations of land use/land cover units from satellite imagery.

The land-use of the alignment is shown in **Figure 4.16**. It is observed to be predominantly agricultural (62 and 75%) both in the core and 7 km buffer zone as seen from **Table 4.13**. This is followed by open land (18 and 10%) and habitation or settlement area (17 and 11%) in both core and buffer zone.

Table 4.13 : Land-Use Classification of the Proposed Alignment

Land-use categories	7 km Buffer	100 m Core
	Area in km^2	Area in km^2
Agriculture	4697.4	45.7
Forest	1.4	0.20
Water Bodies	39.9	0.5
Vegetation	44.2	1.3
Habitation	688.9	12.2
Open Land	630.1	13.2
Waste Land	11.1	0.2

Figure 4.17 : Land-Use Mapping of the Proposed Alignment



4.3. Ecology

The terrestrial ecology of the EDFC proposed project area including core zone and buffer zone was done by following the standard methodology to evaluate the ecological richness in an area.

4.3.1. Terrestrial Ecology

The study was undertaken with a view

- To evaluate the dominant species based on IVI for plant and Shanon Wiener for animals.
- To list the endangered species present in the area (both flora and fauna).
- To mark the wetlands and other ecologically important areas such as national parks/ sanctuaries
- To assess the effect of construction activities and operation of the project on existing ecology

4.3.2. Aquatic Ecology

The study was carried out in the project site aiming at:

- Identification of different aquatic species [plankton (phyto & zoo), benthos, fishes]
- Investigation the breeding grounds of economically important fishes.
- Finding the endangered species present in the core area if any

4.3.3. Methods

4.3.3.1 Methods of Data Collection

To collect the baseline data from Ludhiana to Khurja EDFC Railway Corridor in the state of Uttar Pradesh, Haryana and Punjab tree species available on both sides up to the toeline the proposed EDFC corridor has been counted. The identification of tree species was made as per the book on plant taxonomy[6]. Samplings were carried out after each every km and the data has been gathered within 100 m width of either side of the proposed EDFC corridor. If the circumference at breast height (cbh) of the tree species were =<0.45 meters, then it was categorized as trees, whereas, it was categorized as saplings if the cbh was >=0.45 meters. Saplings were not recorded for analysis. The animal species data was collected in the study sites through direct sighting methods, indirect evidences and information from local inhabitants (through displaying the animal's colour plates). Chainage locations of all the sampling sites and important area were noted down along the railway track to draw conclusions of the study area. Identification of mammalian, avian and reptilian species were made as per the available books and published materials Analysis was done as per the standard methods . **Table 4.14** gives the survey points with chainages.

Table 4.14 : Data Collection from Important Locations with Chainage

Sl. No.	Survey Point	Chainage (Km.)	Sl. No.	Survey Point	Chainage (Km.)
1	Upper Ganga Canal	139.5	2	Kali Nadi	167.5
3	Yamuna River	243	4	Yamuna Western Canal	251.5
5	Markhanda River	185.7	6	Bhakra Canal	361.8
7	Sirhind Canal	294.7			

4.3.4. Flora of the project Area

Field survey of flora has been carried out district wise where the project corridor Khurja to Ludhiana EDFC passes through. The analysis of the vegetation cover of the EDFC Khurja to Ludhiana project was done on the basis of primary data collected during the field survey and secondary data collected from forest department of the respective districts,.

The structure and type of vegetation depends on climatic conditions and physiographic conditions, as well as requirements of the local inhabitants of the area. The vegetation in the study area is deciduous in nature. Mainly three types of forests were found in the study area in a mosaic of small patches which are the remnants of the past forest cover in the area.

i) Tropical moist deciduous forests:

These forests are found in the moist region of terai. These types of forest patches were few and are observed to be present near the riparian zones of the rivers in the buffer zone only. They grow in regions that record 100 to 150 cm of rainfall annually; have an average temperature between 26˚-37 ˚c and have considerable degree of humidity.

ii) **Tropical dry deciduous forests:**

These forests are found in all parts of the plains, and usually in central eastern and western regions. The trees are mostly deciduous. Since sunlight reaches the ground in abundance, shrubs and grasses also grow here.

iii) Tropical thorny forests:

These are mostly found in western parts of the project distance. Such forests are confined to the areas with low annual rainfall (50-70 cms), mean annual temperature between 25˚c to 37˚c and low humidity (less than 47%).

iv) **Plantations**:

Plantations were seen mainly of the polar type- eucalyptus, mango, teak etc. The plantations were observed to be done mainly by the forest department in forest areas (protected and reserved forests area) and by public (in open land).

The occurrence of the different types of the forest in the EDFC project influence area is represented in **Table 4.15**.

Table 4.15 : Relative Presence of Different Types of Forest in the project area

Types of Forest Present	Relative Occurrence in Core Zone (100 m) %	Relative Occurrence in Buffer Zone) %
Tropical Moist Deciduous Forests	6.04	9.45
Tropical Dry Deciduous Forests	8.45	1131
Tropical Thorny Forests	11.02	24.76
Plantations	74.47	54.51

Brief description of flora in the study area is as follows-

- On the both right and Left side of the Proposed EDFC corridor Ludhiana to Khurja stretch was occupied by the secondary vegetation, mainly by plantation and characterized by *Poplar,* Pakori (*Ficus rumphii),* Kadam (*Anthrocephalus cadamba)*, Satiana (*Alstonia scholaris),* Jujube (*Zizyphus jujuba)*, Simul (*Bombax ceiba)*, Siris (*Albizia lebek)*, Bauhinia (*Bauhinia purpurea)*, Dubari Ban (*Cynodon dactylon),* Locosa Ghanh (*Hemarthia compressa),* Kikar or Babul *(Acacia nilotica),* Khair *(Acacia catechu),* Neem *(Azadirachta indica),* Shisham or Indian Rosewood *(Dalbergia sissoo),* Pipal *(Ficus religiosa),* Barh or Banyan *(Ficus benghalensis,* Aam or Mango *(Mangifera indica),* Jamun or Java Plum *(Syzygium cumini),* Imli or Tamarind *(Tamarindus indica),* Sagwan or Teak *(Tectona grandis),* Ber or Indian Jujube (*Zizyphus mauritiana),* Mitha Jal or Pillu *(Salvadora indica), Terminalia arjuna*, Pillu *(Ficus rumphii) and Zizyphus jujuba* etc.
- The Gagoul reserved forest is present in the Meerut detour area through which the proposed track will pass through a distance of 650 meter. Kalanur protected

forest under the Yamuna Nagar forest division is the only forest patch where definite area is touched by the Ludhiana to Khurja EDFC corridor. In both Gagoul Reserved forest and Kalanur Protected forest no major mammalian species are present though birds were present

- According the local people, both the sides of the proposed Ludhiana to Khurja EDFC corridor were full of vegetation with valuable trees and fertile agricultural land in the past. Now the entire area is under the plantation of Eucalyptus tree mainly by the forest department.

The study area falls under the sub-tropical climatic conditions with three pre monsoon, monsoon and winter season. List of plant species and its ecological importance based on secondary data is listed below in **Table 4.16**.

Table 4.16 : List of Plant Species based on Primary data in the Study Area

Tree Species	Importance				Presence	
	Medicinal (M) /Economically Important (E)	Fuel wood	Fruit Bearing	Timber	Core Zone	Buffer Zone
Poplar (*Populus deltoids*)	E	√		√	√	√
Eucalyptus (*Eucalyptus globules*)	E	√		√	√	√
Shisham or Indian Rosewood-(*Dalbergia sissoo)*	E	√		√	√	√
Aam or Mango (*Mangifera indica)*	E	√	√	√	√	√
Jamun or Java Plum (*Syzygium cumini*)	E	√	√	√	√	√
Sagwan or Teak (*Tectona grandis)*	E	√		√	√	√
Ber or Indian Jujube (*Zizyphus mauritiana)*	E	√	√	€	√	√
Khejri (*Prosopis cineraria)*	E	√	√	€	√	√
Khair (*Acacia catechu)*	E	√		€	√	√
Caper, Karil (*Capparis deciduas*)	E	√		€	√	√
Neem (*Azadirachta indica)*	M	√		€	√	√
Kikar or Babul (*Acacia nilotica)*	E	√		€	√	√
Siris (*Albizia lebbek*)	E	√		√	√	√
Simul (*Bombax ceiba*)	E	√		€√	√	√
Bauhinia *(Bauhinia purpurea*)	E	√		€	√	√
Krishnasura (*Delonix regia*)	E	√		€	√	√
Pipal or Bo Tree (*Ficus religiosa*)	M	√		€	√	√
Barh or Banyan (*Ficus benghalensis*)	M	√		€	√	√
Imli or Tamarind (*Tamarindus indica*)	E/M	√	√	√	√	√
Mitha Jal or Pillu (*Salvadora indica)*	M	√		€	√	√
Terminalia arjuna	E	√		€	√	√
Lasura or Lehswa *(Cordia dichotoma)*	E	√	√	€	√	√
Shahtoot or mulberry (*Morus albaatropurpurea*)	E	√		€	√	√
Amrood or Guava (*Psidium guajava*)	E	√	√	€	√	√
Jujube (*Zizyphus jujube*)	E	√	√	€	√	√
Jack Fruit (*Artocarpus heterophyllus*)	E	√		€√	√	√
Popita (*Carica papaya*)	E	√	√	€	√	√
Satiana (*Alstonia scolaris*)	E	√		√€	√	√
Banana (*Musa spp)*	E	√	√	€	√	√
Pakori (*Ficus rumphii*)	E	√			√	√
Amlakhi (*Phylanthus embilica*)	E	√	√	€	√	√
Kadam (*Anthrocephalus cadamba*)	E	√		€	√	√
(*Melia azadirach*)	E	√			√	√
Deodaru (*Polialthia longifolia)*	M	√		√€	√	√

4.3.5. Tree Cutting

The ADB PPTA consultants along the track within 50 meters did tree enumeration, from the edge of the existing track w.r.t proposed alignment. The survey recorded altogether 16,723 trees (table 4.16 (part i)). In order to identify the trees to be cut the tree enumeration was done for thewidth of land to be acquired in each km and trees available in existing row towards the proposed EDFC line side. The trees likely to be cut (about 5707 trees) with species diversity are given at (**Table 4.17 (Part II**)

Table 4.17 : Approximate No. of Trees Present on the Side of Proposed Alignment (50 mtr. From existing track) including the detour area

Part I : Trees Present in 50 Mt either side of the track			
S. No.	**From ChainageKm. (S&W)**	**To Chainage (S&W)**	**No. of Trees within 50 meter**
1	0	50	1630
2	51	100	1740
3	101	150	1083
4	151	200	2391
5	201	250	2897
6	251	300	2023
7	301	350	3517
8	351	400	1442
		Total Trees	**16723**

Source; ADB PPTA_ Consultants' Field Enumeration

Table-4.17 (Part II) - Trees to be cut

Tree Species Present	**Species Wise Tree likly to be cut**
Poplar	1214
Eucalyptus,	1059
Shisham or Indian Rosewood- Dalbergia sissoo,	964
Sagwan or Teak- Tectona grandis,	298
Aam or Mango-Mangifera indica,	476
Jamun or Java Plum- Syzygium cumini,	354
Ber or Indian Jujube- Zizyphus mauritiana,	290
Khejri- Prosopis cineraria,	266
Khair- Acacia catechu,	154
Kikar or Babul- Acacia nilotica,	110
Kair or Teat –Capparis deciduas,	106
Neem- Azadirachta indica,	110
Ranga Kanchan-Bauhinia purpurea,	22
Khara Jal or Pillu – Salvador persica ,	12
Krishnasura-Delonix regia,	11
Siris-Albizia lebek,	106
Barh or Banyan- Ficus indicus,	18
Simul- Bombax ceiba,	15
Pipal or Bo Tree – Ficus religiosa,	9
Imli or Tamarind- Tamarindus indica,	7
Lasura or Lehswa- Cordia dichotoma,	8
Mitha Jal or Pillu- Salvadora indica,	11
Pakori-Ficus rumphii,	7
Bhimkol-Musa sps,	8
Amlakhi-Phylanthus ambilica	6
Kadam-Anthrocephalus cadamba,	5

Tree Species Present	Species Wise Tree likly to be cut
Shahtoot or mulberry-Morus albaatropurpurea ,	9
Amrood or Guava- Psidium guajava ,	9
Bogori-Zizyphus 4-48ujube,	9
Kathal-Artocarpus heterophyllus,	10
Amita-Carica papaya,	9
Satiana-Alstnia scolaris,	8
Ghoranim-Melia azedarach,	4
Deodaru-Polialthia longifolia,	3
Total Tree to be felled	**5707**

4.3.6. Tree Diversity Profile

The vegetation compositions of the terrestrial zones comprise, of Pakori-*Ficus Rumphii*, Amlakhi-*Phylanthus Ambilica*, Banana-*Musa Balbasiana*, Kadam-*Anthrocephalus Cadamba*, *Melia Azedarach*, Deodaru-*Polialthia Longifolia*, Satiana-*Alstnia Scolaris*, Popita-*Carica Papaya*, Jack Fruit-*Artocarpus Heterophyllus*, Jujube-*Zizyphus Jujuba*,Simul- *Bombax Ceiba*,Siris-*Albizia Lebek*, Bauhinia-*Bauhinia Purpurea*, Krishnasura-*Delonix Regia*, The other important terrestrial plants included Dubari Ban-*Cynodon Dactylon,* Locosa Ghanh- *Hemarthia Compressa,* Birina- *Vetiveria Zizanoides,* Khagori- *Phragmites Karka,* Kahua- *Saccharum Sponteneum , Kikar or Babul- Acacia Nilotica, Khair- Acacia Catechu, Neem- Azadirachta Indica, Shisham or Indian Rosewood- Dalbergia Sissoo,* Pipal or Bo Tree - *Ficus Religiosa,* Barh or Banyan- *Ficus Benghalensis,* Aam or Mango-*Mangifera Indica,* Jamun or Java Plum- *Syzygium Cumini,* Imli or Tamarind- *Tamarindus Indica,* Sagwan or Teak- *Tectona Grandis,* Ber or Indian Jujube- *Zizyphus Mauritiana,* Mitha Jal or Pillu- *Salvadora Indica,* Khara Jal or Pillu - *Salvador Persica ,* Khejri- *Prosopis Cineraria,* Lasura or Lehswa- *Cordia Dichotoma,* Shahtoot or Mulberry-*Morus Albaatropurpurea ,Eucalyptus,* Kair or Teat -*Capparis Deciduas,*Amrood or Guava- *Psidium Guajava ,* Kanchan -*Bauhania Purpurea.*

Some small tree species like Careya Arborea, Holarrhena Antidysenterica, Mallotus Philippinensis, Murraya Exotica, Randia Dumetorum, Wrightia Tomentosa, Zizyphus Mauritiana etc were also present along the proposed DFC Corridor

The main shrub species comprise of Adhatoda sp., Callicarpa Macrophylla, Carissa Opaca, Clerodendron Viscosum, Colebrookia Oppositifolia, Euphorbia Royleana, Ixora Sp., Murraya Sp., Woodfordia Sps., Zizyphus spp. Etc.

The main climbers and grass comprise of the species Acacia Pinnata, Arundo Donex, Bauhinia Vahlii, Caesalpinia Sepiaria, Cenchrus Setigerus, Chrysopogon Sp., Clematis Gouriana, Cymbopogon Martini, Oendrocalamus Strictus, Oioscorea Belophylla, Erianthus Munja, Heteropogon Contortus, Eulolopsis Binanta, Ichnocarpus Sp., Milletia Ovaldolia, Mimosa Himalayan, Pueraria Tuberosa, Saccharum Spontaneum, Smilex Sp., Vallaris Solanacea, Vetiveria Zizanioides etc.

4.3.7. Quantitative Analysis of Tree, Shrub and Herb by Quadrate Method

4.3.7.1 *Dominant Tree Species Present In The Entire EDFC Proposed Project Area:*

In the entire EDFC project stretch the top five dominant species found were - poplar-*Populus Deltoids*, Eucalyptus-*Eucalyptus Globules*, Shisham Or Indian Rosewood-*Dalbergia Sissoo*, Aam Or Mango-*Mangifera Indica* And Neem- *Azadirachta Indica* etc. (table 4.17)

In case of the dominance of the trees in the EDFC project area in the core zone it was observed that in the first km 0-100 stretch, the top five dominant species were – *Mangifera Indica, Dalbergia Sissoo, Populus Deltoids, Eucalyptus Globules, Syzygium Cumini etc* .in the second (km101-200) stretch stretch the top five dominant species found were – *Mangifera Indica, Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo, Azadirachta Indica.* In the third (km201-300) project stretch the top five dominant species found were – *Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo, Azadirachta Indica*, Mangifera *Indica*. In the last (km 301-400) project stretch the top five dominant species found were – *Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo, Azadirachta Indica*, Mangifera *Indica*, *Syzygium Cumini.*

Interestingly it was found that in the EDFC project stretch in the Uttar Pradesh the dominant tree is a fruit bearing cash crop i.e. *Mangifera Indica* but the project stretch in Haryana and Punjab was found to be the dominated by timber producing tree i.e. *Populus deltoids. The overall dominance in the entire stretch is poplar.*

Table 4.18 : Overall Dominant Tree Species in the EDFC Project area Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Poplar- *Populus deltoides*	22.75	13.91	15.55	52.21
Eucalyptuș-*Eucalyptus globules*	15.08	11.5	10.51	37.09
Shisham or Indian Rosewood- *Dalbergia sissoo,*	13.98	9.67	10.83	34.48
Aam or Mango-*Mangifera indica*,	12.26	8.99	7.25	28.5
Neem- *Azadirachta indica*,	6.94	8.27	5.03	20.24
Jamun or Java Plum- *Syzygium cumini,*	4.94	7.11	4.59	16.64
Ber or Indian Jujube- *Zizyphus mauritiana*	4.12	6.06	3.25	13.43
Khejri- *Prosopis cineraria*,	3.77	3.71	3.32	10.8
Khair- *Acacia catechu*	2.58	3.22	2.87	8.67
Satiana-*Alstnia scolaris*	1.36	3.08	3.28	7.72
Kikar or Babul- *Acacia nilotica*	1.39	3.46	2.82	7.67
Kair or Teat -*Capparis deciduas*	1.36	3.29	2.89	7.54
Bauhinia-*Bauhinia purpurea*	1.07	2.1	1.56	4.73
Melia azedarach,	3.29	0.41	0.53	4.23
Krishnasura-*Delonix regia*	0.55	1.23	2.3	4.08
Terminalia arjuna	0.63	1.34	1.81	3.78
Simul- *Bombax ceiba*	0.41	0.92	1.92	3.25
Siris-*Albizia lebek*	0.48	0.96	1.81	3.25
Lasura or Lehswa- *Cordia dichotoma*	0.23	0.84	1.97	3.04
Pipal or Bo Tree - *Ficus religiosa*	0.39	0.89	1.73	3.01
Barh or Banyan- *Ficus benghalensis*	0.42	0.94	1.64	3
Imli or Tamarind- *Tamarindus indica*	0.34	0.84	1.51	2.69
Mitha Jal or Pillu- *Salvadora indica*	0.21	0.79	1.02	2.02
Pakori-*Ficus rumphii*	0.21	0.79	0.96	1.96
Jack Fruit-*Artocarpus heterophyllus*	0.11	0.48	1.23	1.82
Amlakhi-*Phylanthus ambilica*	0.19	0.675	0.91	1.77
Jujube-*Zizyphus jujuba*	0.13	0.53	1.05	1.71
Kadam-*Anthrocephalus cadamba*	0.15	0.62	0.82	1.59
Shahtoot or mulberry-*Morus albaatropurpurea*	0.15	0.59	0.83	1.57
Amrood or Guava- *Psidium guajava*	0.14	0.55	0.82	1.51
Sagwan or Teak- *Tectona grandis*	0.09	0.43	0.95	1.47
Deodaru-*Polialthia longifolia*	0.06	0.36	0.51	0.93
Eucalyptuș*Eucalyptus- globules*	15.08	11.5	10.51	37.09
Shisham or Indian Rosewood- *Dalbergia sissoo,*	13.98	9.67	10.83	34.48

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Aam or Mango-*Mangifera indica*,	12.26	8.99	7.25	28.5
Neem- *Azadirachta indica*,	6.94	8.27	5.03	20.24
Jamun or Java Plum- *Syzygium cumini*,	4.94	7.11	4.59	16.64
Ber or Indian Jujube- *Zizyphus mauritiana*,	4.12	6.06	3.25	13.43
Khejri- *Prosopis cineraria*,	3.77	3.71	3.32	10.8
Khair- *Acacia catechu*	2.58	3.22	2.87	8.67
Satiana-*Alstnia scolaris*,	1.36	3.08	3.28	7.72
Kikar or Babul- *Acacia nilotica*	1.39	3.46	2.82	7.67
Kair or Teat -*Capparis deciduas*	1.36	3.29	2.89	7.54
Bauhinia-*Bauhinia purpurea*	1.07	2.1	1.56	4.73
Melia azedarach,	3.29	0.41	0.53	4.23
Krishnasura-*Delonix* regia	0.55	1.23	2.3	4.08
Terminalia arjuna	0.63	1.34	1.81	3.78
Simul- *Bombax ceiba*	0.41	0.92	1.92	3.25
Siris-*Albizia lebek*	0.48	0.96	1.81	3.25
Lasura or Lehswa- *Cordia dichotoma*	0.23	0.84	1.97	3.04
Pipal or Bo Tree - *Ficus religiosa*	0.39	0.89	1.73	3.01
Barh or Banyan- *Ficus benghalensis*	0.42	0.94	1.64	3
Imli or Tamarind- *Tamarindus indica*	0.34	0.84	1.51	2.69
Mitha Jal or Pillu- *Salvadora indica*	0.21	0.79	1.02	2.02
Pakori-*Ficus rumphii*	0.21	0.79	0.96	1.96
Jack Fruit-*Artocarpus heterophyllus*,	0.11	0.48	1.23	1.82
Amlakhi-*Phylanthus ambilica*	0.19	0.675	0.91	1.77
Jujube-*Zizyphus jujuba*,	0.13	0.53	1.05	1.71
Kadam-*Anthrocephalus cadamba*,	0.15	0.62	0.82	1.59
Shahtoot or mulberry-*Morus albaatropurpurea* ,	0.15	0.59	0.83	1.57
Amrood or Guava- *Psidium guajava* ,	0.14	0.55	0.82	1.51
Sagwan or Teak- *Tectona grandis*,	0.09	0.43	0.95	1.47
Deodaru-*Polialthia longifolia*,	0.06	0.36	0.51	0.93

The dominant tree species have been identified for four stretches separately. Dominant tree species present in the the dominant tree species in first stretch of 0-100 km are Mangifera *Indica, Dalbergia Sissoo, Populus Deltoids, Eucalyptus Globules, Syzygium Cumini etc.*(**Table 4.19**).

Table 4.19 : Dominant Tree Species in First Stretch (km 0-100) Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Aam or Mango-*Mangifera indica*,	22.19	12.97	11.03	46.19
Shisham or Indian Rosewood-*Dalbergia sissoo*,	19.02	11.03	10.92	40.97
Poplar- *Populus deltoids*	16.01	10.94	10.93	37.88
EucalyptușEucalyptus- *globules*	14.94	10.54	10.92	36.4
Jamun or Java Plum- *Syzygium cumini*,	4.82	7.81	6.35	18.98
Neem- *Azadirachta indica*,	5.84	8.54	3.19	17.57
Ber or Indian Jujube- *Zizyphus mauritiana*,	3.94	6.64	3.76	14.34

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Khejri- *Prosopis cineraria*,	3.56	3.48	4.28	11.32
Khair- *Acacia catechu*	2.06	3.93	3.24	9.23
Satiana-*Alstnia scolaris*,	1.28	2.18	3.94	7.4
Kikar or Babul- *Acacia nilotica*	1.35	2.59	3.21	7.15
Kair or Teat -*Capparis deciduas*	1.34	2.35	3.19	6.88
Krishnasura-*Delonix regia*	0.21	1.34	2.31	3.86
Lasura or Lehswa- *Cordia dichotoma*	0.13	0.92	2.21	3.26
Siris-*Albizia lebek*	0.14	1.07	2.02	3.23
Bauhinia-*Bauhinia purpurea*	0.95	1.36	0.64	2.95
Simul- *Bombax ceiba*	0.14	1.02	1.77	2.93
Terminalia arjuna	0.29	1.36	1.19	2.84
Pipal or Bo Tree - *Ficus religiosa*	0.13	0.97	1.41	2.51
Barh or Banyan- *Ficus benghalensis*	0.14	1.03	1.16	2.33
Imli or Tamarind- *Tamarindus indica*	0.13	0.92	1.17	2.22
Mitha Jal or Pillu- *Salvadora indica*	0.13	0.87	1.09	2.09
Jack Fruit-*Artocarpus heterophyllus*,	0.09	0.51	1.45	2.05
Jujube-*Zizyphus jujuba*,	0.11	0.55	1.16	1.82
Sagwan or Teak- *Tectona grandis*	0.06	0.48	1.16	1.7
Pakori-*Ficus rumphii*	0.13	0.87	0.63	1.63
Amlakhi-*Phylanthus ambilica*	0.13	0.71	0.67	1.51
Kadam-*Anthrocephalus cadamba*,	0.13	0.64	0.64	1.41
Shahtootormulberry-*Morus albaatropurpurea*	0.12	0.61	0.63	1.36
Amrood or Guava- *Psidium guajava* ,	0.12	0.55	0.62	1.29
Melia azedarach,	0.06	0.43	0.63	1.12
Deodaru-*Polialthia longifolia*,	0.04	0.43	0.62	1.09

The dominant tree species in the second stretch (km101-200):are *Mangifera Indica, Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo,* Neem- Azadirachta Indica. (**Table** 4.20)

Table 4.20 : Dominant Tree Species in the Second Stretch (km 101-200) Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Aam or Mango-*Mangifera indica*,	14.98	10.92	7.76	33.66
Poplar- *Populus deltoids*	12.03	9.77	6.72	28.52
Eucalyptus‚Eucalyptus- *globules*	11.23	9.44	5.38	26.05
Shisham or Indian Rosewood- *Dalbergia sissoo*,	9.5	8.58	7.21	25.29
Neem- *Azadirachta indica*,	8.6	7.62	1.57	17.79
Melia azedarach,	13	0.27	0.19	13.46
Jamun or Java Plum- *Syzygium cumini*,	3.92	5.15	3.98	13.05
Khair- *Acacia catechu*	3.56	4.99	4.15	12.7
Ber or Indian Jujube- *Zizyphus mauritiana*,	3.56	4.42	4.02	12
Khejri- *Prosopis cineraria*,	3.4	4.41	4.02	11.83
Satiana-*Alstnia scolaris*,	1.24	5.83	4.61	11.68
Kair or Teat -*Capparis deciduas*	1.08	6.09	4.36	11.53

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Kikar or Babul- *Acacia nilotica*	1.15	6.15	4.02	11.32
Bauhinia-*Bauhinia purpurea*	1.07	4.35	3.81	9.23
Terminalia arjuna	1.61	1.28	3.77	6.66
Krishnasura-*Delonix regia*	1.55	0.97	3.71	6.23
Simul- *Bombax ceiba*	1.18	0.65	3.21	5.04
Barh or Banyan- *Ficus benghalensis*	1.25	0.65	3.13	5.03
Pipal or Bo Tree - *Ficus religiosa*	1.14	0.63	3.12	4.89
Siris-*Albizia lebek*	1.42	0.67	2.25	4.34
Imli or Tamarind- *Tamarindus indica*	0.97	0.61	2.74	4.32
Lasura or Lehswa- *Cordia dichotoma*	0.52	0.59	2.76	3.87
Pakori-*Ficus rumphii*	0.39	0.59	1.95	2.93
Amlakhi-*Phylanthus ambilica*	0.33	0.59	1.82	2.74
Kadam-*Anthrocephalus cadamba*,	0.21	0.59	1.72	2.52
Shahtoot or mulberry-*Morus albaatropurpurea*	0.21	0.57	1.44	2.22
Mitha Jal or Pillu- *Salvadora indica*	0.43	0.59	1.15	2.17
Amrood or Guava- *Psidium guajava* ,	0.19	0.54	1.44	2.17
Jujube-*Zizyphus jujuba*,	0.15	0.5	0.72	1.37
Jack Fruit-*Artocarpus heterophyllus*,	0.15	0.43	0.52	1.1
Sagwan or Teak- *Tectona grandis*,	0.14	0.31	0.31	0.76
Deodaru-*Polialthia longifolia*,	0.13	0.18	0.17	0.48

Dominant tree species present in the in the third stretch of project length (km201-300):are *Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo,* Neem- Azadirachta Indica, *Mangifera Indica*. (**Table** 4.21)

Table 4.21 : Dominant Tree Species in the Third stretch (km 201-300) Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Poplar- *Populus deltoids*	29.61	13.41	17.37	60.39
Eucalyptus-*Eucalyptus globulus*	17.54	11.07	13.09	41.7
Shisham or Indian Rosewood- *Dalbergia sissoo*	14.07	10.07	12.96	37.1
Neem- Azadirachta indica	6.85	8.95	12.71	28.51
Aam or Mango- *Mangifera indica*	6.11	8.43	9.27	23.81
Jamun or Java Plum- *Syzygium cumini*	5.66	8.17	2.74	16.57
Ber or Indian Jujube- *Zizyphus mauritiana*,	4.63	6.95	2.07	13.65
Khejri- *Prosopis cineraria*	4.17	3.65	1.42	9.24
Khair- *Acacia catechu*	2.43	3.07	1.38	6.88
Kikar or Babul- *Acacia nilotica*	1.58	2.71	1.38	5.67
Kair or Teat -*Capparis deciduas*	1.56	2.46	1.35	5.37
Satiana-*Alstnia scolaris*	1.49	2.29	1.29	5.07
Bauhinia-*Bauhinia purpurea*	1.2	1.42	1.26	3.88
Terminalia arjuna	0.33	1.42	1.26	3.01

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Krishnasura-*Delonix regia*	0.24	1.39	1.26	2.89
Siris-*Albizia lebek*	0.17	1.12	1.26	2.55
Barh or Banyan- *Ficus benghalensis*	0.16	1.08	1.26	2.5
Simul- *Bombax ceiba*	0.16	1.06	1.26	2.48
Pipal or Bo Tree – *Ficus religiosa*	0.16	1.02	1.23	2.41
Jack Fruit-*Artocarpus heterophyllus*	0.11	0.52	1.73	2.36
Imli or Tamarind- *Tamarindus indica*	0.15	0.96	1.13	2.24
Lasura or Lehswa- *Cordia dichotoma*	0.15	0.96	1.07	2.18
Jujube-*Zizyphus jujube*	0.13	0.57	1.38	2.08
Mitha Jal or Pillu- *Salvadora indica*	0.15	0.91	0.92	1.98
Sagwan or Teak- *Tectona grandis*	0.08	0.51	1.38	1.97
Pakori-*Ficus rumphii*	0.15	0.91	0.77	1.83
Shahtoot or mulberry-*Morus albaatropurpurea*	0.14	0.62	0.73	1.49
Amlakhi-*Phylanthus ambilica*	0.15	0.74	0.58	1.47
Amrood or Guava- *Psidium guajava*	0.13	0.57	0.73	1.43
Melia azedarach	0.07	0.45	0.74	1.26
Kadam-*Anthrocephalus cadamba*	0.15	0.67	0.41	1.23
Deodaru-*Polialthia longifolia*	0.04	0.44	0.74	1.22

Dominant tree species iIn the last stretch (Km301-400):are *Populus Deltoids, Eucalyptus Globules, Dalbergia Sissoo,* Neem- *Azadirachta Indica*, *Mangifera Indica*, *Syzygium Cumini* .(**Table** 4.22)

Table 4.22 : Dominant Tree Species in the Last Stretch (km 301-400) Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Poplar- *Populus deltoids*	33.33	17.54	27.19	78.06
Eucalyptuș-*Eucalyptus globulus*	16.61	14.95	12.62	44.18
Shisham or Indian Rosewood- *Dalbergia sissoo,*	13.33	9.01	12.23	34.57
Neem- Azadirachta indica,	5.36	7.31	5.31	17.98
Aam or Mango-*Mangifera indica*,	6.49	7.99	2.66	17.14
Jamun or Java Plum- *Syzygium cumini,*	5.78	7.52	0.97	14.27
Ber or Indian Jujube- *Zizyphus mauritiana*,	4.38	6.21	3.14	13.73
Khejri- *Prosopis cineraria*,	3.95	3.26	3.57	10.78
Khair- *Acacia catechu*	2.29	2.74	2.71	7.74
Satiana-*Alstnia scolaris*,,	1.42	2.05	3.29	6.76
Kikar or Babul- *Acacia nilotica*	1.49	2.42	2.68	6.59
Kair or Teat -*Capparis deciduas*	1.48	2.21	2.66	6.35
Krishnasura-*Delonix regia*	0.23	1.25	1.94	3.42
Bauhinia-*Bauhinia purpurea*	1.06	1.28	0.55	2.89
Siris-*Albizia lebek*	0.17	1.01	1.71	2.89

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Lasura or Lehswa- *Cordia dichotoma*	0.15	0.86	1.85	2.86
Terminalia arjuna	0.32	1.28	0.99	2.59
Simul- *Bombax ceiba*	0.15	0.95	1.47	2.57
Pipal or Bo Tree - *Ficus religiosa*	0.15	0.91	1.18	2.24
Barh or Banyan- *Ficus benghalensis*	0.15	0.97	0.97	2.09
Imli or Tamarind- *Tamarindus indica*	0.14	0.86	0.97	1.97
Mitha Jal or Pillu- *Salvadora indica*	0.14	0.81	0.92	1.87
Jack Fruit-*Artocarpus heterophyllus*,	0.11	0.47	1.21	1.79
Jujube-*Zizyphus jujuba*,	0.13	0.51	0.97	1.61
Sagwan or Teak- *Tectona grandis*	0.08	0.45	0.97	1.5
Pakori-*Ficus rumphii*	0.15	0.81	0.52	1.48
Amlakhi-*Phylanthus ambilica*	0.15	0.66	0.56	1.37
Kadam-*Anthrocephalus cadamba*,	0.14	0.61	0.54	1.29
Shahtoot or mulberry-*Morus albaatropurpurea*	0.15	0.57	0.52	1.24
Amrood or Guava- *Psidium guajava* ,	0.13	0.52	0.52	1.17
Melia azedarach,	0.06	0.41	0.52	0.99
Deodaru-*Polialthia longifolia*,	0.04	0.39	0.52	0.95

4.3.8. Quantitative Analysis of Shrub and Herb (Relative abundance and Relative Density)

Relative abundance and relative density of shrubs and herbs are in project influence area given below in **Table-4.23**:

Table 4.23 : Relative abundance and Relative Density of Shrubs and Herbs

Some small tree species	Relative Density	Relative Abundance
Careya arborea	32.04	29.49
Holarrhena antidysenterica,	26.56	11.45
Mallotus philippinensis,	10.31	18.98
Murraya exotica,	1.86	5.59
Randia dumetorum,	5.07	15.96
Wrightia tomentosa,	18.35	11.51
Zizyphus mauritiana etc.	5.76	6.99
Species of Shrubs:		
Adhatoda sp.,	18.95	16.52
Callicarpa macrophylla	7.36	8.95
Carissa opaca,	12.19	8.99
Clerodendron viscosum,	3.59	4.49
Colebrookia oppositifolia,	10.25	16.66
Euphorbia royleana,	7.38	20.61
Ixora sp.,	4.49	4.49
Murraya sp.,	13.21	8.81
Woodfordia sr.	18.95	4.89

Some small tree species	Relative Density	Relative Abundance
Zizyphus sr. etc.	3.59	5.56
Species of Climbers and Grasses:		
Acacia pinnata,	*8.15*	11.26
Arundo donex,	*4.42*	6.33
Bauhinia vahlii,	*4.43*	6.38
Caesalpinia sepiaria,	*2.21*	3.53
Cenchrus setigerus,	*8.22*	8.11
Chrysopogon sp.,	*10.17*	6.11
Clematis gouriana,	*2.21*	3.83
Cymbopogon martini,	*4.34*	3.62
Oendrocalamus strictus,	*2.41*	6.01
Oesmostachya bipifJnata,	*2.74*	3.62
Oioscorea belophylla,	*4.58*	3.64
Erianthus munja,	*4.34*	3.07
Heteropogon contortus,	*4.34*	2.8
Eulolopsis binanta,	*4.16*	2.8
Ichnocarpus sp.,	*3.88*	3.78
Milletia ovaldolia,	*4.42*	3.61
Mimosa himalayan,	*4.22*	3.88
Pueraria tuberosa,	*3.88*	3.53
Saccharum spontaneum,	*4.76*	3.68
Smilex sp.,	*4.24*	3.788
Vallaris solanacea,	*3.89*	3.53
Vetiveria zizanioides etc.	*3.89*	3.06
Ferns Species:		
Adiantum lunulatum.,	10.98	*21.08*
Adiantum caudatum,	40.71	*19.18*
Adiantum cappilisveneris,	22.41	*20*
Athyrium spo,	12.94	*20.54*
Oryopteris sp.,	12.94	*19.18*

4.3.9. Fauna

The animals observed in the study area are mainly mammals and aves as listed in the **Annexures 4.5 & 4.6**. In absence of natural forest (national parks and sanctuary), there is a dearth of wild animals in the study area. The riparian areas near the major rivers and canals were selected as the intensive study site as riparian zone is the eco-tone zone between the aquatic and the terrestrial ecosystem.

4.3.10. Terrestrial and Aquatic Wildlife Fauna

4.3.10.1 *Birds*

Altogether 120 species of avian fauna were found in Ludhiana to Khurja EDFC corridor influence area, of which 93 species were residential and 27 were migratory birds. Among migratory birds nearly all ducks, geese and waders were recorded in the river Yamuna. Since birds come here in particular season, much species were not found.

4.3.10.2 *Mammals*

There were altogether 14 mammalian species recorded in Ludhiana to Khurja EDFC corridor influence area and no species were categorized as schedule-I under Wildlife Protection Act 1972. Most of the species were recorded in the habitat near small patches of forest near river Yamuna, Ganga canal, Kalanur PF etc.

4.3.10.3 *Amphibian Fauna*

There were altogether 3 amphibian species recorded in Ludhiana to Khurja EDFC corridor influence area, but no schedule - I species under Indian wild life protection act, 1972 was found.

4.3.10.4 *Reptiles*

Altogether 5 reptilian species were recorded in Ludhiana to Khurja DFC corridor reach during the survey. These were 2 snakes and 2 lizards and one turtle.

4.3.10.5 *Faunal Species Diversity(Diversity Index (H):*

For the species diversity index of the fauna in the study area is represented in **Table 4.24.**

Table 4.24 : Species Diversity index of terrestrial fauna in different location of study area

Faunal Class	Shanon Wiener Diversity Index	Study Zones						
		Upper Ganga Canal	Kali Nadi	Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal
Mamm-als	H	3.398	2.748	3.289	2.281	3.221	3.22	2.281
	Variance H	0.002692	0.002697	0.004966	0.004572	0.004702	0.006499	0.004572
Birds	H	3.596	3.127	3.472	3.434	3.366	3.301	3.221
	Variance H	0.002965	0.004044	0.004043	0.002347	0.002502	0.002592	0.004702
Amphib-ian Species	H	3.082	3.026	3.105	3.029	3.066	3.02	3.222
	Variance H	0.007266	0.005183	0.008135	0.006732	0.008482	0.008877	0.004043
Reptiles	H	3.352	3.035	3.562	3.308	3.438	3.519	3.127
	Variance H	0.002856	0.003566	0.00265	0.003309	0.003036	0.003323	0.004044

The species diversity of mammal was highest in the riparian zones of the upper Ganga canal, birds and amphibians were highest in the Yamuna River riparian zones, and reptiles in Yamuna River and near by riparian zone (**Table 4.24**).

4.3.10.6 *Faunal Behaviour Pattern*

The Nilgai and the Wild Boar were found to be free living in the forest patches near the Ludhiana to Khurja EDFC corridor track. They do not have any definite path to cross the railway track. They were observed to be important to train movement. They used to run away when train runs on the track near them.

Nesting colonies of birds:

The DFC alignment from Khurja- Ludhiana passes through indo-gangetic plains which are very fertile. Due to this the trees and vegetation growth is very rapid. Some of the old trees have taken a giant form. These trees are the nesting ground for the birds. This is very common phenomenon in the project influence area. During the study period one such tree has been observed at a distance of about 100 m from DFC RoW(near km 172). About 200 nests were seen on this tree. These nests were of common avifauna such as crow, myna, etc. Similarly on many smaller trees with nests were observed, but these were not of any endangered avifauna. The number of nests of birds observed in biodiversity study is given below **In Table-4.25**

Table 4.25 : Nest of Birds in the Impact Zone (Within 50 m from the track)

S. No.	From	To	No. of Nests within 50 meter
1	0	50	49
2	51	100	52
3	101	150	63
4	151	200	29
5	201	250	23
6	251	300	15
7	301	350	26
8	351	400	17
			Total 274

4.3.10.7 *The prevalence of the above number of nests is a common phenomenon in the entire gangetic plain, therefore, no alternative, bird nest is recommended. However, trees with high number of bird nests may be avoided for cutting as far as possible if falling within the RoW, other trees may be handled properly.*

4.3.10.8 *Land River Interface*

4.3.10.9 *There were several land river interfaces found along the Ludhiana to Khurja EDFC corridor. At the point of the land river interfaces the avian fauna diversity is found to be high. Yamuna canals, Ganga canal and Bhakra canal are the three interfaces which are very important for the entire area for annual biodiversity re-colonization in Ludhiana to Khurja EDFC corridor.*

4.3.10.10 *Migratory Route Of Terrestrial Fauna*

There was no migratory route of terrestrial faunas reported so far throughout the Ludhiana to Khurja EDFC corridor. . But the movements of amphibian and reptilian fauna from rivers to the land surface crossing the Ludhiana to Khurja EDFC corridor and vice versa cannot be ignored. For this reason, no such map could be prepared to protect them, because, their movement is not fixed and varies as per their suitability.

4.3.10.11 *Identification Of Endemic/ Threatened And Endangered Species*

There was no endemic wildlife species found in the study area, no species of endangered species were recorded during survey. Study recorded one (vulnerable under IUCN redlist category) and one schedule I (under the Wildlife Protection Act 1972) avian fauna were found in the Ludhiana to Khurja EDFC corridor, however, these are not affected due to DFC.

4.3.10.12 *Endangered Avian Fauna In Ludhiana To Khurja EDFC Corridor*

There were one vulnerable specie (iucn red list) found in the area i.e. Sarus crane and one schedule-i (iwpa 1972) specie (gyps bengalensis) in the area are listed in **Table 4.26.**

Table 4.26 : List of Endangered/ vulnerable/ Schedule-I species

S. No.	English Name	Scientific Name	Status of IWPA
1.	White rumped Vulture	*Gyps bengalensis*	Schedule-I
2.	Sarus crane	*Grus antigone*	Vulnerable (A2 cde+3cde+4cde) under IUCN red list,2008

4.3.10.13 *Wetlands*

There are no notified wet lands but prevalence of village ponds is seen near the corridor. There is no village pond in the row.

4.3.10.14 Peoples Dependence On Flora And Fauna

The people residing near Ludhiana to Khurja EDFC corridor do not depend on the flora and fauna chiefly. They are economically sound and most of them primarily depend on the agriculture. Very few people were dependent for their livelihood on selling the fuel woods from neighbouring protected forest or naturally growing tree species along Ludhiana to Khurja EDFC corridor.

4.3.10.15 Areas Of Eco-Important Zone / Protected Area

No eco-important and protected areas were found in the Ludhiana to Khurja EDFC corridor and in the buffer zone of existing track. Also, no major wildlife habitat/ reserve forest areas/ sanctuaries were found in this reach except gagoul reserved forest and Kalanur protected forest. Kalanur protected forest with very low population of wild fauna is near the Ludhiana to Khurja EDFC corridor, which cannot be considered as the eco-important zone. Gagoul reserved forest is present in the meerut detour area through which the proposed track will pass through a distance of 650 meter. This reserved forest holds considerable number of trees which are habitat for birds and small mammals.

4.3.11. Aquatic Ecology

In the whole stretch of Ludhiana to Khurja EDFC corridor, it has been observed that the rivers crossed were rich in aquatic fauna starting from the macro-invertebrates to the higher vertebrates including mammals in the terrestrial area near the river. The aquatic fauna was studied from 7 different study zones. The variability and number of each species in all study zones are found to be varied as per the ecological variations in these areas. The major fisheries of these areas are barilius spp, tor sp, labeo sp, etc.

4.3.11.1 Aquatic Or Macro-Invertebrates Ecology

The aquatic fauna gives a rich diversity in the project area. Under macro-invertebrates such as crabs, molluscs, snails, lizards, amphibians are seen in Ludhiana to Khurja EDFC corridor. A few most important snails are also recorded from those areas. Phytoplanktons and zooplanktons were also recorded.

The species diversity and abundance of fish is found to be high in Yamuna River in the proposed Ludhiana to Khurja EDFC corridor (**Table** 4.27**)**. This is because of rich aquatic environment of Yamuna River which forms a suitable breeding ground for the fish. Many fish prefer to breed in the riparian zone (interface between land and river) of the river.

Although the fish species available are more or less similar in all the river channels and canals in the sites but the abundance of some of the species is very much different.

Table 4.27 : Species Diversity of Aquatic Avian Fauna in the DFC Khurja to Ludhiana Project Stretch

Faunal Class	Shanon Wiener Diversity Index	Study Zones						
		Upper Ganga Canal	Kali Nadi	Yamuna River	Yamuna Western Canal	Markhan da River	Bhakra Canal	Sirhind Canal
Fish	H	2.381	2.543	3.306	2.105	3.219	3.014	2.341
	Variance H	0.002692	0.002697	0.004966	0.004572	0.004702	0.006499	0.004572
Avian Fauna	H	3.163	2.954	3.639	3.201	2.915	2.873	2.654
	Variance H	0.002856	0.003566	0.00265	0.003309	0.003036	0.003323	0.004044

The species diversity of fish fauna in the entire project stretch of Ludhiana to Khurja EDFC corridor is highest in the Yamuna River and the aquatic avian diversity is also highest in the Yamuna River area.

4.3.11.2 *Aquatic Avian Diversity:*

During the period of the study there were 28 aquatic avifauna found in the area. The aquatic avifauna found in the area are of migratory and residential. Altogether 17 aquatic birds were found to be migratory and rest 11 were residential **(Table** 4.28).

Table 4.28 : Aquatic avifauna in the DFC Khurja to Ludhiana Project Stretch

Sl. No.	Common Name	*Scientific Name*	Migration Status	Habitat
1	Northern Shoveller,	*Anas clypeata*	M	aq
2	Garganey,	*Anas querquedula*	M	aq
3	Common Sandpiper,	*Actitis hypoleucus*	R	aq
4	Common Kingfisher,	*Alcedo atthis*	R	aq
5	White breasted Waterhen	*Amaurornis phoenicurus*	R	aq
6	Northern Pintail,	*Anas acuta*	M	aq
7	Northern Shoveler,	*Anas clypeata*	M	aq
8	Common Teal,	*Anas crecca*	M	aq
9	Eurasian Wigeon,	*Anas penelope*	M	aq
10	Mallard	*Anas platyrhynchos*	M	aq
11	Spot billed Duck,	*Anas poecilorhyncha*	M	aq
12	Gadwal	*Anas strepera*	M	aq
13	Common Pochard,	*Aythya farina*	M	aq
14	Tufted Duck	*Aythya fuligula*	M	aq
15	Little Bittern	*Lxobrychus minutus*	M	aq
16	Ferruginous Pochard	*Aythya nyroca*	M	aq
17	Black winged stilt	*Himantopus himntopus*	R	aq
18	Median Egret,	*Mesophoyx intermedia (Wagler)*	R	Aq
19	Painted Stork,	*Mycteria leucocephala (Pennant)*	R	Aq
20	Black crowned Night Heron,	*Nycticorax nycticorax (Linnaeus)*	M	Aq
21	Dalmatian Pelican,	*Pelecanus crispus Bruch*	M	Aq
22	Little Cormorant,	*Phalacrocorax niger*	R	Aq
23	Black Ibis,	*Pseudibis papillosa (Temmin)*	R	aq
24	Comb duck,	*Sarkidiornis melanotos (Pennant)*	R	aq
25	Brahminy Duck,	*Tadorna ferruginea*	M	aq
26	Common Shelduck,	*Tadorna tadorna*	M	aq
27	Sarus crane	*Grus antigone*	R/ Vulnerable (A2 cde+3cde+ 4cde)	Aq
28	Common bittern	*Lxobrychus cinnamomus*	R	Aq

4.3.11.3

4.3.11.4 *Fish Species Diversity*

Altogether 67 species of fish has been identified in the study area. Diversity of fishes in different sites gives different results. *Carp species, tor tor* species are predominant in all project sites. Tor & mahaseer is found to be more dominant in the flood seasons because it migrates through main channel of the Yamuna River. In winter season also *tor* is found to migrate though in a lesser number. Other fish species like minnows are found to be less in diversity in some points.

4.3.11.5 Faunal Behaviour Pattern

The existing channel of rivers and canals are found not to support very high diversity of fishes and amphibians species, which breed during pre-monsoon and monsoon season. The bank of the rivers and canals are good habitat for the amphibians and the lizards. They prefer to live in the riverbank. So if the bank is destroyed obviously there will be negative effects to the species. Some fishes as well as other benthos and turtles are very sensitive to the river dumping, sedimentation and abrupt changes of river ecology.

4.3.11.6 Migratory Route Of Aquatic Fauna (Fish)

The game or sports fish species like *Tor Tor* (also an endangered species according to the NBFGR report) shows migratory behaviour through the deeper channels of the river Yamuna. They migrate through the main channel of the river i.e. Through the deeper zones of the river only during the high level of water during the monsoon season from upstream to downstream.

4.3.11.7 Spawning And Breeding Grounds:

The spawning and breeding grounds were recorded only in the Yamuna River. Major and minor carp used to spawn in different areas of current channel of the river in the different zones at different depths. However, it is not possible to demarcate specific locations as the fish spanwing and breeding ground.

4.3.11.8 Area Of Ecologically Important / Protected Area/ Restricted Area/ Legislative And Others Areas

No such protected area, restricted area and others were found in the project sites.

4.3.11.9 Identification Of Endemic/ Threatened And Endangered Species

Only one fish species of fish are found under endangered category (as categorised by NBFGR0). That species is the *Tor Tor*.

4.3.11.10 Peoples Dependence On Aquatic Fauna

Fishery community people are seen in the adjoining areas of Ludhiana to Khurja EDFC corridor does not depend on the aquatic fauna for their livelihood as observed during the study period.

4.3.11.11 The Diversity Of Plankton

The phytoplankton, zooplankton population in the project area was much lower as compared to the normal. A total of 48 phytoplankton were found in Khurja to Ludhiana EDFC corridor. The total density of phytoplanktons ranged from 964 ind. M^{-2} to 1,832 ind. M^{-2} (07),

A total of 99 numbers of zooplanktons were found. Density of zooplankton present was in the range of 9 –25 ind. L-1 (08). The result indicates poor diversity of zooplankton in the wetland though they were found in the higher range in the Yamuna River and Gangacanal.

The species diversity of the plankton in seven major locations of the study area is represented in **Table 4.29**. The diversity both the phytoplanktons and the zooplanktons were found to be high in Yamuna River.

Table 4.29 : Species Diversity of Planktons in the Canals, Waterbody and rivers in the EDFC Khurja to Ludhiana Project Stretch

Plankton Class	Diversity Index	Study Zones						
		Upper Ganga Canal	Kali Nadi	Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal
Phyto plankton	H	3.08	3.03	3.35	3.03	3.07	3.02	2.39
	Variance H	0.01	0.01	0.01	0.01	0.01	0.01	0
Zoo plankton	H	3.07	2.97	3.46	3.12	3.3	3.37	3.26
	Variance H	0.01	0	0	0.01	0	0	0

4.3.11.12 Ecological Important Areas -Aquatic

There are ecologically important locations within the study area as represented in the following table.

Table 4.30 : Ecologically important areas (aquatic) in the EDFC Khurja to Ludhiana Project Stretch

Sl. No.	Ecologically important location (Aquatic)	Chainage (Km.)	Ecological Importance (Habitat of F=Fish,P=Plankton,A= Aquatic Birds)
1	Dharpa Canal	12	F,P
2	WB near Pablihas	110	F,P
3	WB at Daurala	119.5	F,P
4	Upper Ganga Canal	139.5	F,P,A
5	Ganga Canal pt. 2	139.5	F,P,A
6	Main MuzafarNagar Drain	152	F,P
7	Jarauda Distributory	155.1	F,P
8	Kali Nadi	167.5	F,P
9	Markhanda River	185.7	F,P
10	Easter Yamuna Canal	211.5	F,P,A
11	Yamuna River	243	F,A,P
12	Yamuna Western Canal	251.5	F,P,A
13	Sirhind Canal	294.7	F,P,A
14	WB at Ambala	309	F,P
15	Bhakra Canal	361.8	F,P,A
16	Daurala Distributory	118.5	F,P
17	Dangri river	298.1	F,P
18	Gulaothi distributory	43.2	F,P
19	WB at Kahatauli	137.5	F,P
20	Markhanda River	285.5	F,P,A
21	Waterbody	320/08	F,P,A

The main ecologically important (aquatic) locations are in the river Yamuna, Yamuna west canal, upper Gangacanal, bhakra canal, daurala distributory, markhanda river (Table 4.30). These locations are important as they are the habitat of fishes, planktons and aquatic avian fauna.

Sample of Fish Fauna

Vulnerable Sarus Crane Near Chainage 2 km

Black winged Stilt

Little Egret

Common Hoopoe in Hapur Station

Common Myna

House crow

Fuel Wood Collection From Gangol RF
Near the Meerut Detour

Grassland Patches Near Upper Ganga Canal

Kingfisher

Little egret

Black Winged Stilt

Segun or Teak in the Project area (Buffer zone)

Ficus tree

Nest on a Ficus Tree.

Cattle egret Colony (120 meter away from Track)

Cattle egret Colony

Poplar Plantation (Chainage 187 Km/ S&W)

4.4. Social and Cultural Resources

4.4.1. Population and Communities

The total population of Uttar Pradesh, Haryana and Punjab are- 166052859, 21082989 and 24289296 respectively as per census, 2001. The decadal growth rate of population of u.p., Haryana & Punjab are 25.8%, 28.06% & 19.76% respectively. Again the population density of the entire three project states are higher then the national average (324/km^2) viz. Uttar pradesh-689, Haryana-477 & Punjab-482.

It is observed that out of the ten project districts, the total population is highest in Muzaffarnagar (3543362) followed by Ghaziabad (3290586) and Ludhiana. The population is lowest in Fatehgarh Sahib District of Punjab (538041). The population of schedule caste is found to be highest in Fatehgarh Sahib (30.67%) and lowest in Muzaffarnagar district (13.5%). There are no schedule tribe population in all the five districts of Haryana & Punjab while district Saharanpur is having the maximum population among the districts of Uttar Pradesh (498).

Table 4.31 : Demographic Profile of the State and the Project Districts

Project Districts	Total Population			Percentage of Schedule Caste Population			Schedule Tribe Population		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Bulandsahar	2913122	1550326	1362796	20.21	20.32	20.08	188	103	85
Ghaziabad	3290586	1769042	1521544	18.04	18.09	17.99	207	112	95
Meerut	2997361	1601578	1395783	18.44	18.54	18.32	236	112	124
MuzaffarNagar	3543362	1893832	1649530	13.5	13.58	13.40	87	42	45
Shaharanpur	2896863	1553322	1343541	21.73	21.79	21.65	498	279	219
Yamuna Nagar	1041630	559444	482186	24.53	24.43	24.64	0	0	0
Ambala	1013660	542366	471294	21.18	23.57	18.42	0	0	0
Patiala	1844934	987390	857544	23.05	22.87	23.26	0	0	0
Ludhiana	3032831	1662716	1370115	24.99	24.29	25.85	0	0	0
Fatehgarh Sahib	538041	290137	247904	30.67	30.36	31.03	0	0	0

Source: Census of India, 2001

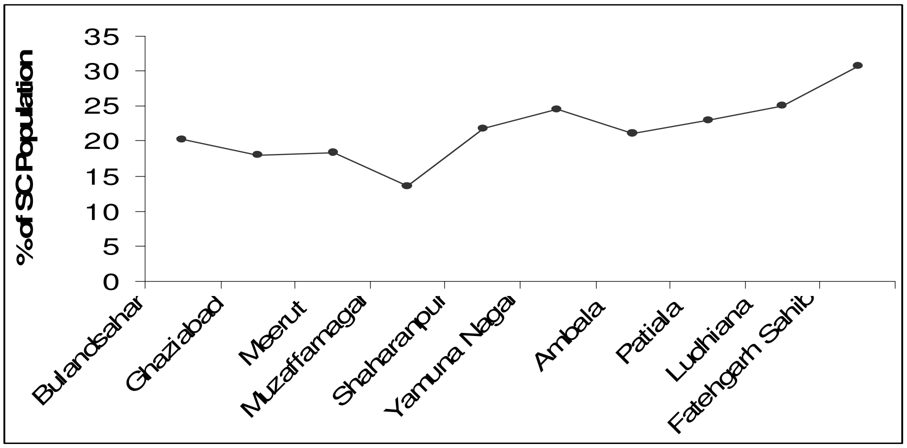


Figure 4.18 : Percentage of SC Population in the project districts

4.4.2. Health Facilities

Medical facilities in project districts are not satisfactory. The availability of these is given in **Table-4.32** below:

Table 4.32 : Health Facilities in the State and Project Districts

Medical facilities	Bulandsahar	Ghaziabad	Meerut	Muzaffar Nagar	Saharanpur	Yamuna Nagar	Ambala	Patiala	Fatehgarh Sahib	Ludhiana
Allopathic dispensary	28	15	22	38	38	34	48	105	78	229
Ayurvedic Dispensary	15	10	5	24	14	14	11	20	5	9
Maternity and child welfare centre	144	105	189	283	203	10	14	26	37	132
Maternity home	71	19	6	59	37	2	17	18	11	33
Child welfare centre	89	37	41	86	64	0	20	25	2	58
Health centre	30	16	13	52	34	2	8	28	7	68
Primary health centre	34	30	34	52	29	12	17	26	11	72
Primary health sub-centre	66	117	66	74	82	96	74	20	31	25
Family welfare centre	73	25	26	51	42	0	5	12	2	11
Nursing home	4	15	1	2	8	7	1	10	5	9
Registered private medical practitioners	470	355	359	955	869	145	421	51	120	723
Other medical facilities	13	7	10	4	26	1	4	10	0	3

Source: Census of India, 2001

4.4.3. Education Facilities and Literacy

The education scenario out of all the districts under project district is lowest in the districts of Uttar Pradesh (48.34 to 57.73 %). The highest percentage of literacy is observed in Fategarh Sahib (67.14%) district of Punjab. The literate percentage of man dominates over that of female in all the project districts with highest in Fatehgarh Sahib district. The women literate percentage is lowest in Bulandshahar (34.63%). The graphical representation of the literacy rate in the project districts are summarized in **Table 4.33 & Figure 4.19.**

Table 4.33 : Literate Scenario in the Project Affected Districts

Project Districts	% of Literate		
	Total	Male	Female
Bulandshahar	**48.34**	68.7	**34.63**
Ghaziabad	57.73	76.8	48.06
Meerut	53.6	71.1	44.02
MuzaffarNagar	49.06	**66.7**	38.73
Saharanpur	49.85	66.8	40.67
Yamuna Nagar	61.32	77.9	54.59
Ambala	66.47	82.8	60.22
Patiala	60.7	75.4	55.17
Fatehgarh Sahib	**67.14**	**85.4**	**63.19**
Ludhiana	64.56	79.7	60.38

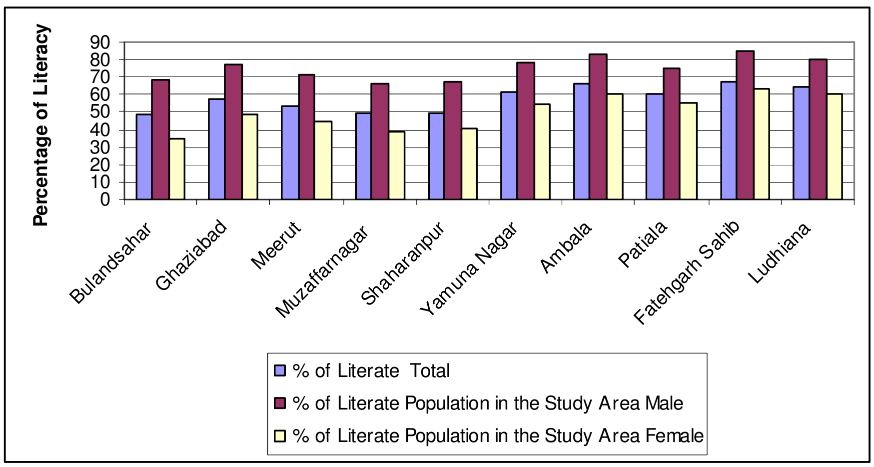


Figure 4.19 : Percentage of Literate population in the study area

The number of primary schools of Bulandshahar (1348), Muzaffarnagar (1365) and Saharanpur (1360) is dominating though the literacy percentage is low in all these three districts. There are also a number of private education institutes in all the project districts. The educational facilities are shown in **Table-4.34** below:

Table 4.34 : Educational Facilities in the Project Districts

Education facilities	Bulandsahar	Ghaziabad	Meerut	Muzaffar Nagar	Saharanpur	Yamuna Nagar	Ambala	Patiala	Fatehgarh Sahib	Ludhiana
Number of primary schools	1,348	714	887	1,365	1,360	169	535	1,022	466	976

Education facilities	Bulandsahar	Ghaziabad	Meerut	Muzaffar Nagar	Saharanpur	Yamuna Nagar	Ambala	Patiala	Fatehgarh Sahib	Ludhiana
Number of middle schools	284	238	274	354	325	69	217	336	130	487
Number of secondary schools	93	39	55	79	68	37	162	128	75	222
Number of senior secondary schools	69	29	44	58	37	28	78	33	29	87
Number of colleges	20	13	6	22	4	0	4	0	0	15
Number of adult literacy class/centers	73	95	107	152	23	1	12	11	5	28
Number of industrial schools	7	3	1	4	3	0	26	10	7	9
Number of training schools	6	4	2	4	3	1	16	6	3	10
Number of other educational schools	27	33	55	35	69	1	6	2	1	24

4.4.4. Socio-Economic Conditions

As per 2001 census, the total workers in the state account for 142.76 lakh, which is 35.73% of the total population of the state. The economy of the districts is primarily agricultural.

As per 2001 census, % of the working population in the study area is in between 40-28% of the total population. The working population percentage is highest in bulandsahar (40.3) and lowest in Saharanpur (28.2%). (**Figure 4.20**).

The other working force dominates among all the working class population in entire project districts. Other working class population is highest in Ludhiana (75.7%) and Ghaziabad (73.2%) of total working population. It indicates high numbers of industrial labours in these project districts. The percentage of agriculture workers to total workers is highest in Saharanpur among all the project districts. Percentage of cultivators is highest in bulandsahar (40.32%) and lowest in Ludhiana (12.59%). The numbers of household workers are low in all the project districts (5.23-1.93%). The percentage of working population to total population is given in **Table 4.35.**

Table 4.35 : Percentage of Working population to total population

Project Districts	% of Working Population			% of Nonworking Population		
	Total	Male	Female	Total	Male	Female
Bulandsahar	40.3	50.9	28.2	59.7	49.1	71.7
Ghaziabad	28.5	45.6	8.6	71.5	54.3	91.3
Meerut	29.9	46.6	10.7	70.1	53.4	89.2
MuzaffarNagar	33.1	49	14.8	66.9	51.0	85.1
Shaharanpur	28.2	47.1	6.3	71.8	52.8	93.6
Yamuna Nagar	31.2	52.3	13.5	68.8	47.7	86.5
Ambala	34.6	54.3	15.7	65.4	45.7	84.3
Patiala	37.0	53.6	17.8	63	46.4	82.1
Ludhiana	37.9	55.6	16.5	62.1	44.4	83.5
Fatehgarh Sahib	38.3	54.9	18.8	61.7	45.0	81.1

Source: Census of India, 2001

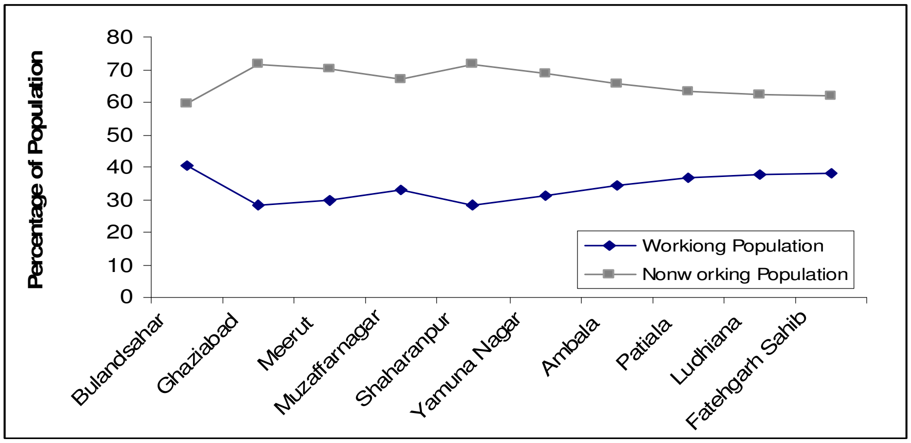


Figure 4.20 : Percentage of Working and Nonworking population

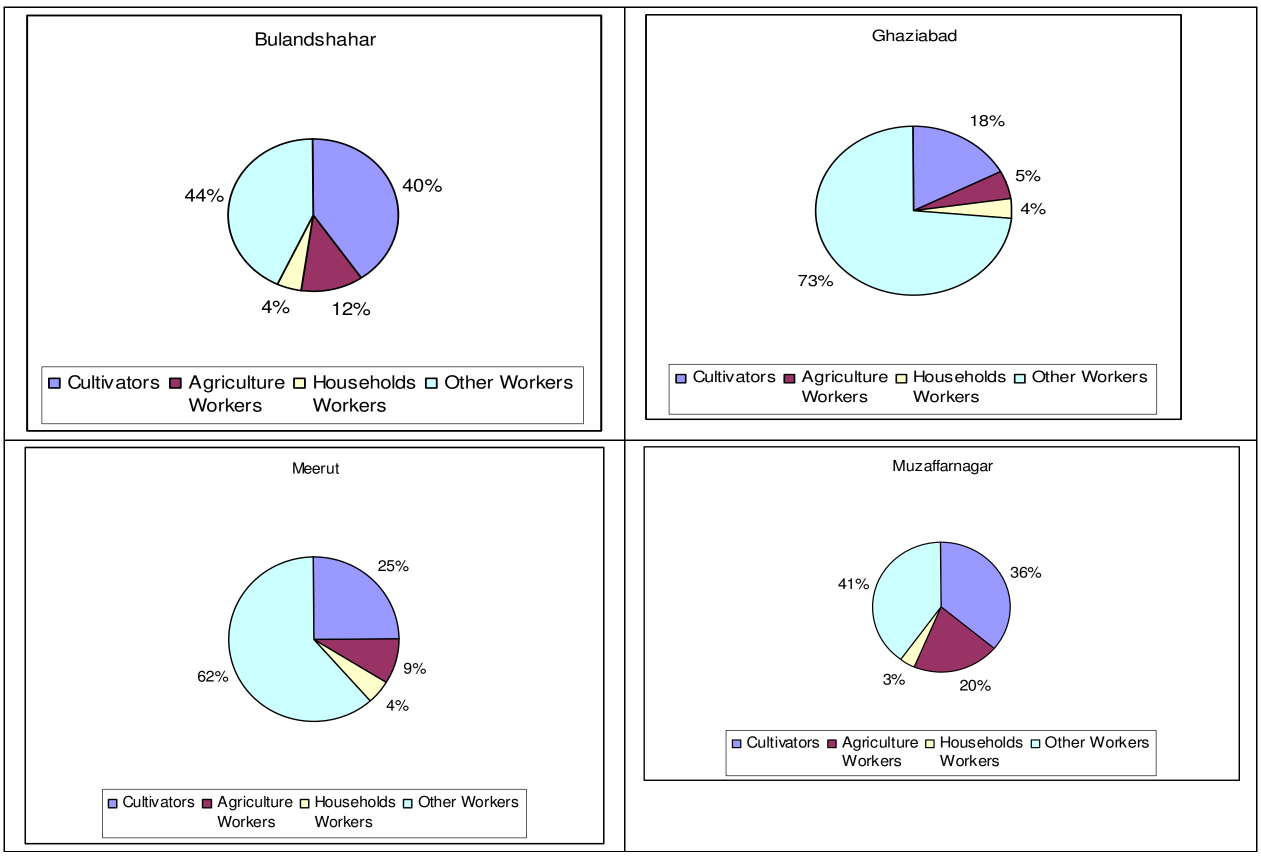


Figure 4.21 : Percentile distribution of Main workers in the project districts

4.4.5. Social Profile of Project Affected Persons (PAPs)

(i) Age-Sex Composition: Amongst PAPs (16404) under the project, there are 9238 male (56.31%) and 7166 female (43.69%). Average family size is about 5.32. It is seen from **Table 4.36** that the sex ratio for this stretch is 775.

Table 4.36 : Age-Sex Composition

Type of Impact	0-6		6-15		15-18		18-45		45-59		59-Above		Total	
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Total	692	470	1454	903	945	676	3986	3210	1196	1143	965	764	**9238**	**7166**

Source: Census Survey SIA Team, 2012

(ii) Annual Income Patterns of the PAFs

Information collected during Census survey on income level of each PAFs indicates that PAFs are economically weak. It can be seen from **Table 4.37** that out of total 988 PAFs, about 25% of total PAFs are earning less than 50,000. PAFs earning less than Rs 25,000 have been considered as people 'Below the Poverty line (BPL) which is about 4.67% of total PAFs.

Table 4.37 : Total Annual Income of PAPs

Section	Income Group (Rs.)				Total
	0 - 25000	25000 – 50000	50000 - 1 Lakh	above 1 Lakh	
Khurja-Ludhiana	144	294	570	2071	3079

Source : Resettlement Action Plan (RAP) Report

(iii) Social Status of the Project Affected Families

Table 4.38 presents information about social status of PAFs. Out of total 3079 PAFs, about 42.10% are general and 50.91% are OBC. About 7% are schedule caste. There is no schedule tribe family in the affected numbers.

Table 4.38 : Social Status of the PAFs

Section	General	Schedule caste	Schedule Tribe	Other backward caste	Total
Kurja-Ludhiana	1556	182	0	1341	**3079**

Source : Resettlement Action Plan (RAP) Report

Furthermore, the SIA has established the proposed project will not impact any tribal groups in the project area. Moreover, the assessment found that there are no tribal specific habitations along the proposed DFC corridor. Therefore, this project triggers the Bank's operational policy (OP 4.12) on involuntary resettlement and **not OP 4.10 on Indigenous Peoples (referred as tribal in Indian context).**

(iv) Vulnerability

Table 4.39 presents number of PAPs under vulnerable categories as per NRRP 2007. Among the PAPs, there are 932 vulnerable persons Out of these, 81.32% are people above the age of 50 years. Other significant categories are widows (13.30%) and unmarried girls above the age of 18 years (2.71%). This would become significant while planning for the women's income generation and restoration strategies. These vulnerable categories of PAPs will be supported by the project but within the purview of NRRP 2007.

From the **Table 4.39** it is ascertained that about 1964 PAFs are below the poverty line. Under the project (as per EM), BPL families are also considered as vulnerable. **Table-4.39** present BPL families considered as vulnerable. These families will be assisted to regain their living standard

Table 4.39 : Vulnerability Status of the PAPs

Section	Project Affected Persons					Total
	Disabled / Orphan	Widow	Un Married Girls above 18 years	Below the Poverty Line	Person above 50 years	
Khurja-Ludhiana	67	1056	216	144	6456	**7939**

Source: Resettlement Action Plan (RAP) Report

Taking into account the socio-economic vulnerabilities of the PAFs, specific provisions in form of additional assistance have been incorporated in the RAP to ensure that they are not marginalized in the process of development. However, the actual number of these vulnerable people eligible for R&R support will be scrutinized by the implementing agencies. The NRRP 2007 defines vulnerable persons as 'disabled, destitute, orphans, widows, unmarried girls, abandoned women, persons above 50 yrs of age, who are not provided or cannot immediately be provided with alternate livelihood, and who are not otherwise covered as a part of family. The information provided in the above table shall be reconfirmed and beneficiaries will be identified for provision of R&R assistance through NGOs.

(v) Education Status

Amongst the PAPs, there is a high degree of illiteracy in the project area. About one-fifth (19.69 %) PAPs are uneduacated. Another 25.20 % of the PAPs are basic literates. About 16.43% of the total PAPs have studied up to the 8th standard school level (**Table 4.40**). Amongst PAPs, there are 2340 (14.27%) graduates in the area. Less number of professionally educated PAPs points to the lower level of opportunities in the project area. Since about 20% of the PAPs are illiterate, special efforts and attention would be required for communicating awareness about social issues resettlement and rehabilitation options, compensation and project related decisions. These efforts will include generating awareness, available income restoration schemes, grievance redressal mechanism, under the project. The facilitating NGOs will be given key responsibility for this.

Table 4.40 : Education Status of PAPs

Section	**Education level**						**Total**
	Un Educated	Educated	8th	10th	Inter mediate	Graduate	
Khurja-Ludhiana	3231(19.69%)	4134(25.20%)	2696(16.43%)	2483(15.14%)	1520(9.27%)	2340(14.27%)	**16404**

Source: Resettlement Action Plan (RAP) Report

(vi) Occupational Background

In the families loosing agricultural land, about 17.52% PAPs are housewives who are engaged in daily household work. Another, 11.72% are students, 8.81% PAPs are labourers in the agricultural sector or otherwise. About 5.46% of the PAPs are engaged in business activities (trade and petty business). Many of these businesses people are associated with the small economic activities such as Tiffin centers, tea centers, general stores, etc.

Table 4.41 : Occupation Profile of PAPs

Section	**Occupation profile(PAPs)**								**Total PAPs**
	Service	Business	Cultivator	Students	House-Wife	Labour	Un-Employed	Workers	
PAPs	**2024 (12.34)**	**895 (5.46)**	**3476 (21.19)**	**1924 (11.72)**	**2873 (17.52)**	**1445 (8.81)**	**1126 (6.87)**	**2641 (16.09)**	**16404**

Source: Resettlement Action Plan (RAP) Report

4.4.6. Industries

All the project districts are in industrial belt. Khurja (starting point of the project) is famous for its pottery industries. There are numbers of large to small-scale industries in the entire study area. Meerut is famous for sport goods manufacture industries along with other heavy to medium scale industries. Sugarcane and paper industries dominate the industrial sectors of Saharanpur, Muzaffar Nagar Yamuna Nagar & Ambala. Steel and iron industries dominate the industrial scenario of Patiala, Fatehgarh Sahib and Ludhiana districts of Punjab. Mandi govindgarh is famous for its large number of steel and iron industries of heavy to small-scale categories.

4.4.7. Agriculture

Agricultural activities play a vital role in economic development of all the project districts. Punjab itself produces almost one-third of the total food grains of India. There are two main growing seasons in the region, summer (locally called Kharif) from April to September and winter (rabi) from October to March. This area produces almost every crop- wheat (Triticum aestivum), rice (Oryza sativa L.), maize (Zea maize L.), gram (Phaseolus mungo Roxb.), pulses, oilseeds, cotton (Gossypium arboreum L.), sugarcane (Sachharum officinarum L.), potato (Solanum tuberosum) etc. The agriculture yield of the Ambala district in last four years is given in **Table: 4.42.**

Table 4.42 : Agriculture Production details in the Ambala District

S. No.	Crop	2006-07			2007-08			2008-09		
		A	Y	P	A	Y	P	A	Y	P
1	Rice	70	3438	261	76	3695	282	81	3299	267
2	Maize	3	2268	7	3	2666	8	2.1	2667	5.6
3	Kharif Pulse	1	804	1				1	1000	1
4	Sugarcane	14	65010	910	15	68670	1030	11	56040	616
5	Wheat	82	3806	312	82	3982	327	84	3673	309
6	Barley									
7	Rabi Pulses	1.3	1000	1.3	1	1000	1	1	1000	1
10	Rabi Oilseed	2	1341	3	2	354	1	2	1065	2

4.4.8. Archaeological Monuments/Protected Areas

There are no protected monuments/sites/structures within stipulated 300 m from the proposed alignment/detours. However, few protected monument are present in the nearby as shown in **Table 4.43**. The nearest monument is a Cemetery at the junction of Meerut - Delhi Road and it is about 750 m distance from DFC alignment. All other ASI monuments are more than 1 Km away from the track. Therefore no formal clearance is required from National Monuments Authority.

Table 4.43 : Archaeologically Important Sites along the Proposed Alignment

S. No.	State	District	Locality	Name	Distance from centre of DFC alignment
1.	Uttar Pradesh	Bulandshahar	Bulandshahar	Balai Kot or Upper Fort	>300 m
2.	Uttar Pradesh	Bulandshahar	Bulandshahar	Large mound known as Moti Bazaar	>300 m
3.	Uttar Pradesh	Bulandshahar	Bulandshahar	Two cemeteries	>300 m
4.	Uttar Pradesh	Bulandshahar	Dankaur	Masonry tank and ancient temple	>300 m
5.	Uttar Pradesh	Bulandshahar	Shikarpur	Khera or mound called TalapatNagari or Myaji Khera	>300 m
6.	Uttar Pradesh	Ghaziabad	Paragana-put, Mustafabad,	Raja Karan ka khera	>300 m
7.	Uttar Pradesh	Meerut	At the junction of Meerut-Delhi road	Cemetery at the junction of Meerut - Delhi Road	>300 m
8.	Uttar Pradesh	Meerut	Meerut	Andhra Court, a high brick fortress	>300 m

S. No.	State	District	Locality	Name	Distance from centre of DFC alignment
				supposed to have been built by Mahi	
9.	Uttar Pradesh	Meerut	Meerut	Cemetery of the Meerut racecourse	>300 m
10.	Uttar Pradesh	Meerut	Meerut	Tomb of Shah Peer	>300 m
11.	Uttar Pradesh	Saharanpur	Badshahi Mahal	Badshahi Bagh locally known as Badshahi Mahal	>300 m
12.	Uttar Pradesh	Saharanpur	Lodhipur	Khera ki Bandi, Old Cemetery	>300 m
13.	Uttar Pradesh	Saharanpur	Saharanpur	Old British Cemetery, Khata Khedi	>300 m
14.	Uttar Pradesh	Saharanpur	Saharanpur	Old British Cemetery, Saharanpur City	>300 m
15.	Haryana	Ambala	Ambala	Kos Minar	>300 m
16.	Punjab	Ludhiana	Dhandari Kalan	Kos Minar	>300 m
17.	Punjab	Ludhiana	Sunet	Ancient Site	>300 m
18.	Punjab	Ludhiana	Sanehwal	Kos Minar	>300 m

Source: Archaeological Survey of India, Agra, Chandigarh and Amritsar Circle

Distance from the boundary of above mentioned Archaeological importance structure is much more than 300 m from the EDFC alignment cetral line. Therefore, no NOC is required as per the Act. Pictorial photographs of some of Archaeological monuments are given below:

Photo :- 1 View of Archeological Monuments, Balai Kot or Upper Fort, Bulandshahr

Photo :- 2 View of Archeological Monuments, Large Mound Known as Moti Bazar , Bulandshahr

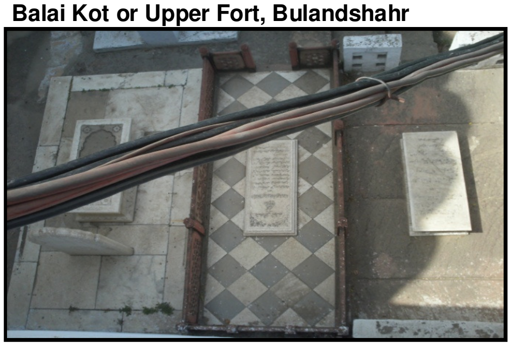


Photo :- 3 View of Archeological Monuments, Two Cemetries, Bulandshahr

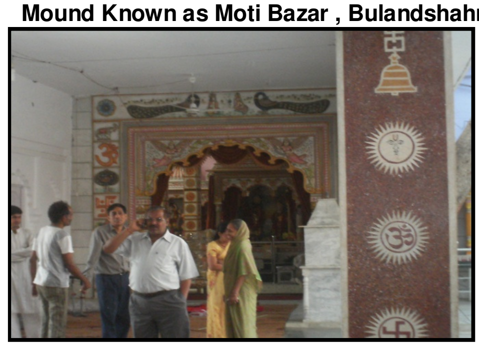


Photo :- 4 View of Archeological Monuments, Masonary Tank and Ancient Temple, Dankaur

Photo :- 5 View of Archeological Monuments, Khera of mound called Talapatnagari or Mayaji Khera, Shikapur

Annexure-_4.1: Ambeint Air Quality Sampling Methodology

I. Sampling Methodology for PM2.5

Instrument Used

The Envirotech APM 550 instrument was used for sampling fine particles (PM2.5 fraction) which is based on impactor designs standardized by USEPA for ambient air quality monitoring.

Ambient air enters the APM 550 system through an omni-directional inlet designed to provide a clean aerodynamic cut-point for particles greater than 10 microns. Particles in the air stream finer than 10 microns proceed to a second impactor that has an aerodynamic cut point at 2.5 microns. The air sample and fine particulates exiting from the PM2.5 impactor is passed through a 47mm diameter Teflon filter membrane that retains the FPM. The instrument allows removal of the PM2.5 impactor from the sample stream so that the same system may be optionally used as a PM10 Sampler.

Principle

Air is drawn through a size selective inlet & through a filter. Particulates with diameter less than 2.5µm in ambient air are collected by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM 2.5 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Procedure

After sampling place the exposed filters in controlled temperature & relative humidity environment (15°C to 27°C) for 24 hours prior to weighing & then takes the wt. on balance. Record it as the final wt. of filter.

Calculations

Calculation of volume of air sampled

V = QT
V = Volume of air sampled in m^3
Q = Average flow rate in m^3/minute
T = Total sampling time in minute

Calculation of PM 2.5 in Ambient air

$$PM\ 2.5 = \frac{(W_r - W_i) \times 10^6}{V}$$

Where:
PM 2.5 = Mass concentration of particulate matter less than 10 micron diameter in µg/m^3

W_i = Initial wt. of filter in g
W_f = Final wt. of filter in g
V = Volume of air sampled in m^3
10^6 = Conversion of g to µg

II. Sampling Methodology for SPM, RSPM, SO_2 and NO_X

Instrument Used

Air quality monitoring was undertaken using Respirable Dust Samplers (Envirotech Model APM 460) with thermoelectrically cooled impinger attachment for gaseous sampling. The APM 460 sampler uses an improved cyclone with sharper cutoff (D50 at 10 microns) to separate the coarser particulates from the air stream before filtering it on the glass microfibre filter. By using the APM 460, measurement of Respirable Particulate Matter can be done accurately and TSPM can also be assessed by collection of dust retained in the cyclone cup.

Principle

SPM and RSPM – Gravimetric Method using Respirable Dust Sampler
SO_2 – Absorption in dilute NaOH and then estimated calorimetrically with sulphanilamide and N (I-Nepthyle) Ethylene diamine Dihydrochloride and Hydrogen Peroxide (Central Pollution Control Board (CPCB) Method).
NO_X – Absorption in Potassium Tetra Chloromercurate followed by Chlorimetric estimation using P-Rosaniline hydrochloride and Formaldehyde (IS: 5182 Part - II).

Procedure

24-hourly ambient air samples were collected for SPM,PM2.5, RSPM, SO_2 and NO_X. These samplers were operated at an average flow rate of 1.1 – 1.2 m^3/min. as per IS: 5182 Part II for sampling/collection of SPM and RSPM levels. The particulate matter is collected through high efficiency cyclone which retains the dust particles greater then 10 micron size and allow only fines (less than 10 micron particles) to reach the glass microfibre filter where these particles are retained. The instrument provides instantaneous flow rate and the period of operation (on-time) for calculation of air volume passed through the filter. Amount of particulates collected is determined by measuring the change in weight of the cyclone cup and filter paper. The passage of air entering in the cyclone is designed to prevent heavier settleable particles from reaching in the cyclone.

For SO_2, NO_X, ambient air samples were collected using above sampler with impinger attachment provided with specific absorbing solutions, which were operated at an average flow rate of 0.2-0.51 lit./min. as per IS: 5182, Parts IV & VI.

The impinger samples (containing SO_2, NO_X in specific absorbing solutions) were analyzed spectro-photometrically using UV-VIS Shimadzu Spectrophotometer (UV-265). The samples were tested as per standard methods prescribed by CPCB.

Annexure- 4.2: Ambeint Air Quality Data

S. No	Location	Chainage	Zone	Date	Category	SPM $\mu g/m^3$	PM2.5 $\mu g/m^3$	RSPM $\mu g/m^3$	SO_2 $\mu g/m^3$	NO_X $\mu g/m^3$
1	Acharya Industries, Nizampur, Bulandshahar (Ch.1.8km)	Ch. 00 km – Ch. 100 km	Core	**10/12/09**	Industrial	345	32	166	16	13
2	Dharpa Dadupur		Buffer	**11/12/09**	Residential	289	23	139	13	12
3	Bulandshahar Station		Core	**12/12/09**	Commercial	278	35	133	11	8
4	Bedmani Hospital, Bulandshahar		Core	**13/12/09**	Commercial	354	27	170	13	11
5	Primary School, Murshidpur, (Ch.49.9)		Core	**14/12/09**	Residential	423	31	203	17	13
6	Rampur,		Buffer	**15/12/09**	Residential	321	34	154	14	12
7	Adarsh Risha Jr. High School, Kharkhoda		Core	**16/12/09**	Residential	286	32	137	11	8
8	Sundra,		Buffer	**17/12/09**	Residential	287	34	138	12	9
9	NH119 Crossing		Core	**18/12/09**	Commercial	462	31	222	15	12
10	Gulauti Station		Core	**19/12/09**	Commercial	365	25	175	18	14
11	Meerut City	Ch. 101 km – 200 km	Core	**20/12/09**	Commercial	431	41	207	17	13
12	Walidpur		Buffer	**22/12/09**	Residential	356	33	171	14	12
13	Naula		Buffer	**23/12/09**	Residential	312	31	150	15	10
14	Sardar Ballav Bhai Patel University of Agri. & Tech., Pabli Khas		Core	**24/12/09**	Residential	274	25	132	13	12
15	Hitkari Kissan Inter College, Sakhauti		Core	**25/12/09**	Commercial	522	28	250	22	18
16	Talheri Buzurg		Core	**26/12/09**	Residential	362	23	174	14	12
17	Rankhandi		Buffer	**27/12/09**	Residential	376	31	180	14	11
18	Rohana		Buffer	**28/12/09**	Residential	432	34	207	15	13
19	Muzaffar Nagar		Core	**29/12/09**	Commercial	541	31	260	21	16
20	Deoband Industrial Area		Core	**04/12/09**	Industrial	320	34	154	15	13
21	Nagal		Buffer	**05/01/10**	Residential	456	29	219	17	15
22	Meerut Cant		Core	**06/01/10**	Commercial	259	38	124	15	12
23	Daurala		Buffer	**07/01/10**	Residential	345	33	166	16	10
24	Jarauda		Core	**08/01/10**	Residential	464	34	223	16	11
25	Tandwal	Ch. 201 km – 300 km	Buffer	**09/01/10**	Rural	354	36	170	18	15
26	Saharanpur Railway Station		Buffer	**10/01/10**	Commercial	436	37	209	14	12

S. No	Location	Chainage	Zone	Date	Category	SPM µg/m³	PM2.5 µg/m³	RSPM µg/m³	SO_2 µg/m³	NO_X µg/m³
27	Jagadhari Railway Station, Yamuna Nagar	Ch. 301 km – 400 km	Core	**11/01/10**	Commercial	442	38	212	18	15
28	Mustafabad		Buffer	**12/01/10**	Commercial	415	31	199	16	14
29	Asian Group of Colleges (Chainage- 240.2)		Core	**13/01/10**	Rural	368	27	177	17	13
30	Kalanaur		Core	**14/01/10**	Rural	386	24	185	16	14
31	Yamuna Nagar		Buffer	**15/01/10**	Commercial	456	31	219	15	12
32	Sarsawa		Buffer	**16/01/10**	Commercial	431	29	207	16	13
33	Near Modern Senior Secondary School (Chainage-393.4km)		Core	**17/01/10**	Residential	200	21	134	12	10
34	Near Sanjivani Group of Institutes (Chainage-379.4km)		Core	**19/01/10**	Residential	234	21	112	15	12
35	Mandi Gobindgarh		Buffer	**20/01/10**	Industrial	521	45	250	23	18
36	Sirhind		Core	**21/01/10**	Commercial	345	44	166	18	15
37	Sanehwal		Buffer	**22/02/10**	Rural	289	32	139	17	13
38	Robin Model School, Khanna (Chainage- 374.5km)		Core	**23/01/10**	Commercial	456	31	219	21	16
39	Om Prakash Bansal School, (Chainage- 364.1km)		Core	**24/01/10**	Rural	225	26	108	13	10
40	Pashupati Kusht Ashram Society, Ambala, (Chainage-309.7km)		Core	**25/01/10**	Commercial	286	31	137	12	9
41	Rajpura		Buffer	**26/01/10**	Commercial	235	24	113	11	9
42	Chawla Pail		Buffer	**27/01/10**	Rural	245	27	118	13	11
43	Doraha		Buffer	**28/01/10**	Rural	227	24	109	14	10
44	Sanehwal		Core	**29/01/10**	Rural	267	21	128	15	12

Annexure- 4.3: Noise and Vibration Monitoring and Prediction Methodology

I. METHODOLOGY FOR SOUND MONITORING

Instrument Used

Ambient Sound levels were measured using an Integrating sound level meter manufactured by Cygnet (Model No. 2031). It has an indicating mode of Lp and Leq. Keeping the mode in Lp for few minutes and setting the corresponding range and the weighting network in "A" weighting set the sound level meter was run for one hour time and Leq was measured at all locations.

Principle

The intensity of sound energy in the environment is measured in a logarithmic scale and is expressed in a decibel, dB (A) scale. Ordinary sound level meter measures the sound energy that reaches the microphone by converting it into electrical energy and then measures the magnitude in dB(A). In a sophisticated type of sound level meter, an additional circuit (filters) is provided, which modifies the received signal in such a way that it replicates the sound signal as received by the human ear and the magnitude of sound level in this scale is denoted as dB (A). The sound levels are expressed in dB (A) scale for the purpose of comparison of noise levels, which is universally accepted by the international community.

Procedure

The day noise levels have been monitored during 6.00am to 10.00pm and night noise levels, during 10.00 pm to 6.00 am in the study area.

II. METHODOLOGY FOR VIBRATION MONITORING

Instrument Used

The iAdept instrument VM 1220 E was used to measure the vibrations from the trains near the track. The instrument comforms to JIS C1510-1995 standard and is capable of measuring vibration pollution from factory, construction site and traffic.

Procedure

It is an automatic instrument that calculates Vibration level Lv, Vibration acceleration level Lva, Max. value Lmax, Min value Lmin, Time rate vibration level (Lx : 5-value), Power averaged level (Leq). The data is stored in a data logger provided with the instrument.

Because the noise and vibration measurement requires samples of various trains such as train types and traction types, the measurement sites depending on the frequency and availability of different types of trains. The standard measurement point for railway vibration is set at the boundary which is 12.5 m away from the centre of the railway track. Additional 2 more measurement points were selected to examine the attenuation patterns; therefore, 3 measurement points, namely 5 m, 12.5 m and 25 m from centre of the track for single track sections, and 5 m, 12.5 m and 25 m from centre of nearest track for double track sections, were selected in total. The measurement results of Maximum Vibration Level (Lp) of each passing train were recorded. 6-10-hourly measurements were made at a single location for to record the vibration pattern in different set-ups. However, the maximum vibration data from different types of train passing was tabulated. Four different set-ups namely – rural, urban, semi-urban and railway bridges were chosen to obtain the data.

III. METHODOLOGY FOR PREDICTION OF RAILWAY NOISE

The railway noise generated by conventional trains (local trains, express trains and goods trains), main causes include (1) traction movements, (2) structures and (3) machines equipped to the train. Among them, the traction movement contributes to the generation of noise greatly. However, from the observed levels it is difficult to identify the contributions of each component to the total noise emissions.

Therefore, prediction was carried out applying the actual data of railway noise level (L_{AE}), running speed (V) of trains, and the distance from centre of the nearest railway track (D). Based on the obtained the data of railway noise at 18 sites, the empirical equation was extracted by using a simple regression and correlation analysis. The data at 2 sites was examined to extract the empirical equation. It was decided to use this equation for noise prediction. Assuming V is constant, D is only one variable, and the empirical equation is shown below.

$$L_{Amax} = A_1 + B_1 \, \text{Log10 (D)} \qquad (1)$$
$$L_{Aeq1} = L_{Amax} + 10 \, \text{Log10 (N/T)} \qquad (2)$$

A predicted railway noise level is shown in the below table.

Train	A_1	B_1	Railway Noise Level (L_{AE} & L_{Aeq} (dB))					Noise Level
			12.5 m	25 m	50 m	100 m	200 m	
Freight (Electric)	81.9	-0.4	81.5	81.3	81.2	80.3	81.0	L_{Amax}
			51.9	51.8	51.7	50.8	51.4	L_{Aeq1}

Note: N – No. of sample: 4;
T – Unit Time: per second
r^2 – 0.97

IV. METHODOLOGY FOR PREDICTION OF RAILWAY VIBRATION

Vibrations require a medium for their transmission. Any variation in the medium present between the track and point of impact plays a significant role and therefore prediction of vibrations. Most of the mechanisms related to the generation of railway vibrations, their propagation through the soil and their transmission into the building, include a large quantity of complex phenomena, complex to approach or characterize.

To eliminate the inaccuracy in the estimation of predictions, monitoring at different locations were carried out to obtain real time values for different combinations of rail movement. From these measurements we obtained the highest vibration generating trains / speeds / loads / grounds and situations. Further, values of vibration for train speeds of 100 km/hr were extrapolated (for the proposed corridor). Thereafter, standard mathematical calculations have been applied to estimate the vibration levels due to multiple trains running together.

Procedure

Factors considered in the predictions:

- Distance from the track
- Speed of train
- Axle load
- Crossing of multiple trains
- Landuse (populated/agricultural field/bridges)

Data Analysis

We have obtained the following results of monitored maximum vibration levels generated by the trains running on the existing tracks for the closest distance.

Distance (m)	Train	Crossing of trains	Landuse	Speed (km/hr)	Vibration dB(A)
12.5	Goods	-	Agricultural	30	71.4
	Goods	Passenger		56 (26+30)	77.1
	Passenger	-		28	66.2
	Passenger	Express		70 (25+45)	70.0
	Express	-		50	70.9
	Express	Goods		59 (38+21)	80.5
	Goods	-	Residential	26.4	72.8
	Goods	Passenger		54 (25+29)	78.5
	Passenger	-		26.4	70.5
	Passenger	Express		68.6 (24.4+44.2)	71.4
	Express	-		54.2	72.2
	Express	Goods		58 (34.2+23.8)	82.5

As seen from the results that maximum vibrations are not occurring on maximum speeds but with multiple train crossings. Similar results are obtained for other distances namely – 25 and 50 m.

Based on these we obtained the maximum vibration levels as given below at all the distances:

Distance	Maximum dB
12.5	82.5
25	77.5
50	64.9

Prediction

The impact from the proposed project will be of two types:

a) Portion of corridor that will run parallel to the existing track and
b) Portion of the corridor that will go through the detours.

a) Portion of corridor that will run parallel to the existing track

1) For multiple trains running together– On one train on IR track

i. On the freight corridor side, one freight trains running in opposite directions with a gap of 6 m .

- Highest value of vibration level by one freight train = 72.8 dB(A)
- This level attenuated to 17.5 m for second freight train = 69.8 dB(A)

For these trains running in same directions, resultant level is difference of the 2 vibration levels.

$$L_{peak2}(D) = 10 \text{ LOG } (10\text{^}(L_{max.1}/10) - 10\text{^}(L_{max.1}/10)) \qquad (1)$$

where,

L_{peak2} (D) = Predicted Peak Vibration Levels at distance D

$L_{max.1}$ (D) = Observed peak vibration level at distance D for multiple train scenario

L_{peak2}= 10*LOG (10^(72.8/10)-10^(69.8/10)) = 69.8 dB.

b) Portion of the corridor that will go through the detours

For the detour locations the scenario will always be one stationery freight train at cross station and one moving in opposite direction therefore the predicted vibration levels will be 82.5 dB at 12.5 m.

Likewise predictions at different sensitive receptors were predicted based on worst case scenario of express train and goods train for different scenarios like above.

Annexure-4.4 : List of Avian Fauna recorded in Ludhiana-Khurja Reach

Name		Habitat & Migration Status		Presence	
English Name	**Family/Scientific Name**	**Status (Migratory /Residential)**	**Habitat**	**Core Zone**	**Buffer Zone**
Northern Shoveller	*Anas clypeata*	M	aq		√
Garganey	*Anas querquedula*	M	aq		√
Common Sandpiper	*Actitis hypoleucus*	R	aq		√
Common Kingfisher	*Alcedo atthis*	R	aq	√	√
White breasted Waterhen	*Amaurornis phoenicurus*	R	aq	√	√
Northern Pintail	*Anas acuta*	M	aq		√
Northern Shoveler	*Anas clypeata*	M	aq		√
Common Teal	*Anas crecca*	M	aq		√
Eurasian Wigeon	*Anas penelope*	M	aq		√
Mallard	*Anas platyrhynchos*	M	aq		√
Spot billed Duck	*Anas poecilorhyncha*	M	aq		√
Gadwal	*Anas strepera*	M	aq		√
Common Pochard	*Aythya farina*	M	aq		√
Tufted Duck	*Aythya fuligula*	M	aq		√
Little Bittern	*Lxobrychus minutus*	M	aq		√
FERRUGINOUS POCHARD	*Aythya nyroca*	M	aq		√
Black winged stilt	*Himantopus himntopus*	R	aq	√	√
Median Egret	*Mesophoyx intermedia (Wagler)*	R	Aq		√
Painted Stork	*Mycteria leucocephala (Pennant)*	R	Aq		√
Black crowned Night Heron	*Nycticorax nycticorax (Linnaeus)*	M	Aq		√
Dalmatian Pelican	*Pelecanus crispus Bruch*	M	Aq		√
Little Cormorant	*Phalacrocorax niger*	R	Aq	√	√
Black Ibis	*Pseudibis papillosa (Temminc)*	R	aq	√	√
Comb duck	*Sarkidiornis melanotos (Pennant)*	R	aq		√
Brahminy Duck	*Tadorna ferruginea*	M	aq		√
Common Shelduck	*Tadorna tadorna*	M	aq		√
Sarus crane	*Grus antigone*	R/ Vulnerable (A2 cde+3cde+4cde)	Aq	√	√
Common bittern	*Lxobrychus cinnamomus*	R	Aq	√	√
Shikra	*Accipiter badius (Gmelin)*	R	T		√
CRESTED GOSHAWK	*Accipiter trivirgatus*	R	T		√
Bank Mynah	*Acridotheres ginginianus*	R	T	√	√
Common Mynah	*Acridotheres tristis*	R	T	√	√

Name		Habitat & Migration Status		Presence	
English Name	**Family/Scientific Name**	**Status (Migratory /Residential)**	**Habitat**	**Core Zone**	**Buffer Zone**
GREEN-TAILED SUNBIRD	*Aethopyga nipalenis*	R	T	√	√
Bar-headed Goose	*Anser benghalensis*	M	T		√
Paddyfield Pipit	*Anthus rufulus*	R	T	√	√
Greater Spotted Eagle	*Aquila chrysaetos*	R	T	√	√
Spotted Owlet	*Athene noctua*	R	T		√
Common Hoopoe	*Upupa epops*	R	T	√	√
Cattle Egret	*Bubulcus ibis (Linnaeus)*	R	T	√	√
White Eyed Buzzard Eagle	*Butastur teesa*	R	T		√
Common Crested Lark	*Calandrella raytal (Blyth)*	M	T	√	√
Greater coucal	*Centropus sinenesis*	M	T	√	√
Pied Kingfisher	*Ceryle rudis*	R	T	√	√
White Storks	*Ciconia ciconia*	R	T		√
Wooly Necked Stork	*Ciconia episscopus*	R	T		√
Pallid Harrier	*Circus cyaneus*	R	T		√
Motagu's Harrier	*Circus macrourus*	R	T		√
Blue Rock Pigeon	*Columba livia*	R	T	√	√
Oriental Magpie Robin	*Copsychus malbaricus*	R	T	√	√
Indian Roller	*Coracias benghalensis (Linnaeus)*	R	T	√	√
Jungle Crow	*Corvus macrorhynchos*	R	T	√	√
House Crow	*Corvus splendens*	R	T	√	√
Common quail	*Coturnix couturnix*	R	T		√
Common Cuckoo	*Cuculus canorus*	M	T	√	√
PALE-CHINNED FLYCATCHER	*Cyornis poliogenys*	R	T	√	√
Rufous Treepie	*Dendrocitta vagabunda*	R	T	√	√
White-Bellied Drongo	*Dicrurus caerulescens*	R	T		√
Black Drongo	*Dicrurus macrocercus*	R	T	√	√
Greater Racket Tailed Drongo	*Dicrurus paradiseus*	R	T	√	√
LESSER RACKET-TAILED DRONGO	*Dicrurus remifer*	R	T	√	√
Little Egret,	*Egretta garzetta (Linnaeus)*	R	T	√	√
Black Shouldered Kite	*Elanus caeruleus*	R	T		√
Red Headed Bunting	*Emberiza bruniceps*	R	T	√	√
Great thick-knee	*Esacus recurvirostris*	R	T	√	√
Asian Koel	*Eudynamys scolopacea (Linnaeus)*	M	T	√	√
Red necked Kestrel	*Falco chicquera*	R	T	√	√
Laggar Falcon	*Falco jugger*	R	T		√

Name		Habitat & Migration Status		Presence	
English Name	**Family/Scientific Name**	**Status (Migratory /Residential)**	**Habitat**	**Core Zone**	**Buffer Zone**
Peregrine Falcon	*Falco peregrinus*	R	T		√
Common Kestrel	*Falco tinnunculuc*	R	T		√
Black Francolin	*Francolin francolinus (Linnaeus)*	R	T	√	√
Black Francolin (Kala Teetar)	*Francolinus francolinus*	R	T		√
Grey Francolin (Teetar)	*Francolinus pondicerianus*	R	T		√
Gray Francolin	*Francolinus pondicerianus (Gmelin)*	R	T		√
White rumped Vulture	*Gyps bengalensis*	Schedule-I	T		√
White breasted Kingfisher	*Halcyon pileata*	R	T		√
Pallas's Fish Eagle	*Haliaeetus leucoryphus*	R	T	√	√
Brahminy Kite	*Haliastur indus*	R	T		√
Booted Eagle	*Hieraaetus kienerii*	R	T		√
BROWN FISH OWL	*Ketupa zeylonensis*	R	T		√
Long Tailed Shrike	*Lanius schach*	M	T	√	√
Bay-backed shrke	*Lanius vittatus*	M	T	√	√
Black tailed Godwit	*Limosa limosa*	R	T		√
Scaly Breasted Munia	*Lonchura kelaarti*	R	T	√	√
Indian silverbill	*Lonchura malabarica*	R	T		√
WHITE-RUMPED MUNIA	*Lonchura striata*	R	T	√	√
Coppersmith Barbet	*Megalaima haemacephala*	R	T	√	√
Brown Headed Barbet	*Megalaima lineata*	R	T	√	√
Green Bee Eater	*Merops orientalis*	R	T	√	√
Blue cheeked Bee Eater	*Merops persicus Pallas*	R	T	√	√
Blue-tailed Bee-Eater	*Merops philippinus Linnaeus*	R	T	√	√
Black Kite	*Milvus migrans*	R	T		√
White Wagtail	*Motacilla alba*	M	T	√	√
Grey Wagtail	*Motacilla cinerea*	M	T	√	√
Yellow Wagtail	*Motacilla flava*	M	T	√	√
Purple sunbird	*Nectarinia asiatica*	R	T	√	√
Purple Sunbird	*Nectarinia asiatica (Latham)*	R	T		√
Eurasian Golden Oriole	*Oriolus oriolus (Linnaeus)*	M	T	√	√
Ruff	*Philomachus pugnax*	R	T		√
Streak-Throated Woodpecker	*Picus xanthopygaeus*	R	T		√
Baya weaver	*Ploceus philippinus*	R	T	√	√
Alexandrine Parakeet	*Psittacula eupatria*	R	T	√	√

Name		Habitat & Migration Status		Presence	
English Name	**Family/Scientific Name**	**Status (Migratory /Residential)**	**Habitat**	**Core Zone**	**Buffer Zone**
Rose ringed Parakeet	*Psittacula krameri (Scopoli)*	R	T	√	√
Crowned Sandgrouse	*Ptero coronatus*	R	T		√
Black-bellied sandgrouse	*Pterocles senegallus*	R	T	√	√
Red vented Bulbul	*Pycnonotus cafer (Linnaeus)*	R	T	√	√
BLACK-BELLIED TERN	*Sterna acuticauda*	R	T		√
Eurasian collared Dove	*Streptopelia decaocto*	R	T		√
Oriental Turtle Dove	*Streptopelia orientalis*	R	T		√
Laughing Dove	*Streptopelia senegalensis*	R	T		√
Red collared Dove	*Streptopelia tranquebarica*	R	T		√
Common starling	*Sturnus vulgris*	R	T		√
Oriental White Ibis	*Threskiornis melanocephalus (Latham)*	R	T	√	√
Yellow-Footed Green Pigeon	*Treron phoenicoptera*	R	T		√
Spotted Redshank	*Tringa erythropus*	R	T	√	√
Common Greenshank	*Tringa nebularia*	R	T	√	√
Wood Sandpiper	*Tringa ochropus*	R	T		√
Marsh sandpiper	*Tringa stagnatilis*	R	T		√
EURASIAN BLACKBIRD	*Turdus merula*	R	T	√	√
Common Hoopoe	*Upupa epops Linn.*	R	T	√	√
Red wattled Lapwing	*Vanellus benghalensis (Boddaert)*	R	T	√	√

(Note: aq = Aquatic; T= Terrestrial habitat; IWPA: Wildlife Protection Act 1972; GT: Globally threatened)

Annexure- 4.5: List of Mammalian Fauna recorded in Ludhiana-Khurja

S. No.	English Name	Order/Family/ Scientific Name	Status in Schedule-I of IWPA, 1972	Presence	
				Core Zone	Buffer zone
1	Five stripped palm squirrel	Order: Rodentia: Family: Sciuridae *Funambulus palmarum*	-		√
2	House Shrew	Family: Soricidae Suncus murinus	-	√	√
3	House Mouse	Family: Muridae *Mus musculus*	-	√	√
4	Large Bandicota – Rat	*Bandicota indica*	-	√	√
5	Black Rat	*Rattus rattus*	-	√	√
6	Long-winged tom bat	*Family: Emballonuridae Taphozous longimanus*	-		√
7	Rhesus Macaque	Order: Primate Family: Cercopithecidae *Macaca mulatta*	-	√	√
8	Asiatic Jackel	Order: Carnivora:Family*: Canidae Canis aureus*	-	√	√
9	Leschenault's Rousette	*Rousettus leschenaultii*			√
10	Indian Flying Fox	Pteropus giganteus		√	√
11	Wild Boar	*Sus scrofa*			√
12	Small India Civet	*Viverricula indica*	-	√	√
13	Indian Mongoose	Family*:* Herpestidae *Herpestes javanicus*	-	√	√
14	Neelgai (Blue Bull)	*Boselaphus tragocamelus, Pallas 1766*		√	√

Annexure- 4.6: List of Amphibian Fauna in Ludhiana-Khurja DFC Reach

Amphibian Species	Study Zones							Presence	
	Upper Ganga Canal	Kali Nadi	Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal	Core Zone	Core Zone
Rana typiensis	1	1	1	1	1	1	1	√	√
Haplobtrachus tigerina	1	1	1	1	1	1	1	√	√
Buffo melanostictus	1	1	1	1	1	1	1	√	√

Annexure- 4.7: List of Reptilian Fauna in Ludhiana to Khurja DFC Corridor

Reptilian Species/family	Present absent data of Reptilian fauna in different study sites							Presence	
	Upper Ganga Canal	Kali Nadi	Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal	Core Zone	Buffer Zone
Enhydris enhydris (Schneider, 1799)	1	1	1	1	1	1	1	√	√
Elapidae : *Naja kaouthia* Lesson, 1831	0	0	1	1	0	0	0	√	√
Agamidae *Calotes versicolor* (Daudin 1802)	0	0	1	1	0	0	0	√	√
Gekkonidae: *Hemedactylus frenatus* Schlegal 1836	0	0	0	1	0	0	1	√	√
Scincidae *Mabuya carinata* (Schneider, 1801)	1	0	1	0	1	1	1	√	√
Chitra Indica (Gray)	0	0	1	0	0	0	0	–	√

Annexure- 4.8: List of fish species found in each study point

SPECIES NAME	STUDY POINTS							Presence	
	1	2	3	4	5	6	7	Core Zone	Buffer Zone
Acanthocobitis botia	-	+	+	-	-	-	-		√
Ailia coila	-	-	-	+	+	+	-	√	√
Ailia punctata	-	-	+	+	+	-	-	√	√
Arius gagorides	+	+	-	-	-	+	-	√	√
Badis badis	+	+	-	-	-	-	+	√	√
Bagarius bagarius	-	-	-	-	-	-	-		√
Bagarius yarrelli	-	+	+	+	-	-	+	√	√
Barilius barna	+	+	+	+	+	+	+		√
Barilius shacra	-	+	+	-	+	+	-	√	√
Barilius tileo	-	+	+	-	-	-	-	√	√
Botia dario	-	+	-	-	-	-	+	√	√
Botia lohachata	+	+	-	-	-	-	+	√	√
Chaca chaca	-	+	-	-	-	+	-	√	√
Chagunius chagunio	+	+	-	-	-	-	-	√	√
Chitala chitala	-	+	+	+	-	-	+	√	√
Coius quadrifasciatus	-	+	+	+	+	-	-	√	√
Colisa lalia	+	+	+	+	+	+	+	√	√
Crossocheilus latius	-	-	+	+	+	+	-		√
Danio rerio	-	+	+	-	+	+	-	√	√
Erethistes pusillus	-	+	+	-	-	-	-	√	√
Eutropiichthys murius	-	+	-	-	-	-	+	√	√
Gagata cenia	+	+	-	-	-	-	+	√	√
Gagata gagata	+	+	-	-	-	-	-	√	√
Gagata sexualis	-	+	+	+	-	-	+	√	√
Gagata youssoufi	-	+	+	+	+	-	-	√	√
Gangra viridescens	-	-	-	-	-	-	+	√	√
Glyptothorax lonah	-	+	+	+	+	-	-	√	√
Glyptothorax stoliczkae	+	-	-	-	-	-	-	√	√
Gonialosa manmina	-	-	-	-	+	+	-	√	√
Gudusia chapra	-	-	-	-	-	-	-	√	√
Ilisha megaloptera	-	+	+	-	-	-	+	√	√
Johnius gangeticus	-	-	+	-	-	-	-	√	√
Labeo ariza	-	-	-	+	-	-	+	√	√
Labeo boga	+	-	-	+	-	-	+	√	√
Labeo pangusia	-	-	+	-	-	-	-	√	√
Lepidocephalus guntea	-	-	-	-	-	-	-	√	√
Mystus gulio	+	+	-	-	-	-	+	√	√
Nangra carcharhinoides	-	-	+	+	+	-	-	√	√

SPECIES NAME	STUDY POINTS							Presence	
	1	2	3	4	5	6	7	Core Zone	Buffer Zone
Nangra nangra	-	-	-	-	-	+	-	√	√
Naziritor chelynoides	-	-	-	-	-	-	-	√	√
Neolissochilus spinulosus	-	-	-	-	-	+	-	√	√
Notopterus notopterus	-	+	-	-	+	+	+	√	√
Otolithoides pama	+	+	-	-	-	-	-	√	√
Parambassis lala	+	+	+	+	+	-	+	√	√
Pinniwallago kanpurensis	+	+	+	+	+	-	+	√	√
Poropuntius clavatus	-	-	-	-	-	-	-	√	√
Pristis microdon	+	+	-	+	+	-	-	√	√
Pseudecheneis sulcata	-	-	-	-	-	-	-	√	√
Psilorhynchus sucatio	-	-	-	-	-	-	-	√	√
Pterocryptis gangelica	-	-	-	-	-	-	-	√	√
Puntius conchonius	+	+	-	-	-	-	+	√	√
Puntius guganio	-	-	+	+	+	-	-	√	√
Raiamas bola	-	-	-	-	-	+	-	√	√
Salmostoma bacaila	-	-	-	-	-	-	-	√	√
Salmostoma phulo	-	-	-	-	-	+	-	√	√
Salmostoma sardinella	-	+	-	-	+	+	+	√	√
Schizothoraichthys progastus	+	+	-	-	-	-	-	√	√
Setipinna brevifilis	+	+	+	+	+	-	+	√	√
Setipinna phasa	+	+	+	+	+	-	+	√	√
Sicamugil cascasia	-	-	-	-	-	-	-	√	√
Silonia silondia	+	+	-	+	+	-	-	√	√
Sisor rabdophorus	-	-	-	-	-	-	-	√	√
Sperata aor	-	-	-	-	-	-	-	√	√
Sperata seenghala	-	-	+	-	+	-	-	√	√
Hilsa sps.	-	-	-	-	-	-	-		√
Tor tor	-	-	+	-	-	-	-		√
Xenentodon cancila	-	-	+	+	+	-	-	√	√
Gastropods									
Pila globosa	+	+	-	+	+	+	+		√

N.B. Fishes were identified after the methods of Talwar and Jhingran (1991), Nath and Dey (2000) and Vishwanath (2002).

Annexure- 4.9: List of Planktons in the DFC Khurja to Ludhiana Stretch

a. Phytoplanktons

Sl. No.	Name	Sites																					No /m-2
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
	Phytoplankton																						
	Blue Green Algae																						
1	Anabaena	-	-	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	-	+	1245
2	Coelospharium	+	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	1132
3	Oscillatoria	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	1456
4	Phormidium	-	+	+	-	-	-	+	+	-	-	-	+	-	-	-	+	-	-	-	+	-	964
5	Polycystis	-	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	1183
6	Spirulina	-	+	-	-	-	+	-	-	-	-	+	-	-	-	+	-	-	-	+	-	+	1129
	Green Algae																						
7	Botryococcus		+	-	-	-	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	1238
8	Characium	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	+	+	+	1476
9	Cladophora	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+	+	+	1592
10	Microspora	-	+	+	-	-	-	+	+	-	-	-	-	+	+	+	-	-	-	-	-	-	1435
11	Protococcus	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1832
12	Richterella	-	+	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	+	+	+	+	1435
13	Scenedesmus	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	+	+	+	+	+	+	1121
14	Spirogyra	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1020
15	Tribonema	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+	+	-	-	-	1451
16	Ulothrix	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1724
	Diatoms																						
17	Ampora	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	+	+	+	+	+	1254
18	Cyclotella	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1621
19	Diatoma	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	1251
20	Frustulia	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	+	+	+	+	+	965

Sl. No.	Name	Sites																					No /m-2
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
21	Gomphonema	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1432
22	Melosira	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	1142
23	Navicula	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	+	+	+	+	+	1562
24	Nitzschia	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1121
25	Stephanodiscus	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	1131
26	Synedra	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1142
27	*Melosira distans*	-	-	-	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	1141
28	*Cyclotella kutzingiana*	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1234
29	*Fraigilaria capucina*	+	+	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-	-	-	-	1251
30	*Synedra affinis*	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	1424
31	*Gyrosigma acuminatum*	-	+	+	+	-	-	+	+	+	-	-	-	+	+	+	+	+	-	-	-	-	1172
32	*Stauroneis phoenicenteron*	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	+	+	-	-	-	-	1524
33	*Navicula cuspidate*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1342
34	*Navicula halophila*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1612
35	*Pinnularia interrupta*	-	-	+	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	+	+	1431
36	*Amphora ovalis*	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	1259
37	*Amphora veneta*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1342
38	*Cymbella ventricosa*	-	+	-	-	-	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	-	1621
39	*Cymblla hustedtii*	+	+	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-	-	-	-	1512
40	*Gomphonema*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1432

Sl. No.	Name	Sites																					No /m-2
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
	gracile																						
41	*Gomphonema olivaceum*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1124
42	*Rhopalodia gibba*	-	+	+	+	-	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	-	1134
43	*Nitzschia acicularis*	-	+	+	+	+	-	-	+	+	+	-	-	-	+	-	+	+	+	-	-	-	1251
44	*Surirella elegans.*	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	-	1321
Desmid																							
45	Closterium	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	1142
46	Cosmarium	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1141
47	Gonatozygon	-	+	-	-	-	-	+	+	-	-	-	-	+	+	-	+	+	-	-	-	-	1245
48	Mesotenia	+	+	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	-	1321

Annexure- 4.10: List of Zooplanktons in the DFC Ludhiana to Khurja Stretch

Sl. No.	Name	Sites																					(Density L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Zooplankton																							
Protozoan																							
1	Actinophrys	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	-	12
2	Actinosphaerium	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
3	Euglena sps.	-	-	-	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	12
4	Paramecium sps.	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
5	Peridinium	+	+	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	-	13
6	Phacus	-	+	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	15
7	*Holophrya simplex*	-	-	+	+	+	+	-	-	+	+	+	+	-	-	+	-	-	+	+	+	+	17
8	*Holophrya indica*	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
9	*Prorodon teres*	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	-	13
10	*Prorodon stewarti*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
11	*Litonotus fasciola*	-	-	-	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	21
12	*Litonotus meleagris*	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
13	*Paramaesium Aurelia*	+	+	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	-	13
14	*Frontonia leucas*	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	14
15	*Uronema turbo*	-	+	+	+	-	-	+	+	+	-	-	-	+	+	+	+	+	+	-	-	-	11
16	*Vorticella campanula*	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	+	+	+	-	-	-	9
17	*Vorticilla citrine*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10

Sl. No.	Name	Sites																					L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
18	*Soirostomum ambiguum*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22
19	*Brachon spiralis*	-	-	+	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	+	+	+	23
20	*Uroleptus mobilis*	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	25
21	*Euglena acus*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
22	*Gonium pectoral*	-	+	-	-	-	-	+	+	-	-	-	-	+	+	-	+	+	-	-	-	-	21
23	*Dinomonas sps.*	+	+	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	-	21
Rotifers																							
24	*Asplanchna brightwelli*	-	-	-	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	+	+	+	13
25	*A. priodonta* Gosse	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	14
26	*Beauchampia crucigera*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
27	*Brachionus angularis*	-	+	+	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	15
28	*B. bidentatus*	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
29	*B. caudatus aculaeatus*	-	+	-	-	-	+	-	-	-	-	+	+	+	+	-	-	-	-	+	+	+	14
30	*B. calyciflorus*	-	-	+	+	+	+	-	-	+	+	+	+	+	+	-	-	+	+	+	+	+	11
31	*Cephalodella catellina*	+	-	-	-	-	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	9
32	*C. forficula*	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	10
33	*C. gibba*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
34	*C. mucronata*	-	-	-	+	+	+	-	-	-	-	+	-	+	+	-	-	-	-	+	-	-	23
35	*Colurella uncinata bicuspidata*	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
36	*C. adriatica*	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	24

Sl. No.	Name	Sites																					ty L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
37	*Collotheca* sp.	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	21
38	*Conochilus* sp.	-	+	+	+	-	-	+	+	+	-	-	-	-	-	+	+	+	-	-	-	-	21
39	*Dicranophorus epicharis*	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	+	-	-	-	-	9
40	*Dipleuchlanis propatula*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
41	*Encentrum* sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22
42	*Eosphora najas*	-	-	+	+	+	+	-	-	-	+	+	+	+	+	-	-	-	+	+	+	+	23
43	*Euchlanis dilatata*	-	+	+	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	+	+	+	25
44	*Filinia opoliensis*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
45	*F. longiseta*	-	+	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	21
46	*F. terminalis*	+	+	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	21
47	*Floscularia ringens*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
48	*Keratella cochlearis*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
49	*Lecane aculeata*	-	+	+	+	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	17
50	*L. doryssa*	-	+	+	+	+	-	-	+	+	+	-	-	-	-	-	+	+	+	-	-	-	12
51	*L. elongata*	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	13
52	*L. eurysterna*	-	+	+	+	+	-	-	+	+	+	+	+	-	-	-	+	+	+	+	+	+	14
53	*L. heterostyla*	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	21
54	*Limnias melicerta*	-	-	-	-	+	+	-	-	-	-	+	+	+	+	-	-	-	-	+	+	+	15
55	*Lophocharis salpina*	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	13
56	*Monommata* sp.	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
57	*Mytilina bisulcata*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	11

Sl. No.	Name	Sites																					(L-1)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
58	*M. mucronata*	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	9
59	*Notommata copeus*	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	10
60	*Notommata* sp.	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	22
61	*Plationus patulus*	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	23
62	*Polyarthra* sp.	+	+	-	-	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	+	+	25
63	*Pompholyx sulcata*	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
64	*Proales* sp.	-	-	-	-	-	+	-	-	-	+	+	+	+	+	-	-	-	+	+	+	+	15
65	*Rotaria* sp.	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	17
66	*Squatinella lamellaris mutica*	-	-	-	-	-	+	-	-	-	-	-	+	+	+	-	-	-	-	-	+	+	12
67	*Synchaeta oblonga*	-	+	-	-	-	+	-	-	+	-	+	-	+	+	-	-	+	-	+	-	-	13
68	*Testudinella emarginula*	-	+	-	-	+	+	+	-	-	+	-	+	+	+	+	-	-	+	-	+	+	14
69	*T. patina*	-	-	-	-	-	+	-	-	-	-	+	+	+	+	-	-	-	-	+	+	+	21
70	*T. bicristata*	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	15
71	*T. cavia*	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	13
72	*T. capucina*	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	14
73	*T. iernis*	-	+	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	11
74	*T. longiseta*	-	-	-	-	+	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	9
75	*T. porcellus*	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	+	+	10
Crustaceans																							
76	Cladocera	-	-	-	-	+	+	-	-	-	-	+	+	-	-	+	+	-	-	+	+	+	23
77	Bosminia	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	+	+	25
78	Daphnia	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24

Sl. No.	Name	Sites																					[illegible]
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Cladoceran																							
79	*Latonopsis australis*	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	21
80	*Diaphanosoma sarsi*	-	-	-	-	+	+	-	-	-	-	+	-	-	+	-	-	-	+	-	-	+	10
81	*Ceriodaphnia cornutta*	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	+	-	-	+	+	22
82	*Daphnia similis*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23
83	*Daphnia obtuse*	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
84	*Daphnia magna*	-	+	-	-	-	+	-	-	-	-	+	-	-	+	-	-	-	+	-	-	+	13
85	*Moina micrura*	-	-	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	15
86	*Moina brachiata*	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
87	*Bosmina longirostris*	-	-	-	-	-	-	-	-	-	+	+	-	+	+	-	-	+	+	-	+	-	12
88	*Moina flagellata*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
Copepod																							
89	*Allodiaptomus similis*	-	-	+	+	+	+	-	-	-	+	+	+	-	-	+	+	-	-	+	+	+	21
90	*Heliodiaptomus cinctus*	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	+	-	-	-	+	+	15
91	*Heliodiaptomus contortus*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
92	*Heliodiaptomus pulcher*	-	+	-	-	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	10
93	*Neodiaptomus diaphorus*	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
94	*Neodiaptomus strigilipes*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23
95	*Phyllodiaptomus annae*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25

Sl. No.	Name	Sites																					[illegible]
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
96	*Tropodiaptomus doriai*	-	+	+	+	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	13
97	*Eucyclops serrulatus*	-	+	+	+	+	-	-	+	+	+	-	-	+	+	+	-	+	+	+	-	-	15
98	*Paracyclops frimbiatus*	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	17
99	*Tropocyclops prasinus*	-	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	12

The plankton were identified after Edmonson (1959), Needham and Needham (1966) and APHA (1998).

Chapter 5. Analysis of Alternatives

The analysis of alternatives is an effective tool to examine the number of options (locational & technological) and establishing most environmentally favourable alternatives or which cause minimum environmental loss to the natural and social environment. This project is site specific and involves construction of EDFC along the existing Indian Railways, largely on the land available with it. DFCCIL has made suitable adjustments in the finalised corridor alignment in terms of expanding on right side or left side of the existing Indian railway track based on social and environmental considerations. The construction of (i) formations parallel to the existing track with the aim of minimum land acquisition and (ii) bridges over major water bodies, parallel to existing bridges with the aim of gaining from suitable river morphology, are location specific options. Therefore, no alternative analysis on the location of parallel alignment portion and bridges is undertaken. However, the alternative analysis is carried out along the detour, which is the new alignment.

To determine whether the project is beneficial to the environment or not, a 'do-nothing' or 'without project' option was evaluated against the "with-project" option. The following sections address these issues.

5.1. Alternatives to the Project

The scope of assessing alternatives to the project is limited to the "With" and "Without Project" (means do nothing or status quo) options and the same is analysed below:

'Without Project' Option

Physical Environment: In the 'Without project' Scenario, the capacity of timely movement of goods will remain constrained. This will create additional pressure on our already stressed roads. The traffic jams on highways and railways crossing will continue to deteriorate the air quality and Noise levels due to idling of vehicles.

Biological Environment: In the 'Without the project' scenario, no direct impact is anticipated on biological environment. However, the very need of road transportation, and resultant widening of roads may lead to cutting of trees and loss of productive agriculture land.

Socio-Economic Environment: Without the project, the agricultural produce may not move from field to market places in a timely manner, which may result in loss of income to farmers. Public at large will continue to waste time in waiting at traffic jams triggered at railway crossings. The project of this size brings substantial investment, employment, and business opportunities, which in turn contribute improving the socio-economic condition of the area. In absence of the project, the project area will be deprived of such benefits.

5.1.1. 'With Project' Option

Physical Environment: In the "With project" scenario, the air quality, noise levels are likely to improve around the railway crossings due to the provision of ROBs at most of such locations. The project will immensely enhance the much-needed capacity for fast transport of goods from one end to another end of the country. This in turn will reduce the pressure on roads. The air pollution and noise level are likely to increase during construction phase but that will be confined within the close vicinity of construction sites and will be temporary in nature. The marginal water withdrawl (during construction) from ground in the over exploited areas will marginally deplete the ground water potential. However, this impact will be minimised with the provision of water harvesting. With project scenario will also result in reducing likely generation of GHG emissions and hence contributing in preventing global warming.

Biological Environment: in the 'with project' scenario, the overall impact of the project is likely to be insignificant on the biological environment except in terms of loss of trees which will be minimised and also regenerate over a period of time due to proposed compensatory tree plantation.

Socioeconomic Environment: The 'with project' scenario will bring large investment to the project area and host of employment and business opportunities resulting in substantial improvement in the overall socio-economic conditions of the area. This will also ease the problem of traffic jams and long wait at railway crossings due to the construction of ROBs.

5.1.2. Conclusion

During the EIA, a number of public consultations have also been carried out with the local communities and stakeholders. The overall findings of the meetings are that most of the people consider this project as timely and much needed. They are in favour of the 'With-project' option.

Under the circumstance, and in light of the assessment of the available alternatives, the 'With-project' option is deemed as the optimal solution, as far as its feasibility and sustainability during its project life and beyond can be ascertained. It will generate overall positive social, environmental, and economic impacts and their negative impacts can be mitigated through appropriate safeguard measures as defined under the EIA and the social safeguards assessments.

5.2. Alternative Analysis of proposed Detours

Three detours are proposed in Khurja-Ludhiana section of EDFC.These detours have been proposed due to non availability of space in the built up portions. These are proposed at Hapur, Meerut, and Ambala Cantt. The change in alignment at Sharanapur area is also analysed from alternatives analysis purposes. The analysis is carried out considering corridor construction parallel to existing railway track, DFCCIL preferred alignment and other possible alternative routes for the detour. Alternative analysis is carried out against environmental, social technical and financial feasibility considerations.

The starting and ending chaninage, length, and route of the detour is given **Table 5.1.**

Table 5.1 : Route and Length of Various Detour Alternatives

Option	Starting Chainage	End Chainage	Route	Length (km)
Hapur Detour				
DFCCIL Preferred alignment (Alternative-I)	71.048	73.821	Parallel to existing alignment, via Hapur city, Shyam Nagar	12.2
Alternative-II	72.23	73.821	Parallel to existing alignment, viz Shyam and Hapur city	5.14
Alternative-III	55.23	73.821	Bisecting Hapur city	9.23
Alternative-IV	55.23	73.821	Passing through city area	5.31
Alternative-V	55.23	73.821	Passing through city area	10.44
Meerut Detour				
DFCCIL Preferred alignment (Alternative-I)	83.7	92.3	Passing through agriculture land and vegetation	11.0
Alternative-II	86.9	91.5	Passing through dense habitation	4.6
Alternative-III	84.5	91	Passing through dense habitation	6.12

Option	Starting Chainage	End Chainage	Route	Length (km)
Alternative-IV	83.7	92.3	Passing through agriculture land and vegetation	9.423
Via Sharanpur vs Tapri Alignment change				
DFCCIL Preferred alignment (Alternative-I)	164.4	182.5	Moves along the existing IR alignment	21.1
Alternatives II	164.4	182.1	Moves through Agricultural field bypasses Tapri, Shaharanpur and Pilkhani	17.7
Ambala Detour				
DFCCIL Preferred alignment	296.247	300.397	Bypassing the Ambala Cant	4.85
Alternative-I	296.247	300.397	Bypassing the Ambala Cant	4.72

5.2.2. Hapur Detour

Six alternatives route including parallel to existing track are analysed. These alternatives and its analysis are shown at **Figure 5.1** and **Table 5.2.** The analysis indicates that DFCCIL alignment is the best-suited and acceptable alignment from environmental, social and engineering perspective.

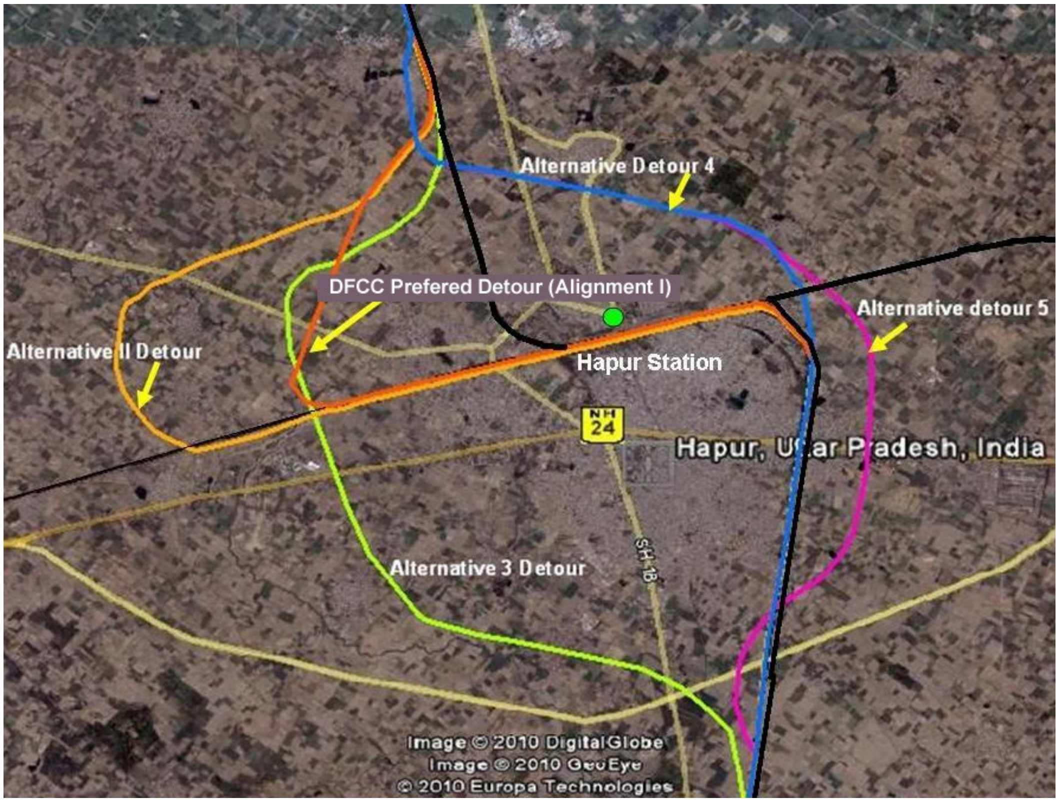


Figure 5.1 : A View of Alternatives to the Hapur Detour

Table 5.2 : Summary of Alternative Analysis of Hapur Detour

Sl. No.	Issues	Along the Existing track of Indian Railways	DFCC Final (Alternative-I)	Alternative-II	Alternative-III	Alternative-IV	Alternative-V
1.	Land Use Change	No availability of land with Indian Railway. Large Habitation around	Minimal acquisition of land involved in the proposed alignment and mostly agriculture land (about 18.0 Ha)	Large area of agricultural and part habitation land acquisition involved. Passes through proposed weaker section colony at Shyam Nagar (about 8.4 Ha)	Large area of agricultural and habitation land need to be acquired (about 15.2 Ha)	Large area of agricultural and habitation land need to be acquired (about 8.76 Ha)	Large area of agricultural and habitation land need to be acquired (about 17.2 Ha)
2	Rehabilitation & Resettlement	Critical Rehabilitation and resettlement issue involved. This will require demolition of about 150 structures	Issue exists but of manageable magnitude, as it involves agriculture land acquisition.	Issue exists and may be difficult to manage due to acquisition of land belonging to weaker section. The number of structures likely to be affected 40	Critical Rehabilitation and resettlement issue involved . The number of structures likely to be affected are 700	Critical Rehabilitation and resettlement issue involved . the number of structures likely to be affected are 450	Critical Rehabilitation and resettlement issue involved . The number of structures likely to be demolished are about 900.
3	Ecological Impact (Loss of trees, impact on forests, impact on wildlife)	No Issue	There will be requirement to cut around 80 trees, however, the loss can be compensated over time with the compensatory rehabilitation plan.	Requirement of cutting of about 20 trees, however the losses can be compensated over time with the compensatory rehabilitation plan.	This alternative requires cutting of about 55 trees, however the loss can be compensated over time with the compensatory rehabilitation plan.	This alternative requires cutting of about 40 trees however the loss can be compensated over time with the compensatory rehabilitation plan.	This option will require cutting of about 120 trees, however the loss can be compensated over time with the compensatory rehabilitation plan.
4	Environmental Impacts (Air, Water, noise & vibration)	Existing baseline condition of noise & vibration exceed the prescribed limit. No impact on other physical baseline environmental features	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. Implementation will imrove pollution levels in Hapur city	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature.There will be overall increase in air and noise pollution in Hapur cityin operation phase.	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. There will be overall increase in air and noise pollution in Hapur city in operation phase.	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. There will be overall increase in air and noise pollution in in Hapur city in operation phase.	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. There will be overall increase in air and noise pollution in Hapur city in operation phase.
5	Traffic	Construction activity	Not much effect on	The construction	Construction activity	Construction activity	Construction activity

Sl. No.	Issues	Along the Existing track of Indian Railways	DFCC Final (Alternative-I)	Alternative-II	Alternative-III	Alternative-IV	Alternative-V
	Management during construction	will create hazardous traffic condition	traffic as alignment is through agriculture area	activities will increase traffic congestion in city	will create hazardous traffic condition in city	will create hazardous traffic condition in city	will create hazardous traffic condition in city
6	Public Acceptability	Acceptable provided no demolition of structures	Acceptable comparatively to other detour, provided compensation at market rate	Acceptable comparatively to other detour	Acceptable provided no demolition of structures	Acceptable provided no demolition of structures	Acceptable provided no demolition of structures
7	Technical Feasibility	Exists	Exist, especially since large part runs parallel to existing IR track and only one Rail over Rail flyover construction is involved.	Weak especially due to increased costs of construction compared to alternative I due to longer route to follow	Not feasible due to involvement of more no of ROB and longer length to traverse	Not feasible due to involvement of more no of ROB, Rail over Rail flyovers and longer length to traverse	Not feasible due to involvement of more no of ROB, Rail over Rail flyovers and longer length to traverse
8	Financial Feasibility	High costs involved, not feasible	Exists	Weak	Not Viable	Not Viable	Not Viable
Recommended Option			**Preferred Option**				

5.2.3. Meerut Detour

Four alternatives route including parallel to existing track are analysed. These alternatives and its analysis are shown at **Figure 5.2 and Table 5.3** . The analysis indicates that DFCCIL alignment is the best-suited and acceptable alignment from environmental, social and engineering perspective.

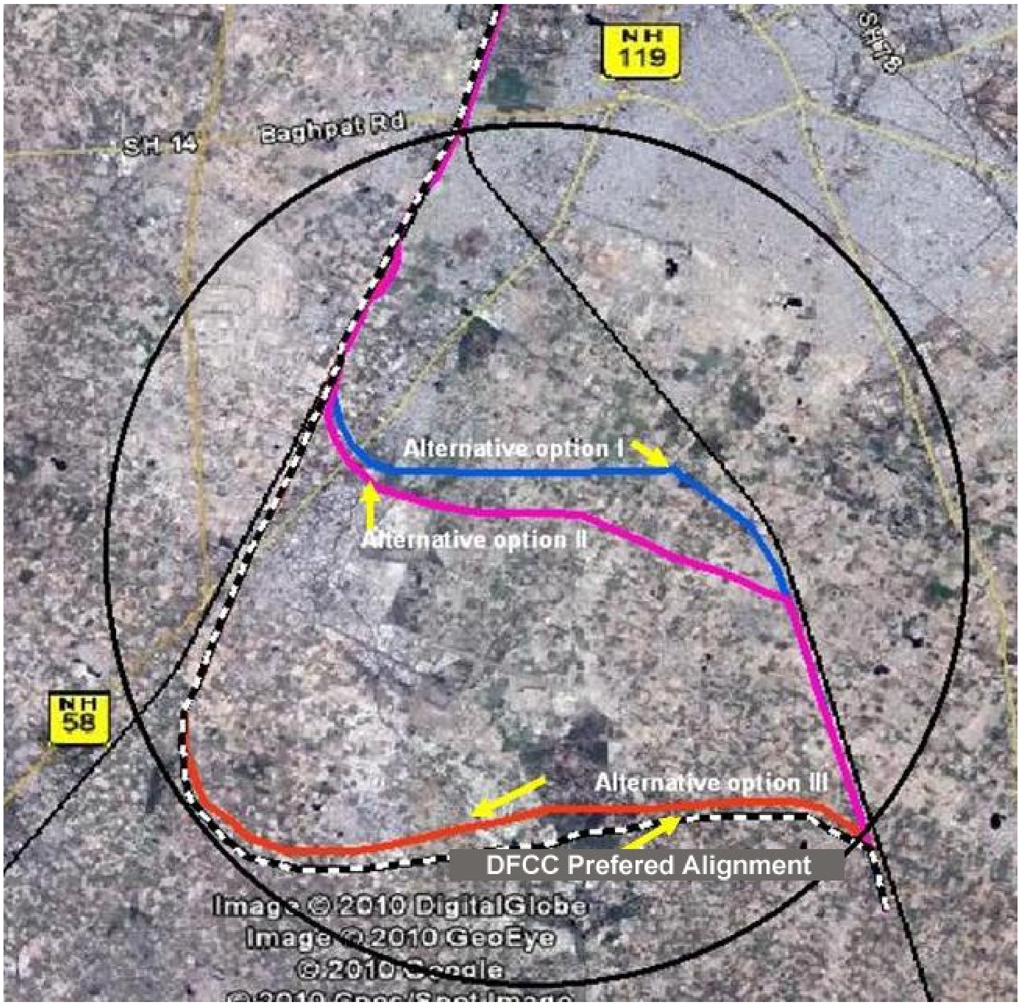


Figure 5.2 : A View of Alternatives of Meerut Detour

Table 5.3 : Summary of Alternative Analysis of Meerut Detour

Sl. No.	Issues	Along the Existing track of IR	DFCC Final (Alternative-I)	Alternative-II	Alternative-III	Alternative-IV
1.	Land Use Change	No availability of land with Indian Railway. Large Habitation around	Acquisition of land involved in the proposed alignment and mostly agriculture land (about 14.1 Ha)	Large area of agricultural and habitation land need to be acquired (about 7.5 Ha)	Large area of agricultural and habitation land need to be acquired (about 10.1 Ha)	Acquisition of land involved in the proposed alignment and mostly agriculture land (about 15.5 Ha)
2	Rehabilitation & Resettlement	Critical Rehabilitation and resettlement issue involved. There will be requirement to demolish around 2000 structures	Issue exists but of manageable magnitude . (About 40 structures need to be demolished). Mostly agriculture land acquisition.	Critical Rehabilitation and resettlement issue involved (About 1200 structures need to be demolished)	Critical Rehabilitation and resettlement issue involved (Requires demolition of about 1300 structures)	Issue exists but of manageable magnitude. Requirement to demolish 1200 structures
3	Ecological Impact (Loss of trees, impact on forests, impact on wildlife)	No Issue, about 35 trees need to be cut	About 200 trees need to be cut, however, the loss can be compensated over time with the compensatory rehabilitation plan. Small portion of Reserved forest land diversion also involved	About 100 trees need to be cut, however the loss can be compensated over time with the compensatory rehabilitation plan.	About 100 trees need to be cut , however the loss can be compensated over time with the compensatory rehabilitation plan.	About 200 trees need to be cut, however the loss can be compensated over time with the compensatory rehabilitation plan**. Larger portion of Reserved forest land diversion also involved**
4	Environmental Impacts (Air, Water, noise & vibration)	Existing baseline condition of noise & vibration exceed the prescribed limit. No impact on other physical baseline environmental features	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. Portion mostly out of habitation area. Increase in pollution level in operation phase within the city	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. Increase in pollution level in operation phase	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. Increase in pollution level in operation phase.	Air, Noise, quality likely to be affected during construction stage but will be temporary in nature. Increase in pollution level in operation phase.
5	Traffic Management during construction	Construction activity will create hazardous traffic condition within the city	No major traffic issue since most of the detour is passing through agriculture field	Construction activity will create hazardous traffic condition within the Meerut city	Construction activity will create hazardous traffic condition within the Meerut city	No major traffic issue since most of the detour is passing through agriculture field
6	Public Acceptability	Not Acceptable due to acquisition of land and property	Acceptable as alignment is along proposed Meerut ring road.	Not Acceptable due to acquisition of land and property	Not Acceptable due to acquisition of land and property	Acceptable as comparatively lesser number of structures are being demolished
7	Technical Feasibility	*Exists*	Exist,	Not feasible due to involvement of more no of ROB and longer length to traverse	Not feasible due to involvement of more no of ROB and longer length to traverse	Exists but constrained due to diversion of large part of Reserved forests
8	Financial Feasibility	High Cost of construction	Exists	Not Viable	Not Viable	Exists
Recommended Option			**Preferred Option**			

5.2.4. Tapri – Saharanpur Alignment Modification

There are only two options in this section as shown at **Figure 5.3**. (i) One development along the existing IR track or (ii) moves away from the city but crossing agricultural a vegetated areas. Since no critical rehabilitation and resettlement issue is involved by developing along the existing track, it will be the preferred option especially when the bypassed or detour alignment will disturb the virgin area and have associated rehabilitation and resettlement issues. No further detailed analysis therefore is carried out.

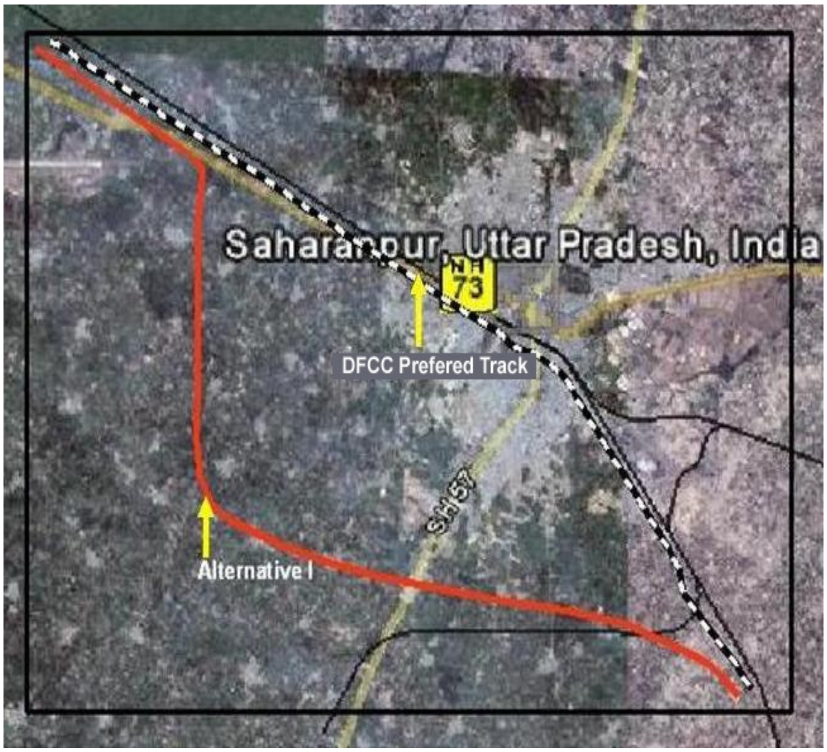


Figure 5.3 : A View of Sharnapur – Tapri Alignment Section

5.2.5. Ambala Cantt Detour

There are only three options in this section as shown at **Figure 5.4.** (i) One development along the existing IR track or (ii) move towards left side of the existing alignment and join near Ambala city. (iii) Move right side of the alignment. The detour on right side of existing alignment is not feasible since it will pass through densely populated areas. Therefore this is not even shown on the figure below. Development along the existing alignment is also not possible due to Critical rehabilitation and resettlement issues. The only preferred option left is development towards left side of the existing alignment. GIS based assessment was also made to for moving 100 m either side of the proposed DFC preferred option with a view of rehabilitation and resettlement point of view (shown as alternative I and II in the figure below). However, it was established that the DFC preferred option is the best suited option from environmental perspective as well.

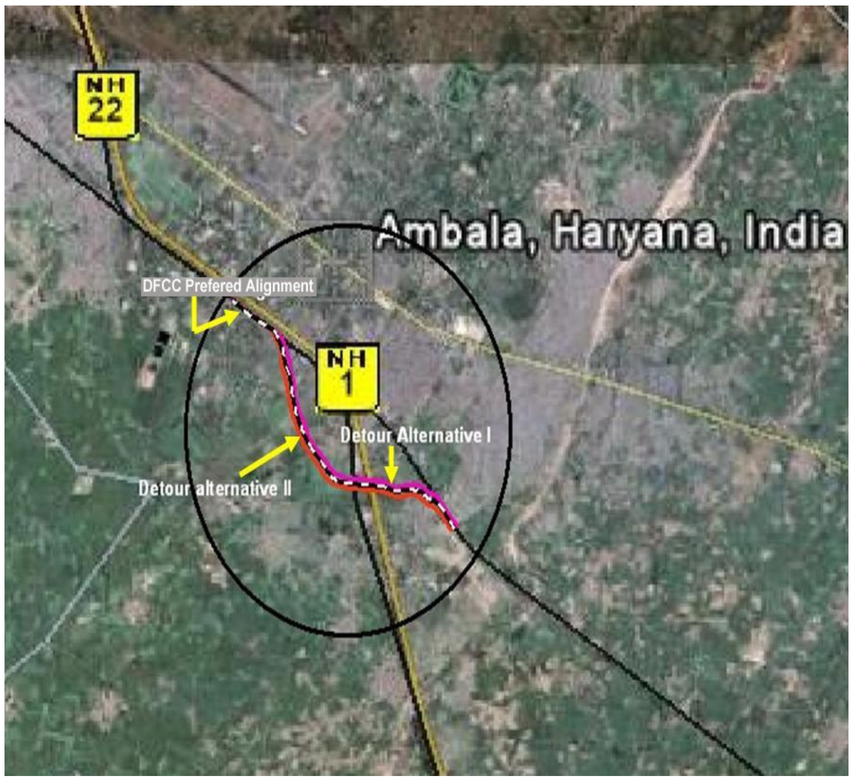


Figure 5.4 : A view of Ambala Cantt Detour

Chapter 6. Anticipated Environmental Impacts and Mitigation Measures

Environmental impacts have been assessed considering present environmental setting of the project area, nature and extent of the proposed activities. Qualitative and quantitative techniques have been applied for direct & indirect impact identifications. The impacts have been classified as (i) impact during design & construction phase (ii) Impacts during operation phase. Some of the important impacts associated with the development of railway corridor and its operational will be associated with air quality, noise & vibration, change in land use, soil & water quality, water availability, forests, tree cutting, fauna (terrestrial & aquatic), drainage pattern, socio-economic aspect, waste and wastewater disposal, construction material sourcing and occupational health and safety. Adequate mitigation measures have been devised to mitigate/minimise all likely environmental impacts and the same have been presented along with the impacts.

6.1. Environmental Impact Assessment Methodology

To assess the impact of the project, a simple qualitative method that determines potential existence of impact has been employed. Thereby, the judgments related to the magnitude and importance of the impacts caused by the project is presented. This involves development of Matrix summarizes environmental impact of the DFC project. The following parameters and scale is adopted for developing matrix. Parameters and scale of impact matrix is presented in **Table 6.1.**

Table 6.1 : Parameter and Scale of Impact Matrix

Significance	Scale	Remarks	
No impact	E	Positive	Negative
Negligible impact	D	Positive	Negative
Insignificant impact	C	Positive	Negative
Relatively significant impact	B	Positive	Negative
Significant impact	A	Positive	Negative

For the assessment of impacts, the following criteria is adopted:-

Scale **A**: If National Parks, Wildlife Sanctuaries, wetland, ecosensitive zone or any designated natural reserve, protected species of any kind are directly affected.

Scale **B**: If large areas of forest, grassland, cultivable land or any natural environment for tourism are indirectly affected.

Scale **C**: If impacts are temporary and reversible

Scale **D**: If impact is hardly measurable

Scale **E**: No impacts or not applicable to assessment.

Sections below assess the impacts following the above method.

6.2. Imapct on Physical Environment

6.2.1. Climate

Design and Construction Phase

Impacts: Short-term impact in terms of minor increase in temperature may happen in the immediate vicinity of the alignment and construction camp area due to construction activities and cutting of trees falling in the row. The project entails cutting of 5707 trees in the corridor of impact.

Mitigation Measures: The maximum possible efforts have been made for minimizing cutting of the trees while designing the alignment and embankment. Compensatory tree plantation will be undertaken as per prevailing guidelines of state's forest department. A minimum of 1:3 ratio shall be followed for tree plantation. Besides, additional plantation shall be done along station areas.

Operation Stage

Impact: No direct negative impact is anticipated in operation phase. Rather this project may contribute positively in GHG reduction since project will significantly reduce the goods traffic load on existing roads network. As per the broad calculation, the construction of this EDFC section may contribute in saving of CO2 emission to the tune of 6.72 tonnes/day. The detailed calculation is given in (**Annexure- 6.1**). The electrified train movement will additionally contribute in GHG reduction equal to the GHG (CO2 emission) generation from other fuel based train movement. The project also envisage compensatory tree plantation along the project section. Hence, the climatic condition of the area will improve moderately.

Mitigation Measures

DFCCIL shall undertake a study of estimating and claiming for GHG emission reduction from the train movement on similar lines of study as Delhi Metro Line Corporation has undertaken in the past. This may result in financial savings for the project.

6.2.2. Natural Hazard

Design and Construction Phase

Impact: The Khurja – Ludhiana EDFC is located in seismic zone IV which is high damage risk zone. This may cause failure of civil structures in the event of earthquake if design consideration related to seismicity is not taken into consideration.

Mitigation Measures

Relevant IS codes shall be adopted while designing the civil structures to sustain the earthquake of highest magnitude in Seismic zone IV.

Operation Stage

Impact & Mitigation: Since, no hazard other than seismicity is expected; no adverse impact is anticipated during this stage. However, the constructed structures should be maintained well.

6.2.3. Air Quality

Design and Construction Phase

Impact: The ambient air quality of area is good except between Meerut to Saharanpur and Rajpura to Khanna sections. The particulate matter concentrations except of size 2.5 microns (PM2.5) exceeds at all the locations along the alignment. Air quality may be affected for short duration in and around the construction sites due to various construction activities and vehicular movement. However specific attention shall be required during this stage, to prevent generation and spread of RSPM in Meerut to Saharanpur and Rajpura to Khanna sections where concentration level is higher than other places.

Table 6.2 : The Ambient Air Quality Exceedance Level along the Alignment

Chainage	Pollutants	Exceedance at Chainage/Location	Maximum Level $\mu g/m^3$	Standards ($\mu g/m^3$)
Ch. 00 - 100 km	SPM	All	362	NA

Chainage	Pollutants	Exceedance at Chainage/Location	Maximum Level $\mu g/m^3$	Standards ($\mu g/m^3$)
	RSPM ($PM_{2.5}$)	All	222	100
	$PM_{2.5}$	None; >40 at Khurja & Meerut	42	60
	SO_2	None	35	80
	NO_X	None	32	80
Ch. 101 - 200 km	SPM	All	376	NA
	RSPM	All	257	100
	$PM_{2.5}$	None; High at industrial areas	37	60
	SO_2	None; High at industrial areas	37	80
	NO_X	None; High at industrial areas	34	80
Ch. 201 - 300 km	SPM	All	356	NA
	RSPM	All	222	100
	$PM_{2.5}$	None	33	60
	SO_2	None	28	80
	NO_X	None	25	80
Ch. 301 - 400 km	SPM	All	421	NA
	RSPM	All	250	100
	$PM_{2.5}$	None; >40 at Sirhind and Mandigobindgarh	45	60
	SO_2	None; High at industrial areas	53	80
	NO_X	None; High at industrial areas	33	80

The fugitive emission, which will form a major portion of air pollution in the form of particulate matter, is likely to be generated during **(i)** sourcing, transportation, storage, and handling of construction materials particularly earth **(ii)** demolition of existing structures and disposal of debris **(iii)** site preparation, embankment and other constructions **(iv)** vehicles plying on the paved and unpaved road. Most of the fugitive dust generated from these activates will be largely in the form of coarse particulate matter (expected in the range from 0.1 µm to more than 300 µm in aerodynamic diameter) which will settle down in close vicinity of construction site. However, dust separation measures shall still be required to prevent the spread of air borne smaller particles to traverse longer distances.

Gaseous emissions will also be generated from the operation of construction equipment and machines, hot mix plants, and idling of vehicles due to increased traffic congestion in construction areas.

Hot mix plant is likely to be installed temporarily for construction of approach roads near ROB, grade separation and important bridge sites. This will generate Carbon Monoxide (CO), un-burnt Hydrocarbon, Sulphur Di-Oxide, particulate matters, and Nitrogen Oxides (NO_x) emissions. In addition to that, emissions from various construction machinery fuelled by diesel and from mobile source will be in the form of PM_{10}, VOC, CO, NO_x and SO_2. The level of emissions from stationary and mobile diesel engines is indicated in **Table 6.3**. This may affect the air quality of nearby areas especially due to emission discharge from low height stack and vehicles at surface levels. The project is passing through vast open agricultural land, which will provide adequate dispersion of gaseous emission from hot mix plant and vehicular sources. Therefore, this impact will be for a short-term and hence it will be minor in nature.

Table 6.3 : Exhaust Emissions for Stationary and Mobile Machinery

Source	PM_{10}	VOC	CO	NOx	SO_2
Diesel exhaust emissions (idle)	0.043 g/min	0.208 g/min	1.57 g/min	0.917 g/min	18.8 S g/l
Diesel exhaust emissions (moving)	0.4 g/mile	3.18 g/mile	18.82 g/mile	8.5 g/mile	18.8 S g/l

Substantial air pollution is caused due to emission from idling of long queued vehicle at railway crossings. This situation worsens at crossings near highways where long queues of waiting vehicle triggers worse traffic jams at highway as well as near industrial areas. The condition further deteriorates during winters due to substantial movement of slow moving sugar cane laden bullock-carts. The construction of EDFC parallel to the existing track shall additionally increase the wait time and worsen the situation further if effective design measures are not taken.

Hazardous traffic movement conditions near the ROB construction site were also observed during field study. This also causes substantial air pollution and occupational health and safety concerns.

No impact is anticipated due to any other activity like crushing, sleeper manufacturing etc. since no crushing unit is either proposed under the project as ballast shall be procured directly from quarry/crushing unit and readymade sleepers shall be outsourced.

The stone aggregate shall be sourced from licensed quarries. No new quarries shall be opened for the project. The pollution related aspects to these quarries are independently complied by the quarry owner. The aggregate shall be transported in the covered Lorries through existing national and state highways.

Mitigation Measures

Control of Fugitive Dust

- Vehicles transporting loose and fine materials like sand and fine aggregates shall be covered.
- Loading and unloading of construction materials, likely to generate fugitive emission, shall be done in covered area or provisions of water sprinkling arrangement shall be made around these areas. Specific attention shall be given (increased frequency of sprinkling) in Meerut-Saharanpur Section and Rajpura-Khanna Section.
- Storage areas shall be located downwind of the habitation area.
- Water shalll be sprayed on earthworks, on a regular basis. During and after compaction of the sub-grade, water shall be sprayed at regular intervals to prevent dust generation. Sprinkling of water on other dust prone areas including unpaved haulage roads and construction yard shall also be done. Following additional option may be considered for control of emissions from the unpaved roads:
  - Vehicle restrictions that limit the speed, weight or number of vehicles on the road;
  - Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
  - Surface treatment, such as watering or treatment with chemical dust suppressants.
  - All efforts shall be made to minimise cutting of existing trees around such sites.
  - Mask and other PPE shall be provided to the construction workers

Control of Gaseous Emissions

- Regular maintenance of machinery and equipment shall be carried out. All vehicles shall carry valid PUC.
- Mixing plants and asphalt (hot mix) plants shall be located at least 1 km downwind of the human settlements. The asphalt plants, and the batching plants shall be sited at least 500m in the downwind direction from the nearest settlement and that too only after receiving a No-Objection Certificate from the SPCB. Hot mix plant shall be fitted with stack of adequate height as may be prescribed by SPCB to ensure enough dispersion of flue gases.
- Diesel Generating sets shall be fitted with stacks of adequate height as per regulations (Height of stack = height of the building + 0.2 $\sqrt{}$ KVA). Low sulphur diesel will be used in DG sets as well as machineries.

Control of Pollution at Crossings and ROB construction sites

- Provision of ROB or underpasses is the most effective measure to control the traffic and linked pollution problem at crossing sites. DFCCIL has made provision of ROBS at almost all the above identified crossings location (depending on TVUs volume) and underpasses at most of the locations in detours. However wherever, provision of ROB or underpasses are not made or it has potential of increased TVU, the following measures can be considered
  i. The maximum crossing closing time shall be assessed based on traffic intensity during different time period of the day. The crossings closing time shall be regulated depending upon above analysis.
  ii. Efforts shall be made to prevent 90^0 exit and entry to highway. Provision of slip roads may be made with the help of highway authorities and village Panchayats or area development authorities.
  iii. Traffic movement to crossings shall be through up and down divided carriage way. Traffic marshals shall also be posted to control the traffic at these locations.
- Before start of ROB, underpass or flyovers construction, the traffic situation and probable traffic diversion or rerouting situation shall be assessed and accordingly effective traffic diversion and management plan shall be developed. These plans shall be finalised in consultation with the public and local residents. Adequate budgetary provisions shall be made for notifying the public for traffic plans. Adequate barricading shall be made around the construction site to confine the construction activities including construction material storage areas. Enough movement space shall be left to allow access to residents on either side of the ROB alignment. Unauthorised and unsafe crossing shall be restricted. Small-levelled corridor duly guarded may be given for movement of local pedestrian, bicycle and rickshaw dwellers movement.
- Ambient air quality monitoring shall be carried out during construction phase. If monitored parameters are above the prescribed limit, suitable control measures must be taken.

Operation Phase

Impact: Electrification operation of trains will not result in any gaseous pollution. The only impact during operation phase may be due to loading and unloading of materials like cement bags, coal at yards, which may create substantial fugitive dust generation.

Mitigation Measures

- Specific guidelines shall be formulated for material handling practices (particularly for loading and unloading) of the materials. Instruction defining precautions like avoiding practices of throwing of the bags while unloading from racks and load to trucks.

- The loading/unloading area shall be covered. Feasibility of mechanical sweeper and loading and unloading option may also be explored. Thick plantation will be carried out around unloading areas to prevent spread of fugitive dusts.
- The appropriate PPE shall be provided to the workers.
- Use of enclosed cars or covering of open cars for transportation of loose materials.

6.2.4. Noise and Vibration

Design and Construction Phase

Impact: Ambient noise level may increase but temporarily due to construction activities, maintenance workshops and vehicles & earthmoving equipment in the nearby areas. However, this increase may be negligible or marginal as source noise will be lesser or equal to the existing noise levels. The expected increase at a distance of 100 m with the source noise of 70 dB (A) is likely to be of the order of only 3 - 5 dB (A).

Mitigation Measures

- All equipments shall be timely serviced and properly maintained to minimize its operational noise.
- All the statutory laws, regulations, rules etc, pertaining to procurement, transport, storage, handling and use of explosives shall be strictly followed.
- Stationary noise making equipments shall be placed along un-inhabited stretches.
- Provision of portable noise barrier shall be made near sensitive locations like schools, religious places and hospitals. If portable noise barriers are not feasible then regulating construction activity and its timing will be necessary so that the impact intensity is minimised.
- Protection devices (ear plugs or ear muffs) shall be provided to the workers operating in the vicinity of high noise generating machines.
- Construction equipment and machinery shall be fitted with silencers and maintained properly.
- Provision shall be made for soil compaction and sand pockets near vibration prone areas.
- The sections passing through forest areas shall be declared as silence zone. In forest areas, noise should be controlled by regulating construction activities and their timings.
- Noise measurements should be carried out along the track to ensure the effectiveness of mitigation measures.
- No construction activity will be carried out during night time at habitations.

Operation Phase

Impacts: During the operation phase, train movement is the prime source of noise and vibration. The train movement will result in impulsive increase in vibration and nearby ambient noise levels. In order to assess the impacts of train movement noise levels have been predicted. The methodology of noise predictions is as below:

(a) Methodology for Noise Level Predictions

Railway Noise

Regarding railway noise generated by conventional trains (local trains, express trains and limited express trains), main causes include (1) traction movements, (2) structures and (3) machines equipped to the train. Among them, the traction movement contributes to the generation of noise greatly.

Several types of prediction equations were proposed for various types of railway track structures, such as the elevation, embankment and cutting.

Therefore, prediction was carried out applying the actual data of railway noise level, running speed (V) of trains, and the distance from center of the nearest railway track (D).

Based on the data obtained for railway noise, the empirical equation was extracted by using a simple regression and correlation analysis. The following equation is used for noise prediction.

Assuming V is constant, D is only one variable, and the empirical equation is shown below. A predicted railway noise level is shown in the below table.

$$L_2 = L_1 - 20 \text{ Log } D_2/D_1 \quad \text{------------- (1-1)}$$

$$L_{Aeq} = 10 \text{ Log } (10^{N1/10} + 10^{N2/10} + 10^{N3/10} + \text{........})/T$$

Where,

L_1 and L_2 are the noise levels at D_1 and D_2 distance.

N_1, N_2, N_3 are the noise pressure levels at a different time interval. T is the number of reading.

(Reference: JICA Study on DFCC Corridor)

1) Conditions Used in Predictions

Following conditions are assumed:

- Type of traction: electrified traction (electric locomotive) as EDFC will be an electrified tack
- Running operation: 150 trains/direction/day with the same time interval (approximately one train for every five minutes)
- Maximum running velocity: 100 km/h
- Majority of the existing railway line structures is the embankment structures with approximately 2 to 5 m high from the ground level at the site.
- Railway noise and vibration generation level due to planned dedicated freight train; remains the same as the existing freight train,
- DFCC plan would have various factors contributing to reduction in railway noise.

2) Prediction and Evaluation Points

a) Sites along the existing railway lines within the parallel sections of the DFCC Project.

b) Sites along the planned detour routes where no railway noise was observed as a reference point of the background level monitoring.

Estimated noise levels (LAeq) were evaluated by using comparative and trends from (i) the ambient noise standard in India, (ii) existing ambient noise levels at monitoring locations and (iii) existing railway noise at monitoring locations.

(b) Predicted Noise Levels at Sensitive Receptors

The increase in noise levels from the proposed project is given in **Table 6.4**. The table suggests that the impact of noise and vibrations from the project will be instantaneous (Peaks of certain decibels) but within permissible levels/tolerant limits . These results are obtained taking into consideration the peak noise levels of different categories of trains like Freight, passenger and their combinations. The impact of noise will therefore not significant during operations of EDFC. Moreover, during public consultations there were no major issues related to noise as the residents near the tracks were found habitual to them.

Table 6.4 : Prediction of Noise from the Proposed EDFC

S.N.	Type of Receptors	Location	Chainage	Distance from the existing track (m)	Existing Peak Ambient Level with passage of train Lmax dB(A)	Distance from the Proposed DFC Corridor (m)	Mitigation Measures Planned	Predicted Level with DFC L'max dB(A)	Permissible Exposure Levels of Impulsive Noise (in numbers)*
	Ch. 00 – 100 km								
1.	Public School	Bulandshahr	20.1	70	72.3	25	Noise Barrier wall	81.3	10000 of 120 dB(A) noise peak
2.	Bedmani Hospital	Bulandshahr	22.6	60	60.3	15	Noise Barrier wall	69.3	
3.	Mosque	Near Baral Station	33.6	70	64.4	25	Noise Barrier wall	73.4	
4.	Primary School	Between Hapur and Chaprawat	49.9	70	60.7	25	Noise Barrier wall	69.7	
5.	Bright Land Public School	Between Hapur and Chaprawat	51.8	60	58.2	15	Noise Barrier wall	67.2	
	Ch. 101 – 200 km								
6.	Temple	Near MuzaffarNagar Station	160.9	60	76.2	15	Noise Barrier wall	85.2	10000 of 120 dB(A) noise peak
7.	Temple	Between Rohana & Nagal Station	176	80	62.8	35	Noise Barrier wall	71.8	
	Ch. 201 – 300 km								
8.	Saraswati gyanvari School	Near Nagal Station	203.1	80	73.1	35	Noise Barrier wall	82.1	10000 of 120 dB(A) noise peak
9.	Temple	Mustafabad	269.2	70	72.1	25	Noise Barrier wall	81.1	
10.	Temple	Near Markanda River	286.5	80	58.1	35	Noise Barrier wall	67.1	
	Ch. 301 – 400 km								
11.	Mosque	Between Sambhu and Rajpura station	317.4	90	78.2	45	Noise Barrier wall	87.2	10000 of 120 dB(A) noise peak
12.	Gurdwara	Between Chawa Pail & Khanna	377.4	70	74.2	25	Noise Barrier wall	83.2	

S.N.	Type of Receptors	Location	Chainage	Distance from the existing track (m)	Existing Peak Ambient Level with passage of train Lmax dB(A)	Distance from the Proposed DFC Corridor (m)	Mitigation Measures Planned	Predicted Level with DFC L'max dB(A)	Permissible Exposure Levels of Impulsive Noise (in numbers)*
	Ch. 00 – 100 km								
13.	High School	Between Chawa Pail & Khanna	383	60	64.3	15	Noise Barrier wall	73.3	
14.	Temple	Between Doraha & Chawa Pail	389.1	100	68.8	55	Noise Barrier wall	87.8	
15.	Primary School	Between Doraha & Chawa Pail	391.5	80	70.2	35	Noise Barrier wall	79.2	
16.	Modern Sr. Sec. School	Doraha	393.4	70	54.3	25	Noise Barrier wall	63.3	
17.	Temple	Doraha	394	70	57.6	25	Noise Barrier wall	66.6	
18.	Gurdwara	Doraha	394	70	52.1	25	Noise Barrier wall	61.1	

**Source: Delhi Factories Rule, 1950*

(b) Methodology for Vibration Levels Predictions

Vibration is a complex phenomenon. Railway vibrations are generated by motion of heavy loads on tracks. Vibrations become more complex as speeds of motion change. Complex scenarios of multiple trains running in the same or opposite directions to each other introduce further complications. Vibrations require a medium for their transmission. Any variation in the medium present between the track and point of impact plays a significant role and complicates the assessment further.

Most studies in developed countries have ignored the variation due to multiple factors. They have always considered type of trains and speed. However, impact of variation in medium (ground) between the track and point of impact has mostly not been included in these studies. It did not bring inaccuracy in their estimations and prediction since a wide strip on both sides of the track was of only one kind medium. They did not have the variety of the magnitudes we see in India. The advantage of this simplicity was easy to use of formulae and correlation in those studies.

A factor of variation in the medium has been included in the study so that an assessment of impact is more close to the ground scenario along the corridor.

In our study we have depended heavily on live data from real vibrations caused by the trains. From this data, we have picked up the highest vibration generating trains / speed / load / ground and situations. These are all live values and are not estimation. Having picked up these values, graphical extrapolation is used to estimate the vibration levels for train speed of 100 kmph. Thereafter, standard mathematical calculations have been applied to estimate the vibration levels due to multiple trains running together.

Japanese standards JIS Z8735 and JIS 1510 have been used in the vibration predictions.. We have further explored the Laws relating to factory act, labor laws and laws for occupational health for co-relating norms. We have however not found any standards or limits relating to building vibrations or human annoyance due to vibrations. Most these laws cover are the whole body or hand arm vibrations caused by tools and equipment used by the workers. So we have remained aligned to Japanese standards quoted above and have used Db as units of measurements. This unit also helps in calculating combined effect of two adjacent vibration levels by way of simple formula. The formula used is

$$\mathbf{Lmax_{eq} = Lmax_{track\ 1} - Lmax_{track2} + Lmax_{track\ 3}}$$

As No of variables existing in this study are over a dozen we have not used co-relational equations to estimate as we expected it to introduce mathematical errors in the calculations. Instead we depended on Real time values and graphical assessment and extrapolation.

Methodology We have therefore channeled our study in following steps

1 Identification of Impacts of Freight trains. having different kinds of wagons.

2 Identification of category of train (wagons) causing highest vibrations.

3.Identification of impact of train speeds on vibrations

4.Identification of impact of train axel loads on vibrations

5 Identifying Highest vibration level from above data

6. Extrapolating this highest level of vibration for train speed of 100 Km / Hr

7. Calculation of change in this value of vibration of single train due to presence of multiple trains running together

8. Purifying this highest value for any effects of medium variation between the track and measurement point

9. Predicting the Maximum vibrations for plain route and for populated areas

10. Transposing vibration levels so estimated on to Sensitive Receptors

identified and predicting the impact..

Identification of Impacts:

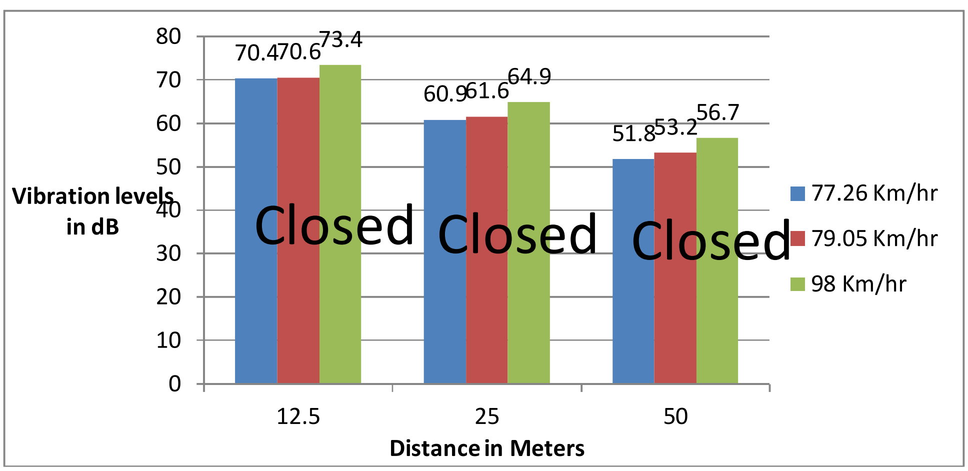
We have identified several kind of impacts from the data collated in previous chapters Typical these impacts could be of following types

1) **Impacts in Plane areas ie** travel of Vibration; reverberations at 90 degree to the track will affect all the buildings, archeological Monuments, inmates of the building. These variations in vibrations could be due to following factors;
   - Distances from the track
   - Speed and
   - Axel loads
   - Train Crossings
2) **Impacts due to train crossings ie** trains while crossing each other or while running parallel to each other in 2 or more numbers cause overall vibrations to increase or reduce. This aspect is to be taken into consideration for estimating maximum impacts in each of the above two situations
3) **Impacts in Populated Areas ie** travel of Vibrations, reverberations through the variety of ground conditions existing between the track and point of measurement / impact assessment. Varieties existing included mix of plain, embankment, hard standing platform of building floors, and roads. .

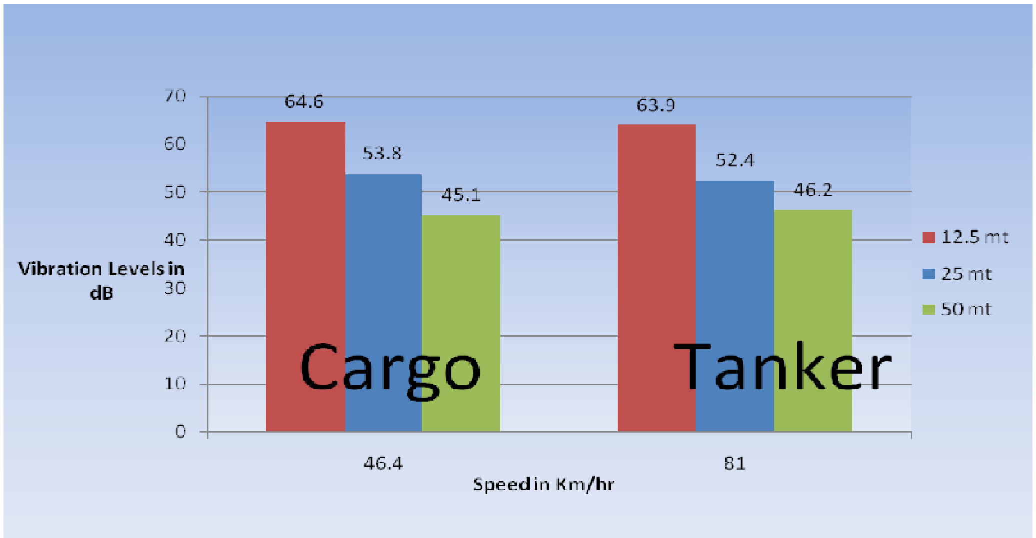
Impacts in Plain areas vis a vis distances from the track

We have compared the existing distance based vibration levels being generated by the trains running on the existing tracks. For the four categories of freight trains considered by us, the levels of vibrations generated in plane areas are provided in the figures below.

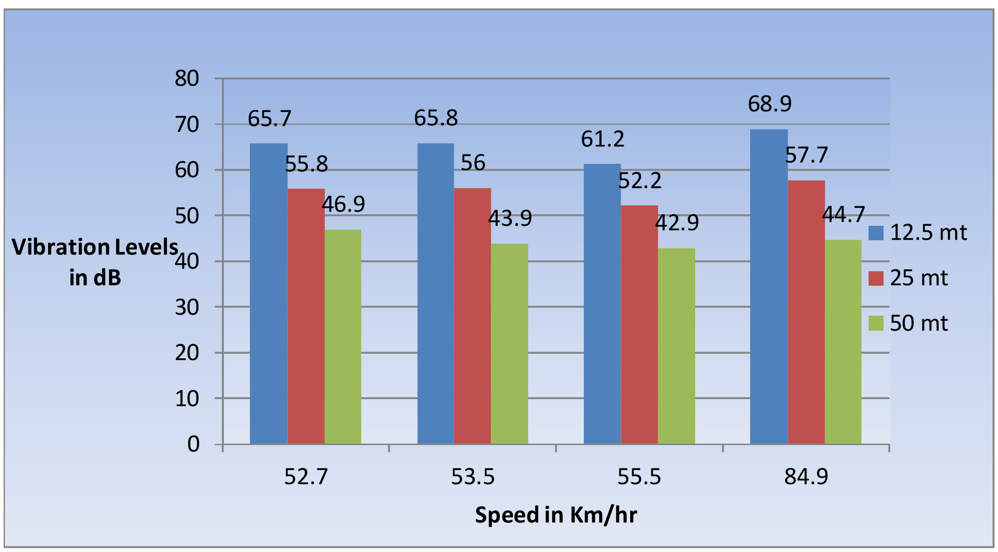
Closed Wagon



Tanker and Cargo



Open Wagon

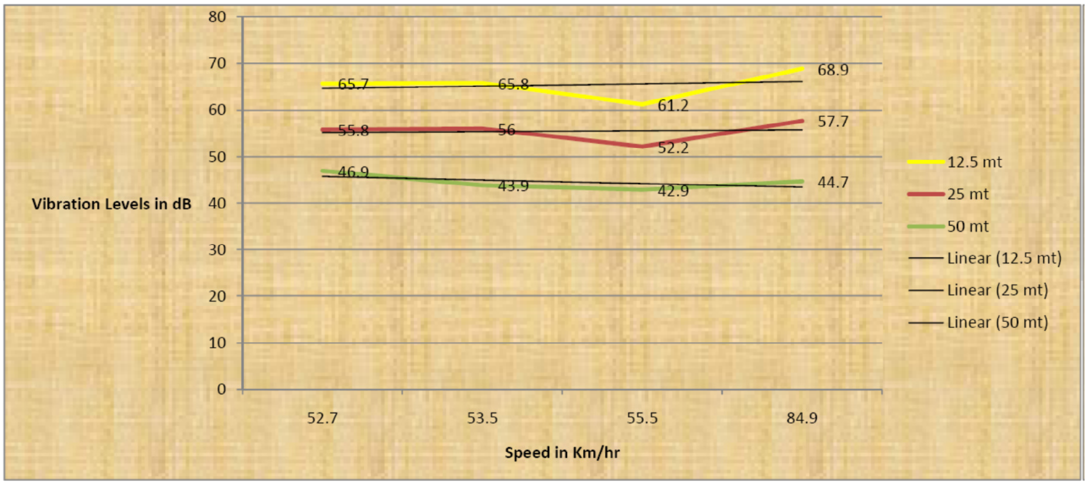


From the graphs above, we can select the highest vibration levels of all the categories of train for one distance (say 12.5 or 25 or 50 meters) as the upper limit for that distance, for estimating the impact at 90 degree to the track. This is tabulated below.

Table 6.5 : Highest Vibration Levels for All Category of Trains

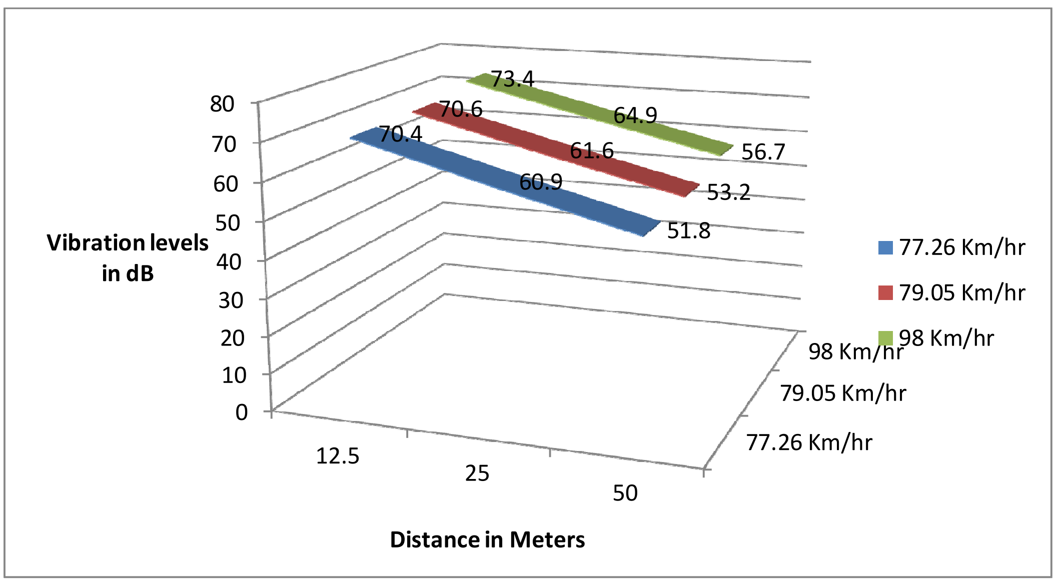
Distance	Maximum dB
12.5	73.4
25	70.6
50	70.4

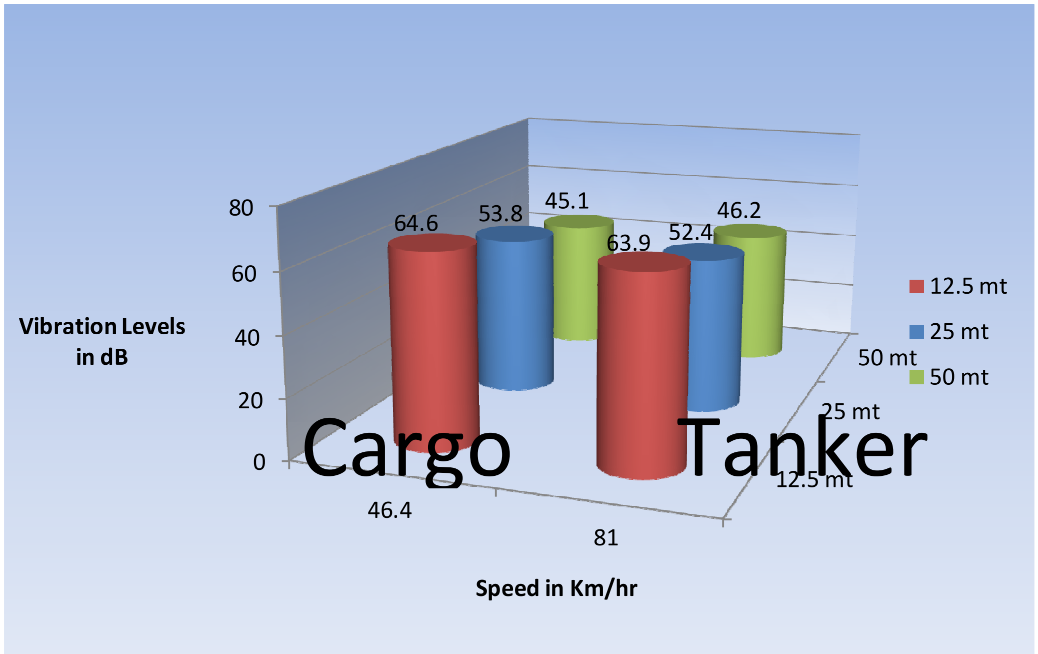
These values for all the three distances coincidentally correspond to only one categories of freight train that is **Closed Wagon**; Graph for this is produced below:



Impacts with speed and axel load were also similarly evaluated. These were identified for

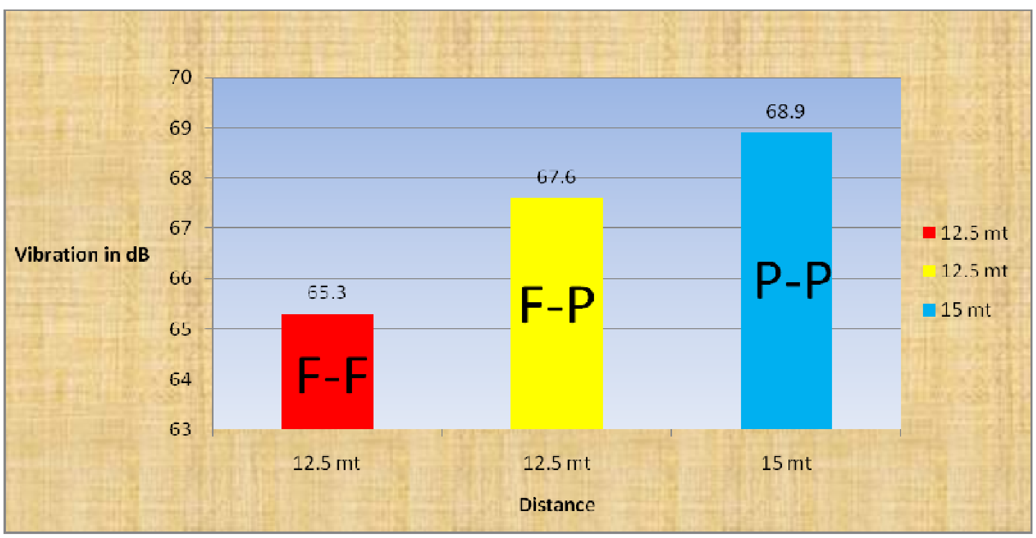
- maximum speeds of trains in each category as well as for
- maximum vibration in these categories and are as placed below:





Impacts of Two Train Crossings

The data available includes several occasions of crossings of trains. These are in the form of Passenger – Passenger crossing (P-P), Passenger – Freight crossing (P-F), Freight – Passenger Crossing (F-P) and Freight – Freight crossing (F-F). These crossings are representation of similar crossing likely to take place on EDFC on parallel tracks. F-F crossing is representation of similar crossing on detours at crossing stations.



From graphs above it is inferred that in parralel section maximum vibrations occur when two Passenger trains cross each other. The expected level is 68.9 dB at 15 Meters. For detour section this will be a crossing between 2 freight trains. Using the graph for vibration amplitude versus distance from the track, its value can be extrapolated.

Impacts In Populated Areas (on residential / commercial / Industry/ Social structure)

It is quite possible to generate similar charts for residential/ industrial / commercial complexes including sensitive receptors. However, it will not be completely appropriate to use these graphs for assessing impacts on other buildings etc along the track. The variation will be due to dis-similarities of the grounds between the railway track and point of measurement for different structures considered for estimation of impacts. Additionally impact of vibration caused by road traffic and other movements in corresponding locations may further complicate the estimation. Therefore, the data collected for such location has also been assigned as reference vibration levels for typical structures interfacing the track and the measurement point. The reference data is appended below in **Tabe-6.6**:

Table 6.6 : Sensitive Receptors along the Alignment of EDFC

S.N.	Type of Sensitive Receptors	Location	Chainage	Distance from the existing track (m)	Existing Peak Ambient Level with passage of train Lmax dB(A)	Distance from the proposed DFC Corridor (m)
1.	Public School	Bulandshahr	20.1	70	72.3	25
2.	Bedmani Hospital	Bulandshahr	22.6	60	60.3	15
3.	Mosque	Near Baral Station	33.6	70	64.4	25
4.	Primary School	Between Hapur and Chaprawat	49.9	70	60.7	25
5.	Bright Land Public School	Between Hapur and Chaprawat	51.8	60	58.2	15
6.	Temple	Near MuzaffarNagar Station	160.9	60	76.2	15
7.	Temple	Between Rohana & Nagal Station	176	80	62.8	35
8.	Saraswati gyanvari School	Near Nagal Station	203.1	80	73.1	35
9.	Temple	Mustafabad	269.2	70	72.1	25
10.	Temple	Near Markanda River	286.5	80	58.1	35
11.	Mosque	Between Sambhu and Rajpura station	317.4	90	78.2	45
12.	Gurdwara	Between Chawa Pail & Khanna	377.4	70	74.2	25
13.	High School	Between Chawa Pail & Khanna	383	60	64.3	15
14.	Temple	Between Doraha & Chawa Pail	389.1	100	68.8	55
15.	Primary School	Between Doraha & Chawa Pail	391.5	80	70.2	35
16.	Modern Sr. Sec. School	Doraha	393.4	70	54.3	25
17.	Temple	Doraha	394	70	57.6	25
18.	Gurdwara	Doraha	394	70	52.1	25

Source: Consultants' Field S

These reference vibration levels for different interfacing ground studies can be transposed to impacted structures under assessment at any location with similar interfacing structure.

Prediction of Impacts

The Vibration measurements carried out fall into two groups broadly: For the portion of corridor that will run parallel to the existing track and portion of the corridor that will go through the detours. Parallel track, running of the trains will engage maximum of two parallel tracks. Of these one would be occupied by the freight trains and one by Passenger trains. The corridor will be completely together and will be parallel to the existing track. Average distance between the centre of passenger and freight trains is expected to be 6 meters

The levels of vibration on two tracks have been examined in previous section.

Out of all possibilities, maximum vibrations will be generated by the various combinations of trains running on two closest tracks as these trains have maximum influence of individual vibrations on each other. From the graphs of two trains crossing each other as placed in previous section, we notice the highest Vibration Level for two train crossed is 68.9 dB for Passenger – Passenger combination. This is however very much below the levels caused by single freight train running on the nearer track. The reason for this phenomenon to occur is the fact that both the trains are running opposite to each other and are therefore canceling effect of vibration waves generated by them individually.

Calculations:-

Check for vibrations for 100 Km/Hr train speed:

By examining the trend of change in Vibration Levels with the increase in speed in the graphs in previous sections, we notice that in most cases the vibration levels increase with increase in speed. We have extrapolated this trend of vibration of freight container & estimated the **vibration level at 100 km/hr to be 71.4 dB**. This however is lower than the maximum vibration level for single freight train being considered by us and therefore not relevant

Check for multiple train running:

From the measurements and graphs as discussed earlier the maximum level of Vibrations occurring for any Freight container Train on any track and at 12.5 mts from the center of the concerned track (Container) = 75.3 **dB**

The Mathematically Attenuated value calculated for vibration at 35 meters in reference to the train running on the 2^{nd} track = **72.8 dB** (Refer variation of vibrations with distance for containers)

Combined effect of these two Vibration Levels at the same measurement location that is 12.5 meters from the nearer track can be calculated as follows.

$$\mathbf{Lmax_{eq} = Lmax_{track\ 1} - Lmax_{track2} + Lmax_{track\ 3}}$$

In the light of this discussion for predictions, 75.3 **dB** as highest vibrations for freight trains have been used in our calculations below.

Predicted Vibration Levels for multiple trains running together– These estimations workout as below.

<u>On DFC side of parallel Track</u>

1. On the freight corridor side, two freight trains running in opposite directions with a gap of 5 meters from each other.

 - Highest value of Vibration level by one freight train = 75.3**dB**
 - This level attenuated to 17.5 mts for second freight train = **71.5 dB**.

For these trains running in opposite directions, resultant level is difference of the 2 vibration levels.

$$\mathbf{Lp_{F\text{-}F} = 10*LOG\ (10\text{^}(75.3/10)-10\text{^}(71.5/10)) = 72.9\ dB}.$$

2. One freight train running closer to the 12.5 mts measurement point in the same direction from a passenger train 10 mts away

 - Highest value of Vibration level by one freight train = **75.3**
 - Highest value of Vibration level of passenger train attenuated to 35mtrs = **72.9**

 Since both the trains are running in same direction the relevant level will be addition of the two levels

$$\mathbf{Lp_F + Lp_{Psngr} = 10*LOG\ (10\text{^}\ (75.3/10) +10\text{^}\ (72.9/10)) = 77.2}$$

3. A Freight train running on the 2nd track farther from the 12.5 meter measurement point and a passenger train running opposite to its direction in the third track.

- Highest value of Vibration Level of Passenger train attenuated to 35 meters = **72.9**
- Highest Value of Vibration level by one Freight train attenuated to 20 meters = **71.5**

Since the trains are running in opposite directions. Therefore, resultant value is difference of the 2 vibration levels.

$$Lp_{F\text{-}P} = 10*LOG\ (10\text{^}\ (72.9/10)-10\text{^}\ (71.5/10)) = 67.3\ dB$$

- Highest Value of Vibration level by one Freight train running in 2nd track attenuated to 20 meters = **71.5**

Since this is a scenario of parallel running of the trains in composite manner

$$Lp_{F\text{-}F\text{-}P} = 10*LOG(10\text{^}(71.5/10)+10\text{^}(77.2/10)) = 78.2\ dB$$

<u>On Passenger Track Side</u>

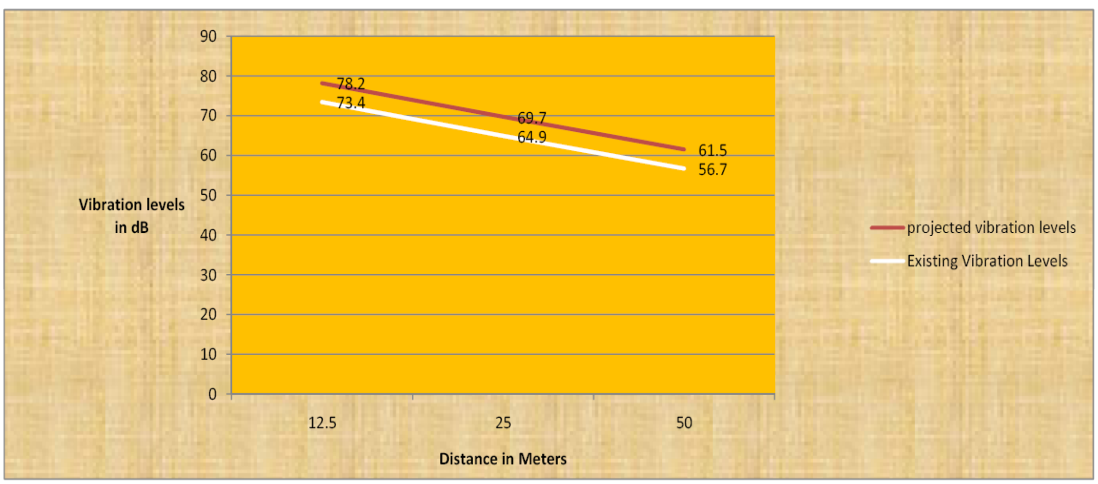
4. On the other side of two tracks the situation will be driven by passenger train in similar four possibilities. The evaluated highest Lmax for these four possibilities are:

(i) 1 Passenger in track and one freight on track 2 both in same direction=**65.1 dB**

(ii) 1 Passenger on track 3 and one freight on track 2 both in opposite direction-**66.5 dB**

The other less effective combinations would be different mixes of trains running on, third and fourth tracks.

We display below graphically the predicted values for various distances from the track alongwith the graph for freight train vibrations for the similar distances.



Predicted highest Vibration Levels for the Detour track – These estimations workout as below

For the detour locations, the scenario will always be two Freight trains crossing each other in opposite directions for which we have calculated highest Vibration level as **71.5 dB** at 12.5 meters measurement point, when the interfacing ground is plain ground. This will be at crossing stations

However, this value is lower than the highest Vibration Levels generated by running of Single Freight train.

Therefore predicted highest vibration levels for the detour portions = **75.3dB** at 12.5 meters from nearer track for freight containers.

Evaluation of Impact

Based on the predicted values, evaluation of the impacts has been carried out in following steps:

1. We have examined the Japanese standards for Permissible Vibration values in Habituated and Plane areas. The pictorial information in this regard which also includes the level of complaints received by procure department of railway vibration in 2006 is displayed below;

Standard of Vibration Intensity (decibel)

90	Violent shaking of house and falling of unstable things
80	Shaking of house and rattling of doors and paper doors
70	Perceived by many people and slight movement of doors and paper doors
60	Perceived only by people at rest
50	Rarely perceived by human beings

Vibration level

The vibration level is determined by the amplitude and speed of vibration. Human beings perceive vibration in a complex manner.Therefore, vibration is corrected so that it can be measured on the same basis even if human perception of the vibration is different. The vibration level is also expressed by the unit of "decibel."

From the extract above it is apparent that standards 70 dB vibration level defines the acceptability criteria in general, however in densely habituated areas the lower level will have to be allowed based on these criteria the permissible limits for vibrations are provided below.

As worked out in the prediction process above, various highest vibration levels likely to occur in different portions of the E DFC are as below:

Plain route: 78.2 as against permissible levels of 70dB

Populated areas 78.2 as against permissible levels of 65dB

Therefore vibration levels have to reduced by

8.2 dBs - for Plain areas

13.2 dBs - Populated areas

8.2 to 13.2 dBs - plain / SR area

Prediction of vibration levels on Sensitive Receptors

Prediction of Impacts on Sensitive Receptors based on the methodology described above has been carried out. The SRs have been identified during survey of the track alignment. From these listed receptors, those falling within the track alignment have been eliminated as they would require removal replacement or shifting. The balance receptors have been listed and predicted levels have been estimated.

The results of predicted vibration levels are given belowin **Table-6.7.** It is clear that vibrations these are exceeding at all sensitive receptors.

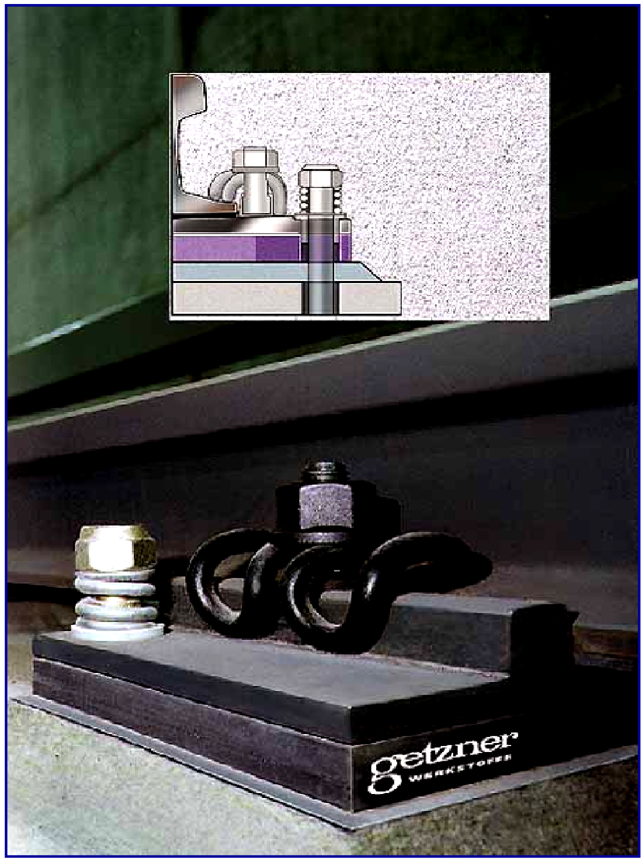
Table 6.7 : Prediction of Vibration Impact from the Proposed DFC

S.N.	Type of Sensitive Receptors	Location	Chainage	Distance from the existing track (m)	Existing Peak Ambient Level with passage of train Lmax dB(A)	Distance from the proposed DFC Corridor (m)	Predicted Vibration Level with DFC L'max dB(A)
Ch. 00 – 100 km							
1	Public School	Bulandshahr	20.1	70	72.3	25	77.3
2	Bedmani Hospital	Bulandshahr	22.6	60	60.3	15	76.3
3	Mosque	Near Baral Station	33.6	70	64.4	25	79.4
4	Primary School	Between Hapur and Chaprawat	49.9	70	60.7	25	79
5	Bright Land Public School	Between Hapur and Chaprawat	51.8	60	58.2	15	83
Ch. 101 – 200 km							
6	Temple	Near MuzaffarNagar Station	160.9	60	76.2	15	83
7	Temple	Between Rohana & Nagal Station	176	80	62.8	35	78
Ch. 201 – 300 km							
8	Saraswati gyanvari School	Near Nagal Station	203.1	80	73.1	35	78
9	Temple	Mustafabad	269.2	70	72.1	25	79
10	Temple	Near Markanda River	286.5	80	58.1	35	78
Ch. 301 – 400 km							
11	Mosque	Between Sambhu and Rajpura station	317.4	90	78.2	45	74
12	Gurdwara	Between Chawa Pail & Khanna	377.4	70	74.2	25	79
13	High School	Between Chawa Pail & Khanna	383	60	64.3	15	83
14	Temple	Between Doraha & Chawa Pail	389.1	100	68.8	55	69
15	Primary School	Between Doraha & Chawa Pail	391.5	80	70.2	35	78
16	Modern Sr. Sec. School	Doraha	393.4	70	54.3	25	79
17	Temple	Doraha	394	70	57.6	25	79
18	Gurdwara	Doraha	394	70	52.1	25	79

Mitigation Measures

Thick plantations around sensitive locations like schools, hospitals and religious places. However, mitigation in the form suitable resilient fasteners are also proposed. These fasteners reduce vibration levels to the extent of 10 dB. The details of this device are given below. With this device vibrations will be within acceptable limits except at Sl. No. 5 and 13. These two schools can be relocated.

Resilient Fasteners: Resilient fasteners are very common fastening equipment used in modern track constructions. We feel these must also be included in design of track installation by DFCC. If so, these become another existing resource that will help mitigation of the impact of vibration. These fasteners are used to fasten the rail to concrete track slabs. Standard resilient fasteners are rather stiff in the vertical



direction, usually in the range of 40 kN/mm (dynamic stiffness), although they do provide vibration reduction compared to classical rigid fastening system. Special fasteners with vertical dynamic stiffness in the range of 8 kN/mm will reduce vibration by as much as 15 dB at frequencies above 30 Hz. (Conservatively these could **reduce vibrations by 5 to 10 dB)** .Rail and base plate pads for rail resilient rail fasteners are used on trams, subways, light rail and main line train. Therefore, this resource alone will be able to provide balance mitigation of track vibration. Therefore it is felt that no additional mitigation measure is required to be considered.

6.2.5. Impact on Land and Soil

The impact on land is expected in terms of change in land use due to land acquisition, change in topography and landscape due to corridor construction. Impact is also expected on soil in terms of soil erosion, soil compaction & contamination and loss of productive top soil. These impacts are detailed in the following sections.

6.2.5.1 Change in Landuse and Landscape

Design and Construction Phase

Impact: The project will require acquisition of 648.38 Ha. land as per the distribution among private and Government owned land given in **Table 6.8**.

Table 6.8 : Details of Land Acquisition

Section	Private Land(in ha)			Government	Total (Ha.)
	Agri.	Resi. /Com.	Community		
Khurja-Ludhiana	530.19 (81.77%)	5.47 (0.84%)	0.67 (0.11%)	112.05 (17.28%)	648.38 (100%)

Source: RAP report

The land use pattern will permanently change due to diversion of agriculture homestead and forested land and the impact would be direct and significant.

The landscape & topography is likely to change in the detour area, ROB and grade separation areas due to construction of embankment and flyovers. The ROB alignments at various locations are yet to be finalised. The impact associated with this would be more primarily in terms of loss of habitat, loss of physical cultural resources, change in land use and landscape.

The sourcing of borrow earth may also change the landscape if borrow areas are not rehabilitated.

No impact is anticipated on geological aspect since ballast / aggregates shall be procured from licensed quarries, and no ballasting is involved either.

Since access roads are available to approach all the construction sites as identified by feasibility consultant as well, no impact is anticipated on land use for reaching the construction area.

Mitigation Measures

- All efforts shall be made to minimize the total land acquisition while finalizing the alignment of ROBs. Efforts shall be made to minimise the land acquisition on similar pattern followed while finalising the corridor alignments. In the high embankment areas (detour), feasibility may be explored for using the retaining wall for minimising the land acquisition.
- Compensatory afforestation plan will be implemented in consultation with forest department to compensate the loss of trees.
- Forest clearance will be obtained well in advance. Budget provision will also be made for compensation equal to the double the size of forest land and it's Net Present Value.
- Enhancement measure to improve the aesthetics of the area or landscaping plan may be formulated which may include landscaping of the surrounding area of the embankment, crossing / junction stations, ROB & flyovers. This may include slope treatments, ornamental tree plantation, and additional tree plantations. It shall also be ensured that borrow areas are appropriately rehabilitated. The top soil of the borrowed areas may be used for these landscaping activities
- The impacts associated with the construction of ROBs, are addressed in respective sections of this chapters. However, attempts shall be made to minimise the impacts on land use and habitats while finalising the ROB alignment.

6.2.5.2 *Loss of Productive Soil and Soil Erosion*

Impact: There are very limited soil erosion prone areas geologically which are located in Ambala & YamuNagar Districts. However no specific soil erosion of area is expected due to project.

The project areas vulnerable to soil erosion are proposed earth stock pile locations, high embankment areas of the detour, River banks, bridge approaches and borrow pits areas. Soil erosion near bridges will be minimal since Riverbanks of major Rivers are composed of comparatively consolidated material. Clearance of vegetation is also limited in the project sections.

The soil erosion is observed during field study near water logged areas along the alignment. Continued water logging along the track may lead to soil erosion of the embankment area.

There will be loss of top soil if not preserved at borrow and embankment areas.

Uncontrolled disposal of debris may contaminate land, air & water and may have a direct negative impact.

Mitigation Measures

- The top soil from the productive land shall be preserved and reused for plantation purposes. It shall also be used for embankment slope for growing vegetation to protect soil erosion
- The Riverbank shall get damaged; the same shall be repaired after completion of construction activity. If Riverbank erosion is found at the bridge construction site, the measures like building of scouring protection structures at Riverbank slopes, protection by geo-textiles matting can be implemented.
- Construction activity shall be restricted at erosion prone location during Monsoon.

- Cross drainage structure shall be provided as required to maintain the natural drainage pattern. Provision of side drain shall also be made to guide the water to natural outfalls to prevent water logging.
- Turfing of embankment slopes shall be along the stretch. Provision shall be made for slope protection frames, dry stone pitching, and masonry retaining walls as may be required. Stone pitching shall be carried out for embankment height of > 3 m or wherever necessary. When soil is spread on slopes for permanent disposal, it shall be buttressed at the toe by retaining walls. The surface of the slope shall be stabilized as necessary, prior to seeding. All steep cuts shall be flattened and benched. Retaining wall on both sides shall be provided. Shrubs shall be planted immediately in loose soil area.
- Soil erosion shall be visually checked on slopes and high embankment areas during construction phase. In case soil erosion is found, suitable measures shall be taken to control the soil erosion.

Operation Phase

Impact: Unexpected rainfall near rob, flyovers and bridge approaches may erode the embankment. Soil erosion may happen around unstabilized or non rehabilitated borrow areas.

Mitigation Measures

- Monitoring of rehabilitation plan of borrow areas shall be done in tune with proposed rehabilitation plan.
- Regular monitoring of side-drains and cross drainage structures will be done to check blockade.
- Periodic checking shall be carried out to assess the effectiveness of stabilization measures viz. turfing, stone pitching measures implemented during construction phase. A detailed inventory (location, reasons of soil erosion) of all areas identified as soil erosion prone during above period will be surveyed. Suitable strengthening measures shall be taken to prevent reoccurrence of soil erosion at existing erosion prone locations and prevent erosion at newer locations.

6.2.5.3 *Borrow Areas And Quarries*

Impact: The project area topography is characterised as flat. GIS based assessment is carried out in 15 km radius along the entire 404.098 km corridor to identify the probable areas for borrow earth. The landuse in the analysed area is agriculture and highly productive. Only about 12-15 sq. km area can be classified as fallow land and potential source for borrow area. It will be difficult to identify the areas for sourcing the borrow earth in the project area. However, during public consultation many farmers conveyed their acceptance to give soil from their field so that there fields are levelled and there is ease in irrigation of crops.. Any uncontrolled borrowing may result in loss of productive soil.

Illegal quarrying may lead to unstable soil condition. Ballast material is proposed to be procured only from existing and approved quarries since many approved quarries are located in the area. Opening of new quarries is not envisaged due to the proposed project. No direct impact is envisaged from sourcing of this material.

Mitigation Measures

Borrow Area Management

- Borrow pits shall be selected with the prior concurrence of the landowner and with the commitment of rehabilitating with as per agreed intended use with the landowner.
- The Indian Road Congress (IRC):10-1961 guidelines shall be used for selection of borrow pits and amount that can be borrowed.
- Borrow areas should not be located on cultivable lands except in the situations where land owners desires either to use the top soil due to its reduced

productivity or to lower the level of the land. The top soil shall be preserved and depth shall be restricted to the desired level.

- No private/fertile land acquisition shall be done for borrow areas. Borrow pits shall not be selected nearby the settlement.
- Priority shall be given to the borrowing from humps/upland/mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the track above the general ground level.
- The depths in borrow pits to be regulated so that the sides shall not be steeper than 25%, from the edge of the final section of the bank.
- Borrow pits shall be centrally located to serve more than one site. The haulage distance from site should not preferably be too far.
- Borrow area shall be rehabilitated in consultation with landowner or community.

Use of Alternate Material

- Alternate material like Ground Granulated Blast Furnace Slag (GGBS) a waste product of steel mills and fly ash can be used for embankment filling. These pozzolanic materials react with clay minerals or silt minerals and convert into di & tri-calcium silicate, which further enhances the strength of the soil. However, suitability for embankment fill shall be verified through laboratory trials and makes designs. A view of embankment filled with earth blended with fly ash and GGBS is shown in **Figure 6.1.**

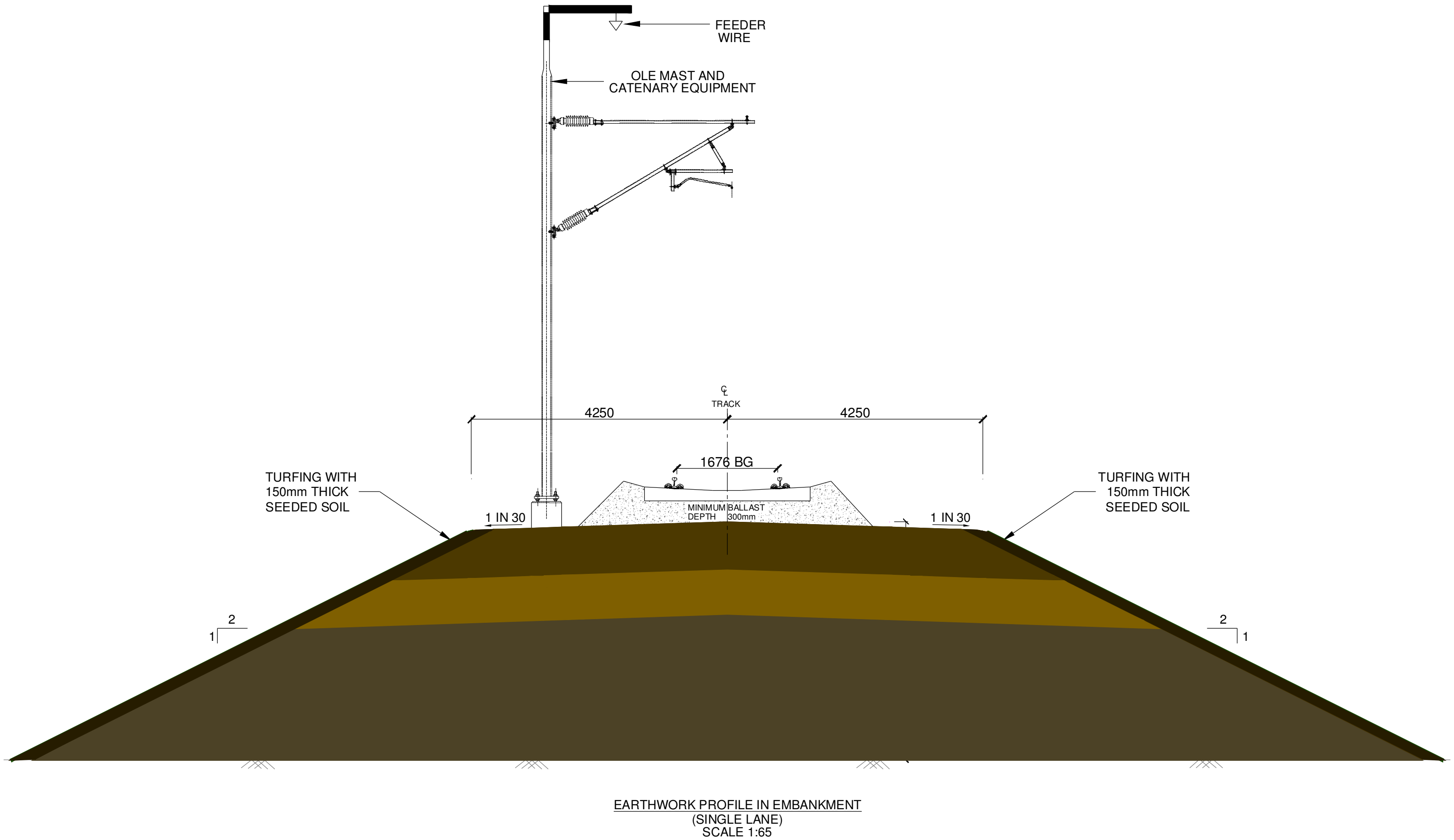


Figure 6.1 : A View of Embankment filled with Earth Blended with Fly Ash / GGBS

6.2.5.4 Compaction And Contamination Of Soil

Impact: Soil in the adjoining productive lands beyond the RoW, haulage roads, and construction camp area may be compacted due to movement of construction vehicles, machineries and equipments. Approach road close to most of the bridge construction sites are available. However, still additional land shall be required for construction camps, and workshops.

Soil may get contaminated due to inappropriate disposal of liquid waste (vehicle/equipment washing effluent) from construction sites, Spill or uncontrolled disposal of waste lubricating oil and grease, vehicular maintenance waste (fuel filters, oily rags, soiled non usable parts), disposal of bitumen waste / waste from hot mix plant and uncontrolled disposal of domestic solid waste and sewage from construction camps.

Mitigation Measures

- Fuel and lubricants shall be stored at the predefined storage location. The storage area shall be paved with gentle slope to a corner and connected with a chamber to collect any spills of the oils.
- All efforts shall be made to minimise the waste generation. Unavoidable waste shall be stored at the designated place prior to disposal. To avoid soil contamination at the wash-down and re-fuelling areas, "oil interceptors" shall be provided. Oil and grease spill and oil soaked materials are to be collected and stored in labelled containers (Labelled: WASTE OIL; and hazardous sign be displayed) and sold off to SPCB/ MoEF authorized vendors.
- To prevent soil compaction in the adjoining productive lands beyond the RoW, the movement of construction vehicles, machinery and equipment shall be restricted to the designated haulage route.
- The productive land shall be reclaimed after construction activity.
- Septic tank or mobile toilets fitted with anaerobic treatment facility shall be provided at construction camp.
- Domestic solid waste at construction camp shall be segregated into biodegradable and non-biodegradable waste. The non-biodegradable and recyclable waste shall be sold off. Biodegradable waste shall be compacted in mechanised and movable composter. Non-biodegradable and non-saleable waste shall be disposed off to authorised landfill site. If land fill site not available then the waste shall be buried in a secured manner.

Operation Stage

Impact: Soil contamination and compaction is not anticipated during operation stage of the project hence, no mitigation proposed.

6.2.6. Water Resources

6.2.6.1 Ground Water

Design and Construction Stage

Impact: The water required for construction is proposed to be extracted from ground. The proposed corridor is passing through (i) Over-exploited (Jagadhri and Mustafabad in YamunaNagar district of Haryana, Sirhind, Khanna, Rajpura in district Fetehgarh Sahib, Ludhiana, Patiala of Punjab respectively) (ii) Critical (Barara, Doraha in district Ambala of Haryana, and Ludhiana in Punjab respectively) and (iii) Semi-critical (Gulaoti, Khatauli, Deoband in district Bulandshahr, MuzafarNagar, Saharnapur respectively in Uttar Pradesh) areas from ground water availability perspective. As per an estimate about 1.44 million cubic meter of water shall be required for the construction of 404.098 Km embankment over the construction period of 5 years. Withdrawal of such a large quantity of water particularly in the overexploited area can deplete the ground water resources and thereby affect the availability of water for competing users. The estimated annual water requirement in the overexploited area of Jagadri, Mustafabad, Sirhind, Khanna, Rajpura section of DFC is 292,000 m3. This much quantity of water can be extracted only with prior permission from CGWA and with the adequate provision of rain water harvesting.

Mitigation Measures

Preference shall be given to source water from Rivers and canal wherever feasible with permission from irrigation department. Since the test results of few of the River water shows some form of contamination, suitability of River water must be established first through laboratory tests before its use in construction. The availability of water is also limited since most of these Rivers except Yamuna near YamunaNagar are not perennial in nature.

Since ground water can be withdrawn only after adoption of appropriate scheme of water harvesting, adequate planning and provision has to be made in design and budgets for the same. An assessment of rain water harvesting potential in about 100 Km stretch of over exploited area was made. As per the assessment the annual run-off volume in 50 meters width and 100 km long stretch is 100000 m3. The maximum probable precipitation in a day of the critical areas YamuNagar, Fategarh Sahib, Ludhiana and Patiala districts are 520 mm, 440 mm, 400 mm and 440 mm respectively. The annual average rainfalls of these areas are in the range of 800 - 1000 mm. If rain water recharges pits of 3.5 m diameter and 4 m length are built and about 30 minutes is assumed as retention time then about 650- 700 numbers of these bore wells are required to recharge the maximum quantity of rain water in this 100 km critical stretch. The cost of constructing these rainwater harvesting pits would be approximately INR 250 million. However, an intensive study needs to be carried out before rain water harvesting plans are implemented. The study should include the identification of the requirement of pits or watersheds in the areas. Also the depth of the rainwater harvesting pits 4m used in the above calculations needs to be checked out with existing geological formation of the area. The depth of bore wells should penetrate through the impervious layer and confined aquifers for proper recharge of the underground water resource. Also proper management of these rainwater harvesting pits in the operation stage would entail certain precautionary measures. Alternate water harvesting option like pond based harvesting shall also be studied.

The check dams shall also be constructed wherever feasible and in consultation with community to reduce burden on ground water resources. This shall form part of project design and included in the bill of quantity.

Efforts shall be made that water intensive activities are not undertaken during summer period (April, May and June).

Operation Stage

Impact: Groundwater will be abstracted for domestic purpose as well for staff quarter areas. The stress on groundwater will increase though marginally at these locations as well.

Mitigation Measures

Stress on groundwater may be reduced by augmenting it through rainwater harvesting. Wherever, installation of harvesting structures is not technically feasible, rainwater may be collected in sumps which can be used for various usages other than drinking and domestic purpose.

6.2.6.2 *Surface Water*

Design and Construction Stage

Impact: There are many rivers and canals crossing the alignment as summarised below. The summary of Major canals and rivers are given **Table 6.9**. Many of the rivers are non-perennial in nature and remain dry most of the time of the year. No impact is anticipated in these dry rivers. Short-term impact in terms of increase in water siltation level may occur during bridge construction over the perennial rivers. However, water level in these rivers is also low throughout the year except during monsoon. Construction activities can be undertaken without causing any impact on river water. However, any uncontrolled discharges (waste oil, construction vehicle maintenance waste) form construction sites near the water body may pollute the river/canal water.

Table 6.9 : Summary of Major Canals and River Crossing the DFC alignment

Chainage	Water Body	Water Availability	Water Quality
0- 50 Km	Upper Ganga Canal	Controlled Flow	Irrigation quality
51-100 Km	None	Not Applicable	Not Applicable
101-150 Km	Upper Ganga Canal	Controlled Flow	Irrigation quality
151-200 Km	Kali River Upper Ganga canal	Perennial Controlled Flow	Irrigation Quality Irrigation Quality
201 – 250 Km	Hindan River Eastern Yamuna Canal Kali River Yamuna River	Perennial Controlled Flow Perennial Perennial	Polluted Irrigation Quality Irrigation Quality Irrigation Quality
251 – 300 Km	Western Yamuna Canal Rakshi River Saraswati River Markanda River Dangri River	Controlled Flow Non Perennial Non Perennial Non Perennial Non Perennial	Irrigation Quality Irrigation Quality Irrigation Quality Irrigation Quality Irrigation Quality
301 – 350 Km	None	Not Applicable	Not Applicable
351 – 400 Km	Bhakra Canal Sirhind Canal	Controlled Flow Controlled Flow	Irrigation Quality Irrigation Quality

Alteration of watercourse flow and channel morphology is not envisaged since prior extension on most of the major bridges is already available. Hence, impact on aquatic life is considered insignificant. However, the mitigation measures recognize the unavoidable situation when additional piling work will be required for the doubling of the bridges.

Mitigation Measure

The piling work shall be undertaken during low flow period. Attempt to reduce number of pillars in the water stream will be undertaken considering the river hydrology and morphology and the bridge shall be designed based on 100 years return, highest water level, right angle to the river flow to the extend feasible. The changes in the stream, if any, made during construction shall be restored to its original level. Precautions shall be made that no nala or canal is clogged. Following additional measures shall be adopted :

- Substructure construction should be limited to the dry season and cofferdams may be constructed and utilized to lift the spoil directly out of it and carried to the riverbank for land disposal.
- The slopes of embankment leading to water bodies shall be modified suitably to restrict the contaminants entering water bodies.
- Silt fencing and/or brush barrier shall be installed for collecting sediments before letting them into the water body. Silt/sediment should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated.
- Large construction camps shall be avoided along the alignment and located away from habitated areas and water bodies. Construction labourers shall be preferable from local population. Sewage from labour camps shall be treated through septic tanks. Untreated sanitary wastewater shall not be discharged into any surface water bodies.
- Prior permission from competent authority shall be taken before drawing surface water for construction purpose.
- Water quality shall be monitored as envisaged in the Environmental Monitoring Plan

Operation Stage

Impact: By and large, no impact is anticipated during the operation phase on the surface water bodies. However, regular monitoring shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels to avoid their blockade/ choking. Regular monitoring of siltation shall be done. Due to electrified movement, no contamination risk associated with diesel engine movement is anticipated.

6.2.6.3 Effect on Drainage pattern

Design and Construction Stage

Impact: Drainage pattern were changed partly with the construction of existing Indian Railways. Though adequate provision of cross drainage structure are made, but many water logged areas along the existing Indian Railways corridor were identified as listed at Table 6.9. The reason of water logging was identified as (i) unavailability of drainage network (ii) uncontrolled discharge of domestic waste by the nearby residents (iii) uncontrolled discharges by nearby industries (iv) accumulated rain water mostly due to non rehabilitation of borrow earth areas. Ineffective provision of drainage network while constructing the embankment will worsen the situation.

Disposal of logged but polluted water disposal will be a problem and its uncontrolled disposal may contaminate the receiving body.

The drainage pattern varies all along the River but mostly sloping towards the embankment from one side and moving away from the other side. There are few locations where drainage is sloping towards the embankment from both the sides that make these locations as water logging prone areas. Provision of adequate cross drainage structures is made in the project design, which has minimised any impact on the drainage pattern of the alignment and detour areas.

Table 6.10 : Water Accumulation Locations Along the track

Section	Chainage	Nearest Drain Present	Slope
Ch. 00 - 100 km	36.6	Dasna Distributary	NW-SE
		Upper Ganga Canal	NW-SE
	57	Chhoiya Nala	NW-SE
	62.5	Chhoiya Nala	NE-SE
	62.8	None	
	78	Kharauti Drain	NW-SE
Ch. 101 - 200 km	110	Abu Nala	N-S
		Daurala Distributary	NW-SE
	121	Daurala Distributary	NW-SE
	131	Khatauli Drain	NW-SE
	138	Upper Ganga Canal	NE-SW
	157	Jarauda Distributary	NE-SW
	172	Bastam Distributary	NE_SW
	182	Deoband Ghalauti Drain	NE-Sw
	189	Sakhan Minor	N-S
	200	Kali Nadi West	N-S
Ch. 201 - 300 km	223	Eastern Yamuna Canal	NE-SW
	235	Kala Nala	NE-SW
	243	Branch of Western Yamuna Canal	NE-SW
	253	Nearby natural drainage	NE-SW
	268.5	None	
	268.8	Nearby natural drainage	NE-SW
	276	Chainage of Bentan nadi	NE-SW
	281	Chainage of Bentan nadi	NE-SW
		Markanda River	NE-SW
	300	Nearby natural drainage	NE-SW
Ch. 301 -400 km	301	Nearby natural drainage	NE-SW
	309 on both side of the track	None	

Section	Chainage	Nearest Drain Present	Slope
	325	Nearby natural drainage	NE-SW
	336	None	
	357	Bhakra canal	NE-SW
	372	None	
	379	None	
	382	Pail Minor canal	NE-SW
	386	None	
	397	None	

Mitigation Measure

Adequate provision of drain shall be made on both side of the embankment for channelizing the collected rain water to the nearby water bodies. Direct discharges of domestic waste from the nearby residents should be stopped. Interaction shall be made with concerned development authorities to provide drainage and connection to city sewages network.

Drainage flow shall be analysed again and provision of cross drainage structures if not already made shall be constructed.

It will be ensured that cross drainage structure are not blocked.

The water quality of the accumulated waste water shall be analysed before disposal. Depending on characteristics of the accumulated water, it shall be used either for irrigation, or disposed to city sever if sewer lines are available. In case of non availability of sewerlines a suitable mechanism to treat this waste water will be developed in consultation with local civic authorities.

Operation Phase

Periodic visual check shall be made along the corridor to identify any new water logged areas as well old areas. Corrective action shall be taken to prevent larger accumulation of water if any water logging is noticed.

6.3. Impact on Biological Environment

6.3.1. Terrestrial Ecology

6.3.1.1 *Disturbance To Vegetation*

Design and Construction Phase

Impacts: There would be no major impact on terrestrial flora other than the cutting of trees during project implementation in the EDFC Khurja to Ludhiana Stretch. Except Gagoul reserve forest and Kalanur protected forest no other important reserved forest or sanctuary, national park etc. are present in this area. The natural terrestrial ecosystem (bio-diversity) of the area has already been altered by conversion into agricultural lands in the entire project stretch. Most of the vegetation present in the area was plantations done by the Department of Forest and Public which were under the private ownership. However Kalanur Protected Forest which is covered mostly by planted trees, present at Chainage km 243 near the Yamuna River and Gagoul Reserved Forest present in Meerut detour area where the proposed track will pass through it by 650 meter in length also covered by plantations, will be impacted by the proposed project. The impact will be in terms of loss of trees.

A total tree cutting in the corridor of impact has been estimated as 5707. In most of the area, the trees are located close to the existing track (maximum of 10m from the track). The trees in the EDFC Khurja to Ludhiana stretch were mostly of Populus Deltoids, Eucalyptus-Eucalyptus globules, Shisham or Indian Rosewood- Dalbergia sissoo, Aam or Mango-Mangifera indica and Neem- Azadirachta indica etc. These trees are matured trees with an average age of about 5-15 years. Construction of the new EDFC corridor parallel to the existing track will result in cutting of trees as given below in **Table 6.11.**

Table 6.11 : Total Tree Species present in DFC Project Stretch including Detour area

S. No.	Chainage (from)	Chainage (To)	No. of Trees within 50 meter of Existing IR track
1	0	50	557
2	51	100	593
3	101	150	370
4	151	200	816
5	201	250	988
6	251	300	890
7	301	350	1200
8	351	400	293
Total=5707 Trees To be cut on the sides of the existing track.			

Mitigation Measures.

Efforts shall be made to minimise the tree loss. Provision shall be made for compensatory plantation as per directives of forest clearance. Plantation programme shall be initiated parallel to construction activity. The native and existing vegetation profile shall be maintained during plantation programme, so that local inhabitants can utilize their resources. Indigenous plants namely Pakori-Ficus rumphii, Amlakhi-Phylanthus embilica, Kadam-Anthrocephalus cadamba, Melia azedarach, Jack Fruit-Artocarpus heterophyllus, Jujube-Zizyphus jujuba,Simul- Bombax ceiba,Siris-Albizia lebbek, Bauhinia-Bauhinia purpurea, Krishnasura-Delonix regia, Khair- Acacia catechu, Neem-Azadirachta indica, Shisham or Indian Rosewood- Dalbergia sisoo, Pipal or Bo Tree - Ficus religiosa, Barh or Banyan- Ficus benghalensis, Aam or Mango-Mangifera indica, Jamun or Java Plum- Syzygium cumini, Imli or Tamarind- Tamarindus indica, Mitha Jal or Pillu- Salvadora indica, Khara Jal or Pillu - Salvador persica , Khejri- Prosopis cineraria, Guava- Psidium guajava etc. shall be preferred. Aforestation shall be undertaken with community participation.

If enough land is not available with Indian Railways for planting the trees, the additional tree plantation shall be made in consultation with forest department.

Operation Phase

Impact: No direct impact is anticipated during operation stage except accidental damages or absence of tree management practices.

Mitigation Measures.

Arrangement shall be made for effective tree management to ensure survivability of the tree plantation. Effective tree management shall include the selection of healthy sapling; selection of fertile land for plantation; provision of fertilizers (Bio-fertilizer or artificial-NPK); provisioning of fencing in the plantation area; arrangement of watering facility after plantation. Since the area is lack of sufficient precipitation, so provisioning of sufficient watering is very important which will increase the rate of survivability of the tree saplings planted. Watering should be continued till the saplings or plants reached the height of 1.5 meter. The Department of Environment and Forest - Social Forestry Wing may be consulted or involved in this programme as they have the community participation provisions under the Joint Forest Management. The tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the programme.

6.3.1.2 Forest Fragmentation And Destruction

Design and Construction Phase

Impact: Forest fragmentation will occur in the Gangoul reserved forest in the Meerut Detour area as the proposed alignment will bisect the forest for a stretch of 650 meter (extracted from CAD Map of Scott & Willson) length and 100 meter breadth. However in the Kalanur Protected forest no new fragmentation of the forest habitat will be created since the existing track is already bisecting the forest. In both Gangoul reserved forest and Kalanur protected forest no major mammalian species is present though birds were seen to be present. There will not be any major impact on the birds present in this forest as they were arboreal (means lives on tree/ fly on air/ rarely comes to ground).

Mitigation Measures

Since only in the Meerut Detour area fresh habitat fragmentation will occur; tree loss will occur in the Gangoul Reserved forest hence provision shall be made for planting three trees for one tree cut in the open area near the forest. Plantation programme shall be initiated parallel to construction activity.

Budgetary provision shall also be made to meet regulatory obligation for diversion of reserve forests, which will include costs of land equal to the size of forest land being diverted for non forests purposes and other net present value to be assessed by respective forests officer

Operation Phase

Impacts: No direct impact is anticipated during operation stage except accidental damages or absence of tree management practices.

Mitigation Measures

Arrangement shall be made for effective tree management to ensure survivability of the tree plantation. Effective tree management means the selection of healthy sapling; selection of fertile land for plantation; provision of fertilizers (Bio-fertilizer or artificial-NPK); provisioning of fencing in the plantation area; arrangement of watering facility after plantation. Since the area is lack of sufficient precipitation so provisioning of sufficient watering is very important which will increase the rate of survivability of the tree saplings planted. Watering should be continued till the saplings or plants reached the height of 1.5 meter. The Department of Environment and Forest - Social Forestry Wing may be consulted or involved in this programme as they have the community participation provisions under the Joint Forest Management. The tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the programme. Any loss more than 10% may be made at the beginning of monsoon season.

6.3.2. Migratory Route of Terrestrial Fauna

Design and Construction Phase

Impacts: No definite and permanent migratory route of wildlife species in entire EDFC Khurja to Ludhiana stretch was found. Amphibian species, reptilian species, Nilgai and Wildboar has been seen to cross the railway line without following any definite path or route.

Mitigation Measures

Since there are no definite migratory routes of the terrestrial fauna hence no mitigation measures can be suggested.

Operation Phase

Collision between the animals and rail cars may occur during the crossing over of the rail tracks by the animals.

Mitigation Measures

Cross structures should be designed to allow safe passage for animals, promote habitat connectivity, be accessible, and encourage natural movements. The cross structures may be in the form of exclusion fences, culverts, underpass systems.

6.3.2.1 *Endangered Species*

Design and Construction Phase

Impacts: No impact is anticipated on any endangered, vulnerable, schedule species in EDFC Khurja to Ludhiana stretch. There was one vulnerable species (IUCN Red list) found in the area i.e. Sarus crane along with one Schedule-I (IWPA 1972) species i.e. Gyps bengalensis.

Mitigation Measures

Since they preferred an arboreal life hence no disturbance to them will be occur during the construction of the new track, hence no mitigation measures can be suggested.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to endangered, vulnerable, schedule I species.

6.3.2.2 *Effect On Birds Nesting Colonies*

Design and Construction Phase

Impacts: There were altogether 274 nests present on the trees close to the track, which may be impacted due to cutting of trees or due to construction activities.

Mitigation Measures

During the period of construction, care should be taken to minimize the cutting of the nesting trees in the impact zone if possible. In order to minimise disturbance to the birds the cutting may be taken up during falling of leaves. The necessary consultations ***in this regard may be taken from the Forest and Wild life Department.***

.Operation Phase

Impacts: No impact is anticipated during operation stage with regards to nesting trees get acclimatized soon to traffic or other noise. This was established with presence of one big nesting (i.e. Birds nesting colony with more than 300 nests) colony found near to the track. This was a Cattle egret colony at Chainage 172 km. This the colony is 120 meter far from the existing railway track and is very close (500 m) to Rohana Railway station and 5 m away from the Muzzafar Nagar – Saharanpur highway. .The occupant of this nesting colony was found to be aclimatized to the noises of vehicular traffic noise created by trains.

6.3.3. Aquatic Ecology

6.3.3.1 *Effect on Fish Diversity*

Design and Construction Phase

Impacts: In the stretch of Ludhiana to Khurja DFC proposed project fish fauna occurred in every Rivers and canals present. But the species diversity of fish fauna (3.306) is highest in the Yamuna River than the other areas. The dumping of the mud, land, sand into the River water during the construction will impact the fish diversity and abundance in the Rivers, canal and water body areas.

Mitigation Measures

Provision shall be made in the design to ensure the minimal deposition of mud, land, sand into the River water and minimising the noise during the construction. Attention should be given for Yamuna River in this regard. The flow of the water in the Rivers and canals shall be maintained atleast through one side of the River channel or canal to maintain the normal activities of the fishes and other life forms in the study area.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to fish activities.

6.3.3.2 *Effect on Plankton Diversity*

Design and Construction Phase

Impacts: The Rivers, canals present in the stretch of Ludhiana to Khurja EDFC proposed project have considerable diversity of phytoplankton and zooplankton population in the project area. A total of 48 phytoplanktons were found in Khurja to Ludhiana EDFC corridor. The total density of phytoplanktons ranged from 964 ind. m-2 to 1,832 ind. m-2.

A total of 99 numbers of zooplanktons were found. Density of zooplankton was present in the range of 9 –25 ind. l-1 in the entire project area. The diversity range was narrow at all the sites. The results indicate poor diversity of zooplankton in the waterbody though they were found in the higher range in the Yamuna River and Ganga canal.

The deposition of mud, land, sand into the River water will decrease the level of dissolved oxygen and increase the level of turbidity will have adverse impact on the diversity and abundance of the planktons in the water.

Mitigation Measures

Provision shall be made in the design to ensure the minimal deposition of mud, land, sand into the river water to maintain the turbidity level and dissolved oxygen level at standard level (low turbidity) for the survival of planktonic life. The flow of the water in the rivers and canals shall be maintained at least through one bank of the river or canal to maintain the normal activities of the planktons in the study area.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to planktonic life forms.

6.3.3.3 *Effect on Aquatic Avian Diversity*

Design and Construction Phase

Impacts: Aquatic avian diversity present in the Rivers and canals of the stretch of Ludhiana to Khurja EDFC proposed project is not very high with the exception of Yamuna River area. The dumping of the mud, land, sand into the river water will decrease the availability of food such as aquatic fauna, vegetation to the aquatic avifauna. The noise during the construction will have adverse impact on the aquatic avian behaviour due to which they will not prefer to stay in the area.

Mitigation Measures

Provision shall be made in the design to ensure minimal deposition of mud, land, sand into the river, canal water to maintain productivity of aquatic ecosystem and availability of food such as aquatic fauna, vegetation to the avian fauna. Minimising the noise during the construction will be helpful to maintain the species diversity of the aquatic avian fauna in different rivers and canals. The flow of water in the rivers and canals shall be maintained at least through one of the river channel or canal to maintain the normal activities of the aquatic avifauna in the study area.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to aquatic avifauna.

6.3.3.4 *Migratory Routes(Fish)*

Design and Construction Phase

Impacts: The game or sports fish species like Tor tor (also an endangered species according to the NBFGR report) shows migratory behaviour through the deeper channels of the River Yamuna. They migrate through the main channel of the river i.e. through the deeper zones of the river only during the high level of water i.e. during the monsoon season from upstream to downstream. So their movement will get impacted if the flow of the water through the Yamuna River is disrupted.

Mitigation Measures

The flow of the water in the Rivers and canals shall be maintained atleast through one side of the river channel or canal to maintain the migration environment for the migratory fishes.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to Tor tor activities.

6.3.3.5 *Effect on Spawning and Breeding Grounds*

Design and Construction Phase

Impacts: Along the whole stretch of EDFC Khurja to Ludhiana stretch, the fish spawning and breeding ground were recorded only in the Yamuna River. Major and minor carp used to spawn in different areas of current channel of the river in the different zones at different depths. However it is not possible to demarcate specific locations as the fish spawing and breeding ground.

Mitigation Measures

The construction activity should be restricted during the breeding period of April to August at above breeding sites. All care shall be taken to ensure that construction waste does not find its way to water in this area and pollute it.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to fish activities.

6.4. Impact on Socio-Economic Environment

Impact: The proposed project will contribute in social and economic development of the region. No negative social impact is anticipated except minor land acquisition and relocation of few structures. The proposed projects shall result in increased employment opportunities for local people during construction stage. Immigration of work force during construction phase is likely to be very less. The demographic configuration will be largely unchanged since majority of the workers will be from local population. Bottlenecks at level crossings where traffic congestion is high shall be removed by providing road over bridges. Underpasses near sensitive locations and where there is habitation on both sides shall reduce accident risks and improve social interaction between communities.

During operation phase of the project, significant socio-economic development will take place in the region. The proposed project will enhance the traffic scenario by providing ROBs and flyovers.

As per Social survey, 39 community structures are likely to get affected. Other structures have already been saved by suitable modifications in the alignment design/finalisation.

6.5. Environmental Matrix

Based of the potential impacts on natural resources in planning construction and operation phase an impact matrix has been created. The scale of impact is discussed above under individual parameter with mitigation measures. The Environmental Impact Matrix for pre-construction and construction stages are provided in **Tables 6.12**and **6.13** respectively.

Most of the impacts are localized, insignificant and temporary in nature, except those related to noise and vibration during the operation phase.

Table 6.12 : Impact Matrix (Pre-Construction & Construction Stage)

S.No.	Items	Overall Evaluation on the Project	Pre-construction Stage			Construction Stage											
			Surveying of Planned Areas and Sites	Selection of the Project Location and Sites	Land Acquisition and Resettlement	Extraction of Building Materials (stones, aggregates, sand, soil, etc.) at Quarries and Borrow Areas	Earth Moving: Cutting and Filling of the Construction Works	Preparation of Construction Plants, and Warehouses, Work Camps, etc.	Operation of Construction Plants, Machines and Vehicles for Construction Works	Construction Works for railway line and related structures						Localized Employment Opportunities of the Construction Works	Localized Business Opportunities Related to the Construction Works
										(A) Construction Works for Railway Lines and Installation of Related Facilities (signals, rails, etc.)	(B) Construction Works for ICDs and Freight Logistic Parks	(C) Construction Works for Stations (Terminal, Junction and Crossing)	(D) Construction Works for ROBs and RUBs	(E) Construction Works for Bridges	(F) Construction Works for Tunnels		
1	Topography and Geology	C	D	D	D	C	C	C	C	C	C	D	D	C	E	E	C
2	Soil	B	D	D	E	B	B	C	C	C	C	B	D	D	E	E	E
3	Groundwater	C	D	D	C	D	D	D	D	D	D	D	D	D	E	E	E
4	Hydrological Condition	D	E	E	E	D	E	D	D	D	D	D	D	C	E	C	C
5	Fauna, Flora and Biodiversity	D	D	C	C	C	C	D	C	C	D	D	D	D	E	D	D
6	Protected Areas / Sanctuaries	E	D	D	D	D	D	D	D	D	D	D	D	D	E	D	D
7	Landscape	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
8	Local Meteorological Conditions	E	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
9	Global Warming	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Table 6.13 : Environmental Impact Matrix (Post Construction Phase)

S.No.	Project Activities / Items of the Environment Subject to Positive / Negative Changes	Traffic conditions of passenger trains	Logistic conditions of goods, raw materials, agro & industrial products	Traffic condition of roads	Operation & maintenance of railway lines & related structures	Employment opportunities (whole country / local level)	Freight oriented business opportunities	Passenger oriented business opportunities	Promoting development of surrounding areas	Increase in settlers & vision to the project area
1	Topography and Geology	C	D	D	D	D	C	C	C	C
2	Soil	E	D	D	E	D	E	C	C	C
3	Groundwater	E	D	D	C	D	D	D	D	D
4	Hydrological Condition	E	C	C	C	D	C	D	D	C
5	Coastal and Marine Environment	Not Applicable								
6	Fauna, Flora and Biodiversity	D	D	C	C	C	C	D	C	C
7	Protected Areas / sanctuaries	E	D	D	D	E	D	D	D	D
8	Landscape	E	D	D	D	D	D	D	D	D
9	Local Meteorological Conditions	E	D	D	D	D	D	D	D	D
10	Global Warming	E	D	D	D	D	D	D	D	D

Table 6.14 : Scaling of Impacts on Natural environment due to DFC Section from Khurja -Ludhiana

IDENTIFICATION, PREDICTION & EVALUATION OF IMPACT

S.No.	Natural Environment Contents	Scaling	Reasons (during construction phase)	Reasons (after-construction phase)
1	Topography and Geology	C/ D	C-During construction marginal changes in Topography are likely to take place because of excavation, construction of bridges, embankment etc. 2) No significant change in Geology is anticipated as requirement of construction material is not significant.	D: Negligible impact, no change is expected.
2	Soil Erosion	C/D	C-During construction marginal effect on soil because of erosion is likely to take place due to the loss of upper crust of soil in the local area. The impact will be marginal only since the project is linear in nature.	D: Negligible impact
3	Ground water	D	D: Negligible impact is likely to occur There will be requirement of about 2000 litres/day for every 15 km length	D: Only marginal impact is supposed to be felt. As there will be requirement of water for operation of stations.
4	Hydrological Condition	D	D: negligible, no river involved	D: no significant impact.
5	Costal and Marine Environment	E	E: No impact	E: No impact
6	Fauna, Flora and bio diversity	D	Cutting of trees and removal of vegetation from RoW will resut in loss of marginal herbal cover.	D: Only marginal impact is supposed to be felt.
7	Protected areas, Natural/ecological reserves and sanctuaries	E	E: Negligible impact, no such area is getting directly affected. It is not within 10 km radius	D: Negligible Impact
8	Landscape	D	D: Negligible impact	D: Negligible impact.
9	Local meteorological condition	E	E: No impact	D: Negligible impact
10.	Global Warming	E	E: No impact	Positive impact as shifting of freight transportation from road to rail will decrease the emission of greenhouse gaseous
11.	Air Pollution	D	D : Negligible impact	Positive impact due to shifting of freight transport from road to rail as rail transport requires six times less fuel as compared to road

6.6. Accident Risk and Safety

Design and Construction Stage

Various safety aspects related with the project during design construction phase are (i) pedestrians safety (i) safety related with handling of machines, equipments (ii) rail safety at road intersections and (iii) safety to cattles and other wild animals; (iv) unsafe/hazardous traffic conditions due to construction vehicle movement.

Mitigation measures

- During the construction phase, contractors shall be required to adopt and maintain safe working practices. Usage of appropriate signage in local language at the construction sites shall be displayed generously and visibly to make the travellers aware of the ongoing work. Adequate lighting and fluorescent signage shall be provided at the construction sites.
- Pedestrian passageways shall be provided near settlement and sensitive (hospitals, schools, religious locations) locations. DPR consultant shall identify and finalise these locations while finalising the designs.
- Separation of two-way traffic by solid white centre lines or physical medians, and separation of slow and fast road traffic at the railway level crossing.
- Training shall be provided to workers, especially machinery operators, on safety procedures and precautions. Helmet will be required at all construction sites. The contractor will be required to appoint a safety officer who will conduct regular safety inspections at construction sites.

Operation phase

Important issues related with safety during operational phase is monitoring of emergencies and establishing procedures to carry out rescues during sudden disasters such as , fires, high winds, and accidents. Accidents risks are higher in habitated areas particularly where children need to cross the track in absence of any pedestrian crossings

Mitigation measures

Emergency equipment will be made available at stations along the alignment and personnel will be trained to serve on rescue teams. To further ensure public safety, the entire right-of-way will be fenced. Pedestrian passageways shall be constructed under the raised railway embankment to allow people to cross from one side of the track to the other in populated areas. All road crossings will be grade-separated. Use of latest railway operational mechanism is recommended to avoid derailment, collisions, and other accident risks.

6.7. Impacts due to Construction Camp

Poor sitting and improper management of construction camp may lead to several adverse impacts on environment land and water bodies.

Mitigation measures

Construction camp shall be located considering its accessibility to all social and physical infrastructures to utilize the available resources in the region. No productive land should be utilised for setting up of construction camp. All camps shall be well drained. All sites must be graded, ditched and rendered free from depressions such that water may get stagnant and become a nuisance. The living accommodation and ancillary facilities for labour shall be erected and maintained to standards and scales approved by the resident engineer. All camps should maintain minimum distance of 500 m from habitation, water bodies through traffic route and 1000 m from forest areas.

All construction camps shall be provided sanitary latrines and urinals with provision of septic tanks attached with soak pits. Storm water drains shall be provided for the flow of used water outside the camp. Drains and ditches shall be treated with bleaching powder on a regular basis. Compliance with the relevant legislation must be strictly adhered.

Garbage bins shall be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner. LPG cylinders shall be provided as fuel source for cooking to avoid any tree cutting.

At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided. Workplaces remote and far away from regular hospitals shall have indoor health units with one bed for every 250 workers. Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital. At every workplace, an ambulance containing the prescribed equipment and nursing staff shall be provided.

At every construction site, provision of a day crèche shall be worked out to enable women to leave behind their children. At construction sites where 20 or more women are ordinarily employed, provision shall be made for a hutment for use of children under the age of 6 years belonging to such women.

6.8. Right-of -Way Maintenance

Design and Construction Stage

Unchecked growth of trees and plants can cover signals, fall onto the tracks and prevent workers from getting to places of safety when trains are passing. Regular maintenance of rights-of-way to control vegetation may involve the use of mechanical methods (e.g. mowing), manual methods (e.g. hand pruning), and use of herbicides. Vegetation maintenance beyond that which is necessary for safety may remove unnecessary amounts of vegetation, resulting in the continual replacement of succession species and an increased likelihood of the establishment of invasive species.

Mitigation Measures

Recommended measures to prevent and control impacts from right-of-way vegetation maintenance include:

- The track area shall be kept completely clear of vegetation. From the edge of the track area to the boundary of the right-of-way, vegetation should be structured with smaller plants near the line and larger trees further away from the line to provide habitats for a wide variety of plants and animals.
- Native species shall be planted and invasive plant species removed.
- Railways should be designed and maintained to discourage plant growth in the track area (e.g. providing lateral barriers to plant migration and ensuring rapid drainage of the track area);
- Biological, mechanical, and thermal vegetation control measures shall be used where practical, and use of chemical herbicides on the bank beyond the transition area should be avoided (approx. 5 meters from the track);
- Personnel shall be trained in herbicide application to control fast-growing vegetation within RoW.

6.9. Impact due to Electrical, Signalling,Communication facilities.

The electrical, signalling and communication facilities are unlikely to cause any significant impact since the corridor is proposed to be constructed largly along the existing electrified rail and also majority of the stretches passes through agriculture field/open field. Some occupational health effect may occur which is defined under subsequent sections .

6.10. Occupational Health and safety

6.10.1. Rail Operation

6.10.2. Train/Worker Accident

Railway workers in the vicinity of rail lines are always at risk of accidents due to moving trains. A set of following mitigative measures can be taken :

- Training to workers on personal track safety procedures
- Blocking train traffic on lines where maintenance is occurring. If blocking is not feasible, use of automatic warning system shall be installed.

6.10.3. Noise and Vibrations

Crewmembers are usually exposed to higher noise levels from locomotives, rolling stocks and machinery and repeated mechanical shocks and/or vibration.

- Reduction of internal venting of air brakes to a level that minimizes noise without compromising the crew's ability to judge brake operation.
- Use of PPE if engineering solutions are not feasible.
- Use of dampers at the seat post to reduce the vibration experienced by the operator.
- Installation of active vibration control system for locomotive suspension, cabs or seat post.

6.10.4. Fatigue

Locomotives engineers and other railway workers are often required to work irregular working hours resulting in fatigue. Fatigue, particularly of dRivers, signallers, maintenance workers is critical to safe operation of Railways, which if not given proper attention may pose serious safety risk to workers/passengers and general public.

- Railway operators should schedule rest periods at regular intervals and during night hours, to the extent feasible, to maximize the effectiveness of rest breaks.

6.10.5. Electric and Magnetic Fields

Railway worker on electric Railway systems may have a higher exposure to electric and magnetic fields (EMF) than the general public due to working in proximity to electric power lines. There is no conclusive link between occupational EMF exposure and adverse health effects

EMF exposure shall be prevented or minimised through the preparation and implementation of an EMF safety program including the following components.

- Implementation of action plan to address potential or confirmed exposure levels that exceed permissible reference occupational exposure levels.

6.10.6. Maintenance of Rolling Stock

Occupational hazards typically associated with locomotive and railcar maintenance activities may include physical, chemical, and biological hazards as well as confined space entry hazards. Physical hazards may be associated with work in proximity to moving equipment and machine safety, including work-portable tools, and electrical safety issues. Chemical hazards may include potential exposures to a variety of hazardous materials (e.g. asbestos, PCB, toxic paint, heavy metals, etc). Biological hazards may include potential exposures to pathogens present in sewage storage compartments. Confined spaces may include access to rail tank and grain cars during repair and maintenance.

Mitigation measures

- use of PPEs by workers during maintenance activities shall be ensured
- Regular checkups and repairing of working platform in workshop to avoid any slippage due to grease & oil.
- Proper collection, storage and disposal of hazardous waste, if any
- Regular assessment of risks presented by wheel sets

6.10.7. Community Health and Safety

The impacts associated with community health and safety is (i) general rail safety, (ii) transport of dangerous goods, (iii) level crossing safety and (iv) pedestrian safety. The impacts and mitigative measures of level crossing safety and pedestrian safety have already been discussed in previous sections. The other two have been described in following paragraphs.

6.11. General Rail Operational Safety

Any slippage in operation may cause threat of serious injury or the potential loss of life due to train collision with other trains or road vehicle and derailment. Recommended actions to avoid any such risk are:

- Regular inspection and maintenance of the rail lines and facilities to ensure track stability and integrity in accordance with national and international track-safety standards.
- Implementation of an overall safety management program that is equivalent to internationally recognized railway safety programs.

6.12. Transport of Dangerous Goods

- Proper screening, acceptance and transport of dangerous goods will be made in line with the international standard applicable for packaging, marking and labeling of containers.
- Use of tank cars and other rolling stocks that meets the national and international standards.
- Preparation of spill prevention and control and emergency preparedness and responsive plans based on an analysis of hazards, implementation of prevention and control measures.

6.13. Pedestrian Safety

Trespassers on rail lines and facilities may incur risks from moving trains, electrical lines and equipment, and hazardous substances. Measures to minimize, prevent or control trespassing include

- Posting of clear and prominent warning signage at potential points of entry to track areas (e.g. stations and level crossing).
- Installation of fencing of other barriers at stations ends and other locations to prevent access to tracks by unauthorized persons.
- Local education, especially to young people, regarding the dangers to trespassing.
- Designing stations to ensure the authorized route is safe, clearly indicated, and easy to use.
- Use of closed – circuits television to monitor rail stations and other areas where trespassing occurs frequently, with a voice alarm system to deter trespassers.

6.14. Chance Find

Any archaeological article or structure found during construction shall be as per the provision of the Rules.

6.15. Summary of Impacts

With implementation of proposed mitigation measures the residual impact in most of cases is expected to be insignificant. The summary of impacts/ mitigation measures & residual impacts is given in **Table 6.15.**

Table 6.15 : Summary of Environmental Impacts and Residual Impacts

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
DESIGN AND CONSTRUCTION PHASE				
Climate	Cutting of trees may affect the local climate	Moderate	Compensatory Plantations in the ratio of 1:3	Insignificant
Natural Hazard	Earthquakes may cause failure of civil structures	significant	Relevant IS codes for earthquake resistance while designing civil structures such as bridges, flyovers, underpasses, etc.	Insignificant
Air Quality	Air quality may get affected due to construction activities	Significant	▪ Certain dust and fugitive emission prevention and control measures ▪ Plantations ▪ Construction RoBs/RuBs to prevent vehicular pollution	Moderate
Noise and Vibration	Increase in ambient noise levels	Moderate	▪ Timely serviced and properly maintained equipment s to minimize its operational noise ▪ Stationary noise making equipment placed away from populated areas ▪ Provision of temporary noise barrier ▪ PPEs to workers ▪ Soil compaction and sand pockets near vibration prone areas.	Insignificant
Soil				
Land Use	Change in Land Use because of land acquisition and change in topography due to borrow areas	Moderate	▪ Minimization of land acquisition to the extent possible ▪ Proper borrow area management	Moderate
Productive Soil	Loss of productive	Moderate	▪ Top soil preserved and reused for	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
and Soil Erosion	soil due to Borrow areas and eosion at River banks, embankment areas of detours, bridge approaches		plantations ▪ Repairing of River banks after construction ▪ Cross drainage structures to prevent water logging and thus soil erosion ▪ Turfing of embankment slopes ▪ Surface slope stabilization prior to seeding	
Illegal Quarrying	Impact on soil and land topography	Insignificant	▪ Borrow area management ▪ Alternate material like GGBS and fly ash	Insignificant
Compaction and contamination of soil	Compaction due to movement of construction vehicles and machineries and contamination due to disposal of effluent, leaks and spills and waste	Moderate	▪ To prevent compaction movement of vehicles and machineries through designated haulage route ▪ Fuel and lubricants to be stored at the predefined storage location ▪ "Oil Interceptors" at the wash-down and re-fuelling areas to avoid soil contamination ▪ Proper solid waste management at construction camps	Insignificant
Water Resources				
Water quality (Surface and Ground)	Impact on surface and ground water quality Depletion of ground water Contamination of water due to construction waste Contamination of water from fuel and lubricants	Significant	▪ Provision of Rainwater harvesting structures ▪ Collection of rainwater in sumps ▪ Septic tanks shall be provided to treat the domestic sewage from construction camps. ▪ Construction work close to the channels or other water bodies to be avoided. ▪ Construction camps to be located away from water bodies and	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
			habitated areas ▪ All necessary precautions to be taken to construct temporary devices to prevent water pollution due to increased siltation and turbidity. ▪ Oil and grease traps to be provided at fuelling locations, to prevent contamination of water. ▪ Slopes of embankment leading to water bodies to be modified and screened so that contaminants do not enter the water channel/ water body. ▪ Water quality to be monitored as envisaged in the environmental monitoring plan.	
Drainage pattern	Change in drainage pattern may result in water logging	Moderate	▪ Provision of adequate cross drainage structures as per drainage flow analysis made in the project design ▪ Prevention of blockage of cross drainage structures	Insignificant
Terrestrial Ecology				
Disturbance to vegetation	Cutting of 5707 trees in core zone during project intervention	Significant	▪ Minimization of tree cutting to the extent possible ▪ Compensatory tree plantation preferably on the basis of 3 trees plantation against each tree cut ▪ Native species to be planted ▪ Monitoring of survival rates of trees planted during afforestation programme	Insignificant
Forest	Gagoul reserved	Moderate	▪ Afforestation in the ratio of 1:3	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
bisection and destruction	forest in the Meerut Detour will get bisected as a stretch of 650 meter will pass through this area. The forest area to be diverted 3.4 Ha. There is diversion of protected forest land at Kalanaur Protected Forest to the extent of 4 Ha.		▪ Monitoring of survival rates of trees planted during afforestation programme ▪ Forest Land diversion proposal submission and necessary cost provision for compensatory pland based on NPV.	
Endangered species	Only one vulnerable species of Sarus crane	Insignificant	Arboreal species so no remedial measures suggested	Insignificant
Birds and nesting colonies	Disturbance to birds and their nest because of tree cutting	Moderate	▪ Minimize the cutting of the nesting trees in the impact zone if possible ▪ It is a common phenomenon and tree cutting to be taken up in fall season and in consultation with Forest and Wild life Department	Insignificant
Aquatic ecology				
Fish, plankton and aquatic avian diversity	Effect due to dumping of the mud, land, sand into the River water during the construction	Moderate	▪ Ensure the minimal deposition of mud, land, sand into the River water ▪ Minimizing the noise during the construction ▪ Flow of water in the Rivers and canals shall be maintained	Insignificant
Migratory Fishes	Disturbance	Moderate	Flow of water in the Rivers and canals atleast through one channel to be maintained to allow migration of fishes	Insignificant
Spawning and	Disturbance on	Moderate	Restriction of construction activities	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
Breeding Grounds	breeding and spawning grounds		near the identified breeding and spawning grounds during the breeding period of April to August	
Socio economic				
Socio-economic impact	Beneficial impact due to increased employment opportunities and traffic congestions reduced by RoBs/RuBs Impact on livelihood due to land acquisition	Significant	Compensation planned. The resettlement Action plan has been prepared.	Positive impact
Safety	Risk of accidents and safety near rail tracks and at crossings	Significant	▪ Adopt safe working practices ▪ Trainings to workers ▪ Adequate lighting and fluorescent signage shall be provided at construction sites. ▪ Signage in local language ▪ Setting up of speed limits ▪ Pedestrian passageways ▪ PPEs to workers	Insignificant
Construction Camp	Improper siting and management may lead to adverse effects on environment	Significant	▪ No productive land shall be utilised for setting up of construction camp ▪ Proper Location of construction camp with minimum distance of 500 m from habitation, water bodies through traffic route and 1000m from forest areas. ▪ Proper sanitary facilities at camps ▪ LPG cylinders as fuel sources	insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
Occupational Health and safety	Risks of accidents due to moving trains, noise and vibrations, Fatigue	significant	▪ Training to workers on personal track safety procedures ▪ Blocking train traffic on lines where maintenance is occurring ▪ Reduction of internal venting of air brakes to a level that minimizes noise ▪ Use of PPE if engineering solutions are not feasible. ▪ Railway operators should schedule rest periods at regular intervals and during night hours, to the extent feasible, to maximize the effectiveness of rest breaks.	Insignificant
OPERATION PHASE				
Climate	Contribute positively in GHG Reduction	Significant Positive Impact	None Required	Significant Positive Impact
Natural Hazard	-	-	No impact, no mitigation	-
Air Quality	Fugitive dust emissions due Loading and unloading of cargo	Moderate	▪ Guidelines shall be formulated for material handling practices (particularly for loading and unloading) ▪ Covered areas used for loading and unloading ▪ Covered vehicles for transportation ▪ PPEs to Workers	Insignificant
Noise and Vibration	Train movement – source of noise and vibrations	Moderate	▪ Thick tree plantation around the sensitive location ▪ Noise Barrier if not avoidable due to public requirement	Insignificant
Land and Soil				

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
Soil Erosion	Due to unexpected rainfall and Near unstabilized areas and non-rehabilitated borrow areas	Significant	▪ Regular monitoring of side-drains and cross drainage structures will be done to check blockade ▪ Monitoring of rehabilitation plan of borrow areas ▪ Inventorization of soil erosion prone areas ▪ Periodic checking shall be carried out to assess the effectiveness of stabilization measures viz. turfing, stone pitching measures	Moderate
Water resources	Stress on Ground water as abstraction for domestic purpose	Insignificant	▪ Augmentation through rainwater harvesting ▪ Rainwater collection sumps ▪ Regular monitoring of cross drains to avid blockage	Insignificant
Drainge pattern	No Impact	Insignificant	Corrective action shall be taken to prevent larger accumulation of water if any water logging is noticed	Insignificant
Terrestrial Ecology				
Disturbance to vegetation	Accidental damages or absence of tree management practices	Moderate	▪ Arrangement for effective tree management to ensure survivability of the tree plantation ▪ Selection of healthy sapling; selection of fertile land for plantation; provision of fertilizers (Bio-fertilizer or artificial-NPK); provisioning of fencing in the plantation area; arrangement of watering facility after plantation ▪ Tree survivability audit	Insignificant
Disturbance to fauna	Collision between the animals and rail	Moderate	▪ Cross structures should be designed to allow safe passage for animals,	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
	cars		promote habitat connectivity, be accessible, and encourage natural movements.	
Aquatic Ecology				
Disturbance to aquatic ecology	None	Insignificant	None	Insignificant
Socio-Economic	Employment opportunities and socio-economic development due to better connectivity	Positive	None	Positive

6.15.1.2

Annexure- 6.1: Green House Gas (GHG) Calculations

Reduction in GHGS Emission

In case, the dfc khurja to ludhiana corridor is not built then road transportation will be used for movements of freights instead of rail. The incremental co_2 emission from trucks in case of movement via road traffic is calculated for the same 400 km distance. Just taking a calculation was done to estimate the total co_2 emissions. The calculations for co_2 emission were done assuming 100000 tonnes as total load per annum, each truck can move with the total load of 25 tonne and estimated fuel efficiency of 3.10 km/l. The resultant co_2 emission will increase unitarily with the increase in load.

GHGs Emissions if traffic moved via Trucks

S.N	Total Load (tonnes)	trailing load per trucks (tonnes)	Number of trucks per year	Numbers of trucks per day	fuel efficiency (liters/km)	fuel consumption (liters)	Conversion Ratio (GJ Calorie)	Diesel (GJ)	Conversion Ration (kg/GJ)	CO2 Mass (kg)	CO2 mass (tonnes per annum)	CO2 mass (tonnes per day)
i	100,000	25	4000	10.95	3.1	516,129.03	0.0387	19,974.19	74.1	773.0013	282,145.47	1.93
	Diesel energy conversion:0.3870 GJ/litre, CO_2 Emissions: 74.1 kgCO2/GJ(IPCC data)											
	Fuel efficiency: Japan Ministry of National Transport											

As evidence, it can be seen that there will be total saving of *1.93* tonnes of co_2 in a day or 7044 tonnes in 10 years of operations for 100,000 tonne load if this freight corridor is built. The resultant co_2 emission saving will increase unitarily with the increase in load. This is approx estimation and does not include the co_2 emissions from burning of coal for electricity generation.

Chapter 7. Information Disclouser, Public Consultations and Participation

7.1 Introduction

The Public Consultation meetings for the Khurja-Ludhiana Section of Eastern Dedicated Freight Corridor were conducted in the affected villages from June 2009 to February 2010 by the ADB appointed PPTA Consultants. In addition to these consultations, the E&TS also conducted public consultation meetings in the months of November-December 2011 and January 2012. The villages were selected keeping in view of environmental sensitivity and likely to be affected due to the project. The overall objective of public consultation was to provide information to the stakeholders and collect feedback on environmental issues from them at village level. The consultations with institutional level stakeholders were taken up to seek their comments and to disclose the information to them so that their cooperation is available during project implementation.

7.2 Objectives of Public Consultations

Public consultations intend to obtain people's participation in the project. It is an ongoing process which can improve communication, interaction and joint decision making between different stakeholders. Through public participation, all parties are well informed about the project, likely impact on environment & society as well range of views on issues and mitigation proposals. Most importantly, a good public participation process will result in better decision making process which is sensitive and responsive to public concerns and values.

It is widely acknowledged that public participation process should vary according to the size, complexity and level of interest in any one issue, policy or plan.

The broad objectives of Public Consultation Meetings (PCMs) were as follows:

- To understand the view of the people affected and Public living in surroundings of alignment
- To identify all major environmental characteristics of the villages to enable planning and implementation.
- To resolve the issue related to environment i.e. air, water, soil, noise pollution and vibration
- Disseminate information to the lowest possible hierarchy in the social system

7.3 Methodology of Organising Public Consultations Meetings

These meetings were organized at village level through DFCC project offices at Meerut, Ambala and Ludhiana. These fresh consultations were taken up in the months of November-December 2011. Project officers of DFCC have been working in the project area since long and have fairly a good idea of the issues involved at village level. Moreover, the technical drawings, maps and other papers of the alignment were readily available with them and were used while disseminating information and responding to the queries of the stakeholders/ participants. They have developed a network of field functionaries and these field functionaries have established good rapport with the villagers and stakeholders.

7.4 Information Disclosed in Public Consultation Meetings

The discussions primarily focussed on to receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. To begin with, they were given the brief outline of the project to which their opinion was sought. Environmental issues were discussed in depth with the government officials, ngos and other organizations/ association representatives. During consultation with the villagers, railway officials of the existing network and other users of the proposed facility, issues from the project pertaining to them and their surrounding were mainly touched upon.

The discussions with the local people were focussed mainly on the following points:

- Problems related to environment i.e. existing status of physical, cultural, ecological and socio-economic environment.
- Whether the project will help in providing safety to the people, their property and environment of the area.
- Possible impacts of the project on agriculture, drinking water facilities and local economy.
- The location of any nearby sensitive locations like schools, hospitals, historical monuments, religious places and accident scenario including due to track crossing was also inquired.
- Suggestions were also sought for mitigating any potential adverse impact foreseen.

Impact on flora-fauna was mainly discussed with the officers of the forest department, air and water quality with regional pollution board, municipal development authorities and River water impact with the irrigation and flood control department. These issues due to the project (during the design and construction stage) were consulted in detail with the officials.

The consultation process was undertaken after studying the project design and identifying the possible impacts due to the project execution and commissioning. The impact assessment study focussed mainly on the findings of the assessment and acceptability of the proposed mitigation measures. Issues of tree cutting, impact on fishing activity and productivities were also discussed.

7.4.1 Compliance with Relevant Regulatory Requirements

In india, public consultation is mandatory only in case of category A and B projects in select conditions. As per regulation, no public hearing is required for the proposed project under the environmental impact notification, 1986 and amendments thereof. The requirement of public consultation during the implementation of the project is proposed as part of the mitigation plan.

Public consultation was undertaken as per the ADB requirements in the years 2009 and 2010. After appoint of consultants for updation of EIA and SIA for meeting the World Bank requirements, the EIA and SIA team conducted a series of consultations in December-2011 and January 2012. All the five principles of information dissemination, information solicitation, integration, coordination and engagement into dialogue were incorporated during the task. A framework of different environmental impacts likely from the project was strengthened and modified based on opinions of all those consulted, especially in the micro level by setting up dialogues with the village people from whom information on site facts and prevailing conditions were collected.

7.5 Concerns Raised in Consultations

A large range of people from different administrative, social and economic backgrounds were consulted. Their concerns and opinions about various environmental issues have been summarized in the following four categories in **Tables-7.1-7.3**

Table 7.1 : Institutional Level Consultations and Concerned Raised During Consultations of 2009-2010

Date and Venue	Institution	Participants	Issues Discussed	Outcome
25-30th May 2009, 31st August -12th September, 2009, 27th Oct -12th Nov 2009, 21st -30th January, 2010), DFCC offices at Meerut , Ludhiana and Delhi	Dedicated Freight Corridor Corporation of India Ltd	Mr. Amarnath, (Assistant Manager Meerut), Mr. Rakesh Goyal (Group General Manager Engg. II), Mr. Sharad kumar Jain, (General Manager SEMU), Mr. Lalji Anand, (Assistant Manager Engineering), Mr. Jitendra Kumar, (Director Planning Special), Mr J B Singh Station Manager, Mr Mukesh Gatman, Nisar Ahemed Khan Asst Divisional Enginner, many other station managers and Indian Railway employees	• Impact due to project on existing environment • Technical information related to the project • Inputs on common problem and mitigative measures	The proponents are of the view that the proposed project activities are not likely to cause any significant environmental impacts. However, they are appreciative of the possible impacts during the construction and operation phases of the proposed project and have shown their willingness to implement. Accumulation of waste water along the track due to inadequate municipal sewage collection system or poor drainage at certain locations, or inordinate discharges by nearby residents or industries Proper disposal of waste generation during construction

Date and Venue	Institution	Participants	Issues Discussed	Outcome
				stage Barricading of the construction area for safety reasons
12th September, 2009, 27th Oct -12th Nov 2009, 21st -30th January, 2010, and 2-5 Feb 2010	Forest Department at Meerut, Deoband, Ludhiana, Yamuna Nagar	Mr. Anupam Gupta (Conservator of Forest, Meerut), Mr. V.Chauhan (D.F.O. Ludhiana), Deputy Superintendent, Mrs. Saroj Bala Forest Department Yamuna Nagar), Mr. R.K. Tyagi (Range Officer, Deoband), Mr. J.Singh (Sub Division Forest Officer, Meerut)	• Status of Forest • Afforestation Policy • Procedure for permission • Availability of any National Parks/ Wildlife Sanctuaries in project area	The officials welcomed the project, but cautioned the railway authorities about the permissions for acquiring forest land and about implementation of comprehensive management plans for the loss of trees and other ecologically ensitive damage by the project. They suggested procedure should be started for clearance immediately to avoid delays in project implementation. On reviewing DFCC alignment the forest officials confirmed that it will pass through gagol rf and Kalanaur pf

Date and Venue	Institution	Participants	Issues Discussed	Outcome
				They suggested forest land diversion should be minimised Construction camps should be located at safe distances from these forests.
31st August -12th September, 2009, 21st -30th January, 2010)	Uttar Pradesh State Pollution Control Board (UPPCB) and Punjab Pollution Control Board	Mr Anan Kumar, (Regional Officer), Mr J B Singh Asst Env. Engineer meerut U PPCB. Mr. R.C. Chaudhary (Environmental Officer, UPPCB, Meerut), Mr. A.K. Anand (Environmental Officer, UPPCB, Bulandshahar), Mr. A.K. Tiwary (Environmental Officer, UPPCB, Shaharanpur), Mr. S. Goyal (Environmental Officer, PCB Patiala)	• Air, water and soil pollution in the project area • Environmental issues related to existing industries • NOC Required	All the officers are apprehensive of increase in water and air pollution levels in the area near daurala, mansurpur, deoband and saharanpur as lots of small, medium and large sugar industry exist in the neighbourhood of station. The contamination of groundwater due to untreated industrial discharge in these areas also came out during the discussion. All the officials indicated that the water quality of the areas is not very good. High concentrations of iron

Date and Venue	Institution	Participants	Issues Discussed	Outcome
				and total dissolved solids, total suspended solid are normally available in the ground water. Most of the people use deep tube well to harness drinking water. The contractors will need to obtain noc for establishment of construction camps and consent to establish
(21st Jan to 30th January, and 21st Feb to 28th Feb	Fishery Department, Meerut	Dr. H. Prasad (Asst. Director, Fisheries, Meerut)	• Fishery Activities in the project area	There is no major fishery activity in the project area and no concern due to project.

Table 7.2 : Village Level Consultations and Concerned Raised (2009-2010)

Date	Location	Participants	Issues	Outcome
12-09-2009	Near Khanna Station and nearby areas along the track	Kulvindar Singh,Ramsarup, Raghuveer Singh, Rajesh Kumar, Pitam Singh,Panjab Singh, Avatar Singh, Om Prakash Verma Hansraj, Rajesh Kumar,	• Problem of access through the existing level crossing. • Problem of traffic congestion. • No sewerage facility. • Since the habitation is	Since the proposed track is parallel to the existing one, at most of the locations, the residents staying close to it were concerned about safety of their

Date	Location	Participants	Issues	Outcome
		Amarjeet, Shripal, Shriram, Duli, Manoj Kumar, Vishnu, Prakash, Neeraj, Trilok Chand, Sukhdev, Rammurti, Dilip Kumar, Arjun Kumar, Raghuveer Singh, Hari Singh, Devo, Baazigar, Maya, Paban Kumar, Kanchan, Krishana Davi , Keshuram, Babla, Rampal, Ram Kishan, Pramjeet, Bakchar, Yespal, Major Singh, Bhopal	very close to the track, accidents are frequent. • Problem of noise and vibration which affects studies of children.	children. People were concerned about expected demolition of robin model school which is very near to the existing track in this section of DFC alignment. The respondents of khanna informed that the major utilities are concentrated on the opposite side of the proposed track which is the reason for frequent accidents. Thus, they demanded safe and separate access for themselves. The public also raised concerns of noise and vibration
27-10-2009	Public Mandi Govindgarh and near by areas along the track	Harpal Singh,M.H Siddiqui, Amarjeet Singh, Navjot Singh, Lalit, Saurabh, Prince, Haridev Sharma, Ashok, Devinder Kaur, Narinder Kaur, Achhe Lal, Ram Sagar, Gama Yadav, Meena Kaur, Balwant	• Problem of access through the existing level crossing. • Problem of traffic congestion. • No sewerage facility. • Since the habitation is very close to the track,	• Welcomed the project but want these issues to be addressed before planning its onstruction. • Since the proposed track is parallel to the existing one, at most

Date	Location	Participants	Issues	Outcome
		Singh, Gurcharan Singh, Sirjeet Kaur, Jaswant Singh, Kuldeep Singh, Harvinder Singh, Usha Rani, Babli, Suvarn Kaur, Sita Devi, Sukhvinder Kaur, Papinder Kaur, Mangat Ram, Manjit Kaur,Narinder,Darshan Singh, Daljit Kaur, Jasveer Singh	accidents are frequent. • Problem of noise and vibration which affects studies of children.	of the locations, the residents staying close to it were concerned about safety of their children.
12-11-2009	Meerut, Khurja and nearby areas	R.B Salwo, Jaipal Singh, Jai Chand Saharma, Udal Singh, Harpal Singh, Pranjal Yadav, Hareunder Prased, Bhagheahor Prased, Chetan Kumar, B.S. Tyagi, Mandeep, Pradeep Sharma, Anupam Gupta, Joga Singh, S.K Josi, Rajnish Tripathi, Kamal Singh, Ompal Singh, Shishupal, Jagat Singh, Husn Bano, Sachin,	• Issues related to compensation Environmental problem due to nearby industries • Borrow Land for earth works	The potential project affected people stated their resettlement and compensation worries and on being informed of increased air and noise pollution from induced traffic and construction activities. On the issue of borrow earth the farmers were willing to ready to lend the soil of their land if good compensation is provided to them.
13-11-2009	Daurala and nearby areas	Bishmpal, Tajpal Singh, Shiv Kumar, Shiv Dayal, Shiv Kumar, Rampal, Suman, Santosh, Ramprased, Vinod Jain, Ompal	Quality of drinking water Environmental problem due to nearby industries	The residents raised the issue of contaminated ground water problem due to the untreated discharge of effluents

Date	Location	Participants	Issues	Outcome
				from sugar and pulp and paper industry. The people Proper drainage should be provided
20-12-2009	Darazpur and nearby areas	Satish Kumar, Modilal, Soni Prakash, Srinath, Sewaram, Motilal, Mod Ahemad,	Borrow land Impact on physical & cultural resources	On the issue of borrow earth the farmers were willing to be ready to lend the top soil of their land if good compensation is provided to them. The residents also raised their concerns about the remedial measures for physical cultural resources like temples and schools some of which are expected to be adversely affected.
22-12-2009	Yamuna Nagar and near by area along the track	D.B. Batra, Satish Kumar, A.N.Singh, Jaipal	Environmental problem due to nearby industries Impact on living standards	People were highly concerned about existing environmental problems due to heavy industries. People were hopeful that the proposed project of DFC will decrease the vehicular pollution due to road traffic.

Date	Location	Participants	Issues	Outcome
				People are also expecting increasing employment opportunity of the local people.
23-12-2011	Talhedi Buzurg and nearby areas	Rakesh, Taluram, Phal Singh, Sitab Singh, Pradeep, Mohd. Suliman	Impact on living STANDARDS Impact on physical environment Impact on physical & cultural resources	Some residents were concerned about potential changes in their living standard, including increase in noise and air pollution. The residents also raised their concerns about the remedial measures for physical cultural resources like temples and schools some of which are expected to be adversely affected.

Table 7.3 : Consultations with Local NGOs and their Suggestions

Date	Name of the Organization	Participants	Issues Discussed	Outcome
21-01-2010	Janhit Foundation	Office bearer of NGOs	• Concerned environmental and social issues in the project area • Impact (positive & negative) of the project in local	All the NGOS' consulted had welcomed the project and views given by a prominent local ngo of meerut (janhit foundations) revealed that the proposed project is long due and would not have any
30-01-2010	Target Invention	Mr. Jasbir Singh, (Project Coordinator) Mrs. Suman Sharma (Project Manager)		

Date	Name of the Organization	Participants	Issues Discussed	Outcome
12-02-2010	Bharat Jan Gyan Vigyan Jatha	Dr. Arun Mitra (Director)	people	significant adverse impacts. they however, highlighted the issue of solid waste disposal problem generated during construction phase. Janhit being active in the field of water pollution prevention expressed their strong concern about the inaction on part of pollution board officials in controlling the effluent discharge by sugar industries. Another NGO (target interventions) working for the social upliftment highlighted the problem of HIV/AIDS by the migrant workers in the industrial areas of Punjab.

7.5.1 Consultations During December 2011 and January 2012

The summary of consultations carried out during December 2011 and January 2012 is given below in **Table-7.4**.

Table 7.4 : Consultations During December 2011 and January 2012

Category	Key Concerns Raised	Consideration in Project Implementation
Project Impacts	• Cracks in houses because of high speed loaded goods train because of vibration, • Project officials should provide correct information, • Loss of source of livelihood because of loss of fertile agricultural land, • Loss of access to the agriculture field especially in Detour sections, • Loss of religious and other common properties, • Division of habitation and cultural properties because of DFC tracks, • Increase in accidents and suicide because of construction of tracks. • Cutting of trees and removal of water supply sources (Wells, Tube wells should be minimised)	• Vibration will be minimized using plantation, and constructions of boundary, and using suitable fasteners. These measures elaborated in EMP. • Communication will be done with the help of NGOs and community based organizations, • Loss of livelihood is addressed in RAP, • Underpasses/RUB is proposed at suitable locations. • Religious properties will be relocated in consultation with communities. • This type of community properties have been connected through underpasses, foot Over Bridges, • Accidents hotspots will be identified and remedial measures taken. • The water supply sources will be relocated. Tree cutting minimised by planning alignment in most portion along the existing track.
Expectations from the Project	• Provision of Job in lieu of compensation, • Compensation as the replacement value of lost assets, • Gramsabha land should be given as resettlement site, • Job to landless families, • Compensation on the norms of private acquisition, • Compensatory plantation should be taken up in vacant space • During construction noise and dust, generation should be controlled to avoid inconvenience to local communities specially near habitations.	• Provision of job has not been decided upon as yet. • Compensation at replacement value under revised EM. • Since Land Acquisition for DFC project is a linear acquisition, there is no mass Moreover, the surplus land is not available with Ministry of Railways. Therefore, resettlement site has not been planned for DFC project. • Entitlement Matrix has been revised. To offer latest rates for Compensation as per the new EM, • Compensatory plantation will be taken up as per directive of Forest Department. • During construction noise and dust generation will be minimised through EMP implementation. No construction activities will be taken up in night time at habitations.
Design and Alternatives	• Pipeline and underground pipe damage should be minimised • Width of land for DFCC Track	• Lost pipeline will be replaced, • Width of Land is reduced to 17 meters at many locations to minimize the impact,

Category	Key Concerns Raised	Consideration in Project Implementation
	should be reduced to minimize land acquisition, • Underpasses should be constructed near important crossing especially near school, • Foot over bridges should be given at important locations • Remodeling of yard and platform to minimize ROW	• About 86 underpasses/RUB are planned (mainly on detours) to compensate loss of connectivity, • Location of FoB will be finalized after another round of PCMs by facilitating NGO during the course of implementation. These Fobs will be finalized with close coordination with MoR official as at will also cross existing IR Track.

7.5.2 Proponents' Comments:

The proponents are of the view that the proposed project activities are not likely to cause any significant environmental impacts. However, they are appreciative of the possible impacts during the construction and operation phases of the proposed project and have shown their willingness to implement suggested mitigation measures in the EIA. The DFCCIL officials provided the requisite technical information about the project. The issues of benefits to the public due to the proposed project were also discussed with them.

7.5.3 Local People/Beneficiaries' Comments and Consideration in Project Design

The compensation will be paid as per R&R policy prepared for the project. The pollution will be reduced/mitigated through implementation of EMP. The safety provisions for crossing such as RoB, underpasses, manned crossings, flyover etc. have been made. All the common property resources (CPRs) will be relocated before demolition. The CPRs include schools, Temples, wells, handpumps, mosque, etc. The water stagnation and waste water problems will be solved through provision of drains and channelizing the water. The waste water treatment issue will be taken up in consultation with local civic authorities.

7.5.4 Government Regulators' Comments and Consideration in Project Design

Discussions with concerned forest officials, including Divisional Forest Officer of Ludhiana, Divisional Forest Officer of YamunaNagar and Forest Conservator Meerut confirmed the absence of any National Park / Wild Life Sanctuary in the project corridor and about the presence of any wild animal in the project areas.

The project will acquire minimum land in forest areas and construction camps will be located away from forest areas. The ground water withdrawal will be minimised during construction. The water will be treated to meet drinking water standards and construction water specifications. The surface water sources will be utilised. Pollution control board has raised increased pollution levels in Deoband, Saharanpur, Daurala, Yamuna Nagar. The construction camps will not be established in these areas.

7.5.5 Local NGOs' Comments and Consideration in Project Design

There are limited NGOs' active in the study area and directly dealing with environmental issues. However, all the NGOs' consulted had welcomed the project and views given by a prominent local NGO of Meerut (Janhit Foundations) revealed that the proposed project is long due and would not have any significant adverse impacts.

The EMP prepared will address the proper handling and disposal of solid waste. During project implementation HIV/AIDS awareness program will be conducted through NGO to educate construction workers and public living in nearby areas.

7.6 Integration of Comments into the EIA

During discussions, notes were taken for any issue raised and suggestions made. References have been taken from public opinion where no official data were available for understanding of the study area characteristics. Each of the issues were then analysed for practical and scientific basis. The opinions were used for identifying impacts and developing management and monitoring plan, depending on their importance and practicality. For any significant concern, preventive or mitigative measures have been suggested drawing points from all the suggested measures.

Consultation at Khurja Railway Station

Consultation at Khurja Railway Station with Others

Consultation with NGO at Khanna

Consultation with inhabitants near MandiGobindgarh Railway Station

Consultation near Sanehwal Station with Passengers

Consultation with inhabitants near Khanna

Consultation with Villagers at Gagaul Forest

Consultation with Station Master at Khatauli

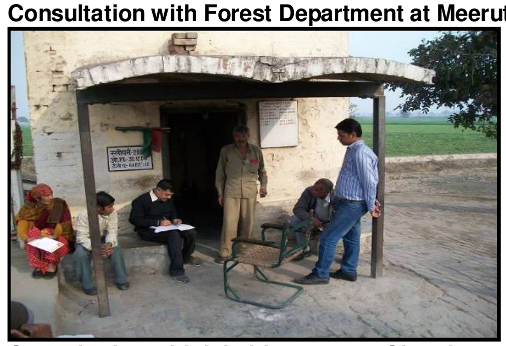

Consultation with Station Master at MuzaffarNagar Railway Station

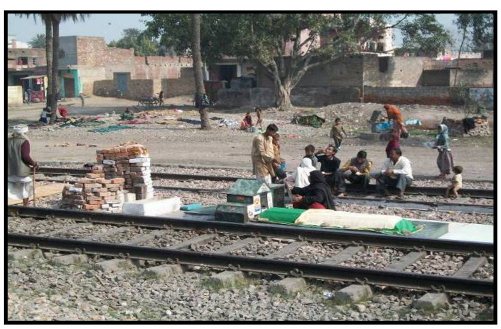

Consultation with Pollution Board Official at YamunaNagar


Consultation with Forest Conservator at Meerut


Consultation with Forest Department at Meerut


Consultation near Gagaul Forest with Villagers


Consultation with inhabitants near Chandsara Halt


Consultation with Passengers near Khatauli


Consultation with Villagers near Deoband Station


Consultation with Passengers at Tapri


Consultation with villager near Hindon Railway Bridge

Consultation with inhabitants near Daurala

Consultation with Station Master at MuzaffarNagar

Consultation with villagers at Hasangarh Jafrabad in Bulandshahar district on 30-12-2011

Consultation with villagers at Walidpur in Meerut district on 30-12-2011

Consultation with villagers at Barara in Saharanpur district on 16-01-2012

Chapter 8. Environmental Management Plan

Environmental Management Plan is an implementation plan to mitigate and offset the potential adverse environmental impacts of the project and enhance its positive impacts. Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section enumerates the set of measures to be adopted in order to minimize adverse impacts. The process of implementing mitigation and compensatory measures, execution of these measures, agencies responsible for the implementation of these measures and indicative costs are discussed in this chapter.

The project has overall positive impacts by providing a competitive, cost effective, congestion free reliable mode of dedicated freight service. It will certainly reduce the load on the roads and facilitate fast transfer of goods. Railway being an eco-friendly mode will also enhance or at least will not degrade the environmental quality.

The development of EDFC entails civil work, including excavation, filling, construction of RUB/ROB, bridge and cross drainage structures, and utility shifting etc., which are likely to cause adverse impacts on natural and social environment. The impacts can not be fully avoided; however, appropriate mitigation measures are suggested to minimize and compensate the potential adverse impacts and enhance positive impacts. Most of the impacts are temporary in nature and are limited to the construction phase. These impacts can be potentially minimized and managed by proper planning and execution. The environmental management plans includes activities for pre-construction phase, construction phase and operation phase.

8.1 Environmental Management Process

Environmental management is based on the potential impacts assessed for the project. Assessment of potential impacts is based on the review of secondary data substantiated by site visits – environmental monitoring, public consultation, household survey and discussion with concerned Govt. Dept. The implementation of Environmental Management Plan (EMP) requires the following:-

- An organizational structure
- Assign responsibilities
- Define timing of implementation
- Define monitoring responsibilities

8.2 Regulatory Clearance Requirements

The list of clearances to be obtained/ applied by DFCC/Contractors from the respective statutory bodies is **summarized in Table 8.1.**

Table 8.1 : List of statutory clearances Required

S. No.	Clearance Required	Statutory Authority	Status
1.	EIA Notification, 2006 issued under EP Act, 1986	Ministry of Environment & Forests, Government of India.	Not Applicable for this project
3.	Ground Water Extraction	Central Ground Water Board	To be obtained
4.	Hot mix Plants, Crushers and batching plants (Air Act)	Respective State Pollution Control Boards, where construction camps to be located	To be obtained by Contractors
5.	Storage, handling and transport of hazardous materials.(Haz waste rules & MSIHC rules) at Construction camps such as	Respective State Pollution Control Boards, where construction camps to be located	To be obtained by Contractor

S. No.	Clearance Required	Statutory Authority	Status
	fuels		
6.	Clearance of the project for underground cables & transmission lines	Department of Telecommunication and Elecricity of Government of India and respective states	To be obtained by Contractor
7.	Clearance and No objection certificate from River authorities (Yamuna) for sand borrowing	Irrigation Department of Haryana and other statutory bodies.	To be obtained by contractor.
8	Surface water withdrawal for construction from Yamuna River, Upper Ganga Canal, Western Yamuna Canal, Hindon River and Kali River	Irrigation department of concerned state from where water is planned to be withdrawn	

8.3 EMP during Construction & Operation

The project activities will be executed in a phased manner, pre-construction phase, construction phase and operation phase. The major activities to be undertaken are described below.

8.3.1 Construction Phase

The environmental issues during construction stage generally involve equity, safety and public health issue. 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. Environmental pollution during the construction phase will be less but control of pollution during this phase is of considerable importance. The EMP is an executable part of project, and the activities are to be guided, controlled, monitored and managed as per the provision provided. Following activities require attention during construction phase.

1. Social Impact Management Plan

Minimum land acquisition and disturbance to existing features will be prime objective of the design. Socially sensitive stretches have been avoided and alternatives have been selected with bypass around settlements and realignments. Rehabilitation of PAFs and removal of affected structures will be planed in consultation with the PAFs and local authrorities to ensure minimum disturbance to the PAFs. This is required to minimize impacts within the limitation of technical requirements with emphasis on cost effectiveness.

2. Land Acquisition / Diversion Plan

- Acquisition of land is indispensable for construction of EDFC. The proposed alignment traverses through forest, settlement and agricultural areas. Approximately 7.4 ha of forest land and extensive agricultural land are likely to be acquired for the project.
- At the outset as a part of the Land Acquisition Plan, the Right of Way (RoW) along the entire EDFC alignment has to be established and confirmed from the State Forest, Agriculture and Land Revenue Departments.
- Diversion of 7.4 ha. forest land will be carried in compliance to Forest Conservation Act, 1980.
- The acquisition of land and private property shall be carried out in accordance to the Resettlement Action Plan (RAP).

It will 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. RAP is to be referred for the purpose. No construction work will start before total compensation has been paid to the PAPs.

3. Utility Shifting Plan

There are some utility services along the proposed EDFC alignment such as electric lines, telephone lines, cable line, pipe lines etc which may be shifted on consultation with the concerned department before commencement of construction activity. There are road crossing with the EDFC. Construction of bridges will be required to maintain their utility. These structures will be shifted in consultation with the concerned departments.

4. Construction / Labour Camp Management

- During the construction phase, the construction / labor camp will be located along the project area. Large numbers of labour are likely to move into the project area. A proper Construction Camp Development Plan has will be formulated to control degradation of the surrounding landscape due to the location of the proposed construction camp. The contractor will provide, construct and maintain necessary living conditions and ancillary facilities. These must be included in contract documents provided to the contractor.
- Sufficient supply of potable will be provided at camps and working sites. If the drinking water is obtained from the intermittent public water supply, then storage tanks will be provided. All water supply storage may be at lest 15 m away from the toilets or drains.
- Adequate and clean washing and bathing facilities must be provided. The camp will also adequate drainage facilities.
- Adequate sanitary facilities will be provided within every camp. The place will be cleaned daily and maintain strict sanitary conditions. Separate latrine will be provided for women. Adequate supply of water will also be provided.
- The contactor will ensure that there is proper drainage system to avoid creation of stagnant water bodies.
- Periodic health check ups will be conducted. These activities may be provided by the construction contractor in consultation with State Public Health Department.
- At every camp, first aid facilities with suitable transport will be provided to take injured or ill person to the nearest hospital.
- Adequate supply of fuel in the form of kerosene or LPG will be provided to construction labourers, to avoid felling of trees for cooking and other household activities. No open fires will be allowed in camps.
- The sites shall be secured by fencing and proper lighting.
- The construction contractor may ensure that all construction equipments and vehicle machinery may be stored at a separate place / yard. Fuel storage and refuelling areas may be located 500 m away from the water bodies and from other cross drainage structures.
- All the construction workers will be provided with proper training to handle potential occupation hazards and on safety and health which include the following:-
    - Environmental awareness programme
    - Medical surveillance
    - Engineering controls, work practices and protective equipment
    - Handling of raw and processed material
    - Emergency response
- Construction / labour camps may be located away from forest areas, settlements, cultural heritage and historical sites and water bodies and dry Riverbeds.

- It will be ensured by the contractor that the camp area is cleared of the debris and other wastes after the completion of construction. On completion of construction, the land shall be restored back to its original form.

5. Borrow Area Management Plan

An appropriate Borrow Area Management Plan will be formulated to control the degradation of the surrounding landscape due to the excavation work. The national standard which applies to the manual borrowing of earth is the IRC-10:1961.

- Borrowing of earth shall not be done continuously. Slopes of edges shall be maintained not steeper than 1:4.
- Top soil (15 cm) from all areas may be preserved in stockpiles and utilized for redevelopment of borrow/quarry areas.
- Borrow pit shall be developed as far as possible from the River side, where the inner edge of any borrow pit shall be not less than 15 m away from the toe bank. As per as the borrow pits on the rear on landside are considered, it is to be avoided. Where it is unavoidable a berm, at least 25 m wide shall be left between borrow pits and toe bank. The toe of the bank on the rear side shall have a cover of 0.75 m to 1.25 m over the saturation line drawn at a slope of 1:6 from the high flood level on the River side.
- Borrowing of earth shall not be carried out on productive land. In the event that such an occasion arises, the contractor has to obtain permission from the supervising engineer.
- Sources of borrow areas will be identified by the contractors.
- No borrow area will be opened without the prior permission from the local administrative bodies like Village Panchayats, State Department of Irrigation, Agriculture and State Pollution Control Boards etc.
- Reclamation of borrow area shall be mandatory and will be included in the agreement made with the construction contractor.
- Borrow pits may be located at least 1 km away from the villages and settlements.
- All borrow pits may be reclaimed: -
    - The quarry and borrow area should be reclaimed back. The pits formed shall be backfilled by construction waste and site shall be stabilized.
    - Spoils may be dumped with an overlay of stocked piled top soil with respect to MoEF/SPCB guidelines.
    - Borrow and quarry pits can be also be developed as ponds and be used for aquaculture as per local requirement. These can also serve as park or picnic spots.
    - Landscaping of borrow and quarry area may be done, and the grasses, shrubs and tree species may be planted around the reclaimed area. Ornamental plants can also be planted on the access route.
    - Reclamation of borrow area may included in the agreement of the construction contractor.

6. Public Health and Safety

The contractor is required to comply with all the precautions required for the safety of the workers. The contractor must comply with all regulation regarding scaffolding, ladders, working platform, excavation, etc. as per SHE manual of DFCCIL.

- The contractor must supply safety goggles, helmets, earplugs and masks etc. to the workers and staff.
- Adequate precaution must be taken to prevent danger from electrical equipments. Necessary light and fencing shall be provided to protect the public.

- All machines and equipments used for construction purposes must conform to relevant Indian Standards (IS) codes. This equipment must be free from patent defects, in good working condition, regularly inspected, and properly maintained as per IS provisions.
- All labourers working on mixing of asphaltic material, cement, lime mortars, concrete etc shall be provided with protective footwear and protective goggles. Workers involved in welding work shall be provided with welder's protective eye shields.
- No men below the age of 18 years or women of any age will be employed to work with paint products containing lead in any form. Face masks must be supplied to workers when they use any form of spray paint or work with surfaces that have been dry rubbed and scrapped with lead paint.
- All reasonable measures will be taken to prevent any damage to the public from fire, floods, etc.
- All necessary steps will be taken to prompt first aid treatment for injuries that may be sustained during the course of work.
- The contractor will conform to all anti malarial instructions, including filling up of borrow pits.
- Work that affects the use of side roads and existing accesses must not be taken without providing adequate provision.
- On completion of the works, all the temporary structures may be cleared away, all rubbish disposed, excreta and disposal pits or trenches filled in and effectively sealed off and the entire site left clean and tidy.

7. Silicosis Exposure Reduction Strategy

Silicosos reduction strategy shall be adopted during construction.Details are given at **Annexure 8.7**.

8. Green Belt

The green belt has been recommended as one of the major components of the EMP which will further enhance the environmental quality through:

- Mitigation of air pollution problems
- Attenuation of noise level
- Maintain the Green area and improve aesthetics.

It is most important to chalk out a long-term approach to keep the air in the area clean. One such measure is using the plants for absorbing and trapping the air pollutants. The hypothesis that trees are important particulate sinks is supported by evidence obtained from studies dealing with diverse particulate matter including pollen, salt, precipitation, dust and other unspecified particles. As far as gaseous pollutants are concerned, substantial evidence is available to support the fact that plants in general, and trees in particular, function as sinks for gaseous pollutants. This is achieved through various physiological processes occurring within the plant system.

The gaseous pollutants are transferred from the atmosphere to vegetation by the combined forces of diffusion and flowing air movement. Once the gaseous pollutants come in contact with the plants, they may be bound or dissolved on exterior surface or taken up by the plants via stomata. If the surface of the plant is wet and if the gas is water soluble, the former process can be very important. As a matter of fact, plants act as bio filters for the air pollutants and play a major role in safeguarding the environment and controlling the increasing level of air and noise pollution.

A. Preparation of the Plantation Area

A green belt will be proposed along the alignment. Plantation site should be cleared from all wild vegetation. Suitable soil and water conservation measures will be adopted, if required. Since planting area is large, it should be divided into blocks inter-linked by paths laid out in such a way that every tree is accessible for all post plantation care. The planting arrangement and size should be based on the optimum use of the available land and quantum of irrigation water.

A tree requires sufficient space below and above the ground to spread its roots and branches. However, spacing varies with the type of trees, soil fertility, available moisture and purpose of plantation.

B. Preparation of Pits and Sapling Transplantation

The location of each pit shall be marked according to the design and distance of the plantation. The size of the pits may vary with the type of trees. While digging the pit, care shall be taken to place the topsoil on one side and bottom soil on the other side. Dug-out soil and pit shall be exposed to weather for two to three months. After exposing to the weather, the pit should be filled two-third to three-fourth height with a mixture of topsoil and decayed farmyard manure.

Planting of the tree shall be done with a suitable between each. While planting the trees, care shall be taken that the installation structure shall be difficult to see through the foliage when seen from a point outside the green envelop. For preventing the horizontal dispersion of the pollutants, the trees shall be planted in alternate rows in a straight line. Tree trunks are free from foliage up to a height of 2 –3 meters, it is advisable to grow shrubs in front of tree so as to provide coverage to the open portion.

C. Time of Plantation

Plantation shall be done two weeks after the rain starts, as the trees benefit from the seasonal rains. It is advisable to avoid planting during the dry season, as this will require watering. It is advantageous to plant trees on cloudy days.

D. Protection of Greenbelt

- No pruning or lopping of branches shall be done within the greenbelt for at least 10 – 15 years
- Gap filling in the greenbelt shall be done in the same season to avoid future gaps.
- Protection of young plants from the ravages of cattle, sheep and goat and other animals.
- Timely replacements of damaged plant and thereafter care is important.

E. Selection of Tree Species

Plants possess a large surface area and their leaves exhibit an efficient pollutant trapping mechanism. The effectiveness of plants to control pollution depends upon the physiological, morphological traits such as leaf epidermis, size, leaf orientation, internal enzyme system, etc. Systematic screening of plants for their ability to tolerate pollutant need be undertaken. For pollution abatement purposes tree species should be fast growing, wind firm, unpalatable to animals, hardy and pollutants tolerant/resistant. List of some plant species for greenbelt plantation purpose is given in **Table-8.2** below:

Table 8.2 : Recommended List of Tree Species for Green Belt Plantation

Sl. No.	Botanical Name	Common Name
1	*Alstonia scholaris*	Chattivan
2	*Mimusops elengi*	Bakul
3	*Cassia fistula*	Amaltas
4	*Bauhinia purpurea*	Khairwal
5	*Zizyphus mauaritiana*	Ber
6	*Cassia siamea*	Senna
7	*Ficus religiosa*	Peepal
8	*Albizia lebbeck*	Siris
9	*Pongamia pinnata*	Karanj

10	*Polyalthia longifolia*	Ashok
11	*Diospyros melanoxylon*	Tendu
12	*Ailanthus excelsa*	Mar Maharakha
13	*Melia azedarach*	Bakain
14	*Tamarindus indica*	Imli
15	*Terminalia arjuna*	Arjuna
16	*Azadirachta Indica*	Neem
17	*Grevillea robusta*	Savukkamaram
18	Shrubs & Grasses	
19	*Calotropis gigantea*	Akand
20	*Nyctanthus arboriristis*	Harsighar
21	*Nerium indicum*	Kaner

It is recommended to use local species for better survival rate.

F. Plantation For Noise Pollution Control

Trees having thick and fleshy leaves with petioles flexible and capacity to withstand vibration are suitable. Heavier branches and trunks of the trees also deflect or refract the sound waves. The density, height and width are critical factors in designing adequate noise screen with vegetation.

Combination of trees and shrubs together appears to be the best system for combating pollution. The following species are suggested for noise pollution:

- *Alstonia scholaris*
- *Azadirachta indica*
- *Melia azedarach*
- *Grevillea robusta*
- *Tamrindus indica*
- *Terminalia arjuna*

Varied plantation techniques and types will reduce noise unequally. In addition to this, it is also relies on categories of plant to block noise. Some type of trees with varying heights block noise better than trees forming a straight line, which can reduce noise up to 3.48%. The formation of plant of different heights planted such that they stand highest to lowest in straight line will have best noise blocking. Port line can reduce noise up to 4.39%. The formation of plant from the highest to lowest in alternate formation will have the best noise reduction in the fifth line which is 7.63% (Chakree, 1989).

8.3.2 Operation Phase

During operation phase, the noise and vibration control along the sensitive and residential area is most important. Regular monitoring will be done for these parameters, and appropriate measures as suggested in the report shall be implemented.

8.4 Environmental Management Plan & Responsibilities

Table 8.3 presents summary of Environmental Management Plan (EMP) with the objective to minimize adverse environmental impacts as discussed. The table covers all possible environmental issues involved in the project and the necessary mitigation measures. Taking appropriate mitigation measures for the construction phase is the responsibility of the contractor, and of the contractor's Environmental Engineer who will supervise the implementation of the EMP. The DFFCIL will also appoint a supervision consultant/Independent Engineer to check the quality.

Social and Environmental Management Unit (SEMU) of DFCCIL, which includes a GM & an Environmental Specialist will supervise the implementation of EMP. and implement the mitigation measures during the operation phase. The SEMU is headed by General Manager. Thus, the overall responsibility of the implementation of mitigation measures will be with the Contractor during the construction phase and with the DFFCIL-SEMU unit during operation phase. The details of Environmental Management Programme and Environmental Management Unit (EMU) are discussed in the subsequent paragraphs.

Table 8.3 : Environmental Management Plan

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
Pre-construction phase				
1.	Removal of Trees	5707 Trees are likely to be felled in the existing and acquired area for the proposed corridor The Reserved forest land in Meerut Detour and in Kalanaur Protected Forest along the existing rail line along the railway line is likely to be acquired for the project. This will be compensated by providing value of land as per Net Present Value (NPV) Double area of land may be provided for Forest Dept for carrying Compensatory afforestation. Compensation may be provided for plantation of trees. Necessary budget for this may be included project cost. Tree cutting may be carried out as per prevailing Act.	Forest Dept. / DFCCIL	DFCCIL
2.	Land Acquisition /Division	Ownership of land within the RoW and at Junction station, Detours should be confirmed Number of Project Affected Persons (PAPs) to be identified. Resettlement Action Plan to be prepared for the PAPs and provide compensation in compliance with NRRP 2007, RAA 2008 and guidelines given in RAP.	DFCCIL	State Revenue Dept / DFCCIL-SEMU
3.	Relocation of Cultural and Religious Properties	Religious structures shall be shifted only after public consensus. Relocation shall be completed before construction work is taken up. RAP is to be followed.	Construction Contractor	DFCCIL
Construction Phase				
1.	Soil	Suitable protection measures consisting of bio-engineering techniques such as plantation of grasses and shrubs & check dams, may be provided to control erosion. Borrow areas may be finalized in concern with ecological sensitivity of the area. Agriculture land may not be used as borrow area. Priority may be given to degraded area for excavation of borrow	Construction Contractor /DFCCIL	DFCCIL

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
		material. Rehabilitation of borrow area may be taken under the project. Construction work may be avoided during rainy season to evade erosion and spreading of loose material. Top soil removed from agricultural land may be preserved separately in bunded areas and utilized during plantation or refilling of excavated area.		
2.	Water Bodies	Provision of temporary drainage arrangement due to construction activities must be made by Contractor and suitable and strict clause must be incorporated in General Conditions of Contract document for its effective implementation. Silt fencing may be provided near water bodies Proper cross drainage structure may be planned at the crossing of the canal in consultation with Irrigation Department Proper drainage may be planned in the area to avoid water logging	Construction Contractor /DFCCIL	DFCCIL
3.	Flora	Felling of trees must be undertaken only after obtaining clearance from the Forest Dept. forest areas, Railway Dept and local bodies outside forest areas Trees, outside the RoW and on the land not required for the project, should not be felled. Compensation must be provided before initiating construction activity. Fruit bearing trees may be compensated including 5 years fruit yield. Govt. guideline on this may be followed. Labour Camps and office site may be located outside & at least 1 km away from Forest area. Green belt development may be undertaken in the wasteland near railway line to enhance esthetic and ecological value. Social forestry may be practised for success of the plantation. Local people can be involved in plantation and maintenance of plantation as part of the project in	Forest Dept./ Construction Contractor /DFCCIL	DFCCIL

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
		consultation with Forest Department.		
4.	Fauna	Crossing passages must be made for wildlife near forest areas such as under pass followed with some plantation so that it resembles with the habitat of wildlife and facilitate crossing of wildlife in forest area. Ponds may be developed inside forest areas as the birds prefer water bodies. Borrow areas can be also developed as ponds with grasses and shrubs planted around it. Silt fencing may be used near water bodies to avoid runoff into the water bodies. Construction activity may be avoided during night hours in forest area. Poaching shall be strictly banned in the Forest area. Contractor must ensure that no hunting or fishing is practiced at the site by any worker and that all site personnel are aware of the location, value and sensitivity of the wildlife resources. Awareness program on Environment and Wildlife Conservation may be provided to the work force. Forest Act, 1980 and Wildlife Act may be strictly adhered.	Forest Dept./ Construction Contractor /DFCCIL	DFCCIL
5.	Archaeological structure/ article	There is no archaeological structure affected, directly or indirectly, on the alignment. However,,such structures/ articles found during construction stage along the alignment, shall be dealt with as per the Act and procedure detailed in Environmental Management Framework.	Archaeological Dept. Or National Monuments Authority/ Construction Contractor /DFCCIL	DFCCIL
Pollution monitoring				
1.	Air	Adequate dust suppression measures such as regular water sprinkling on construction sites, haul & unpaved roads particularly near habitation must be undertaken to control fugitive dust. Plantation activity may be undertaken at the construction sites Workers may be provided with mask to prevent breathing problems Trucks carrying soil, sand and	Construction Contractor /DFCCIL	SPCB / DFCCIL

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
		stone may be duly covered to avoid spilling. Low emission construction equipment, vehicles and generator sets may be used Plants, machinery and equipment shall be handled so as to minimize generation of dust. All crusher used in construction should conform to relative dust emission devises Air quality monitoring may be conducted at construction sites as per monitoring plan.		
2.	Water	Silt fencing may be provided near water bodies to avoid spillage of construction material. Discharge of waste from construction / labour camp into water bodies may be strictly prohibited. Construction methodologies with minimum or no impact on water quality may be adopted, disposal of construction wastes at designated sites and adequate drainage system may be provided. Project design takes care of irrigational canal and proper culverts may be proved so that irrigation setup is not disturbed	Construction Contractor /DFCCIL	SPCB / DFCCIL
3.	Soil	Asphalt emulsifier must be handled with caution and any leakage detected must be immediately rectified. Construction work should not be done during rainy season to avoid erosion and spreading of loose material Top soil removed during excavation work shall be utilized stored separately in bunded area and shall be utilized during plantation or refilling of excavated area.	Construction Contractor /DFCCIL	DFCCIL
4.	Solid Waste	Construction work shall be carried in such a way that minimum or no solid waste is generated at construction site. Extra earth material produced may be utilized for refilling of borrow areas. Rainy season may be avoided to minimize spreading of loose materials. Solid waste management may be	Construction Contractor /DFCCIL	SPCB / DFCCIL

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
		framed for camp areas. Dustbins may be provided in the Camps. Proper sanitation facilities must be provided in Camp by the Contractor.		
5.	Noise & Vibration	Modern technologies producing low noise may be used during construction. Construction equipment and vehicles must be in good working condition, properly lubricated and maintained to keep noise within permissible limits. Temporary noise barriers installed at settlements and forest area, if required Noise barrier shall be provided at the sensitive receptor locations mentioned in Table-6.3. This is because noise levels are exceeding the limits at these noise sensitive receptors. Plantation may be carried at the work site. Head phones, earplugs shall be provided to the workers at construction site. Noise level monitoring shall be conducted during construction phase. All vehicles, equipment and machinery used in construction should be fitted by exhaust silencers. Equipments shall be maintained regularly and soundproof gadgets shall be used. Temporary sound barriers shall be installed near sensitive locations near settlements and Forest area, of required Provision of ear-plugs to heavy machinery operators Plantation along the DFC shall be maintained.	Construction Contractor /DFCCIL	SPCB / DFCCIL
6.	Land Subsidence	Plantation must be carried to control erosion	Construction Contractor	DFCCIL
7.	Bottom Sediment	Silt fencing will be provided to avoid runoff into the River. Construction activity shall be taken in dry season to avoid spreading of construction material and minimize impact on water quality	Construction Contractor	DFCCIL
Operation Phase				
1.	Maintenance	Provision for maintenance of	DFCCIL	DFCCIL

S. No.	Environmental Issue	Action to be Taken	Implementation by	Supervision by
	Plantation	plantation must be made for at least three years. Plantation may be taken to replace dead sapling. Survey of survival of plants may be taken annually. Any fresh plantation for lost may be taken up during monsoon season. Lopping of branches may be undertaken to remove obstruction, if any		
2.	Air Quality	Plantation should be carried out and maintained along EDFC. Green belt development with proper specifies shall be undertaken on priority basis. AAQ monitoring shall be carried out at all locations identified in monitoring plan.	DFCCIL	SPCB / DFCCIL
3.	Water Quality	Waste Collection facility shall be provided at all Junction station Proper drainage system should be provided at all Junction station Water quality monitoring at all locations specified in the monitoring plan	DFCCIL	SPCB / DFCCIL
4.	Noise & Vibration	Noise and Vibration monitoring may be conducted in operation phase at Sensitive Receptors (SRs) mentioned in Table-6.3.	DFCCIL	SPCB / DFCCIL

8.5 Environmental Monitoring

The environmental monitoring shall be undertaken during construction and operation phases as per the following details. The purpose of environmental monitoring is to check the efficacy of mitigation measures.

Table 8.4 : Proposed Monitoring ProgrammeConstruction Phase

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Implementation	Supervision
1	Air Quality	$PM_{2.5}$, PM_{10}, CO, NOx, SO_2	CPCB standards	Construction camps (10), Sahnewal, Rajpura, Khanna, Yamuna Nagar, Kalanaur, Asian Group of colleges(km 240.0), Daurala, Meerut Detour (Forest Area), Gulaoti, BullandShahar, Khurja	3 times in a year (once in every season except monsoon) during construction period	DFCCIL through contractors	CS/SEMU
2	Water Quality	As per IS:10500 standards	CPCB standards	Surface water sources- western Yamuna Canal, Hindon River, Kali River, Upper Ganga canal, Yamuna River Ground water- Khurja station, Gulaoti, Meerut Cantt, Daurala, Jarauda, Deoband, Tapri, Saharanpur, Sarsawa, Jagadhari, Barara, Shambhu, Ambala, Rajpura, Sirhind and Doraha	Once in a season During construction period (Excluding Monsoon Season)	DFCCIL through contractors	CS/SEMU
3	Noise	Noise level on dB (A) scale	CPCB standards	At construction camp (10)and at noise sensitive receptors- Bedmani Hospital Bullandshahar, Gangol RF, NH-119 Crossing, Hitkari Kissan Inter College-Shakauti, Tapri, Mustafabad near School Rajpura, Sirhind,	3 times in a year (once in every non monsoon season during construction period)	DFCCIL through contractors	CS/SEMU

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Implementation	Supervision
				Aryapuri Senior Secondary school Doraha			
4	Soil Quality	Parameters are NPK, Sodium Absorption Ratio, Oil & Grease	CPCB Standards	Locations where baseline monitoring done i.e.Khurja station, Hapur detour, Baral, Meerut Cant, Daurala, Khatauli, Mansurpur, Deoband, Tapari, Kalanaur, Jagadhari, Ambala cant, Sirhind Detour, Doraha	Once in a year during construction period	DFCCIL through contractors	CS/SEMU
5	Vibration Measurements	Vibration Levels in dB(A)	70 dB(A)	Locations of sensitive receptors- Bedmani Hospital (km 22.6), Commercial Area (km 61.8), Temple at km 106.200, Mosque at km 219, Temple at Ambala at km 306, Rajpura km 337.50, Temple at km 367.500 and Gurudwara at km 390.000	Once in year during construction phase	DFCCIL through contractors	CS/SEMU

Operation Phase

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Implementation	Supervision
1	Air Quality	$PM_{2.5}$, PM_{10}, CO, NOx, SO_2	CPCB standards	Sahnewal, Rajpura, Khanna, Yamuna Nagar, Kalanaur, Asian Group of colleges(km 240.0), Daurala, Meerut Detour (Forest Area), Gulaoti, BullandShahar, Khurja	3 times in a year (once in every season except monsoon) for 3 years	Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted Laboratory	SEMU
2	Noise	Noise level on dB(A) scale	CPCB standards	Bedmani Hospital Bullandshahar, Gangol RF, NH-119 Crossing, Hitkari Kissan Inter College-Shakauti, Tapri,	3 times in a year (once in every non monsoon season) for 3 years	Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted	SEMU

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Implementation	Supervision
				Mustafabad near School Rajpura, Sirhind, Aryapuri Senior Secondary school Doraha		Laboratory	
3	Vibration level	Vibration on dB scale respectively	70 dB(A)	Locations of sensitive receptors- Bedmani Hospital (km 22.6), Commercial Area (km 61.8), Temple at km 106.200, Mosque at km 219, Temple at Ambala at km 306, Rajpura km 337.50, Temple at km 367.500 and Gurudwara at km 390.000	Once a year for 3 years	Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted Laboratory	SEMU
4	Plantation	Survival rate	Survival rate may be calculated annually. Minimum 75% survival should be maintained. Any loss should be made up during monsoon	At compensatory afforestation site and along Kaura – Chamraula Section of EDFC	Annually for 3 years	Respective offices of CPMs at Meerut, Ambala and Ludhiana	SEMU
5	Water Quality Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted Laboratory	As per IS:10500 standards	CPCB standards	Surface water sources- western Yamuna Canal, Hindon River, Kali River, Upper Ganga canal, Yamuna River Ground water- Khurja station, Gulaoti, Meerut Cantt, Daurala, Jarauda, Deoband, Tapri, Saharanpur, Sarsawa, Jagadhari, Barara,	Once in a season for 3 years (Excluding Monsoon Season)	Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted Laboratory	SEMU

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Implementation	Supervision
				Shambhu, Ambala, Rajpura, Sirhind and Doraha			
6	Soil Quality	Parameters are NPK, Sodium Absorption Ratio, Oil & Grease	CPCB Standards	Locations where baseline monitoring done i.e.Khurja station, Hapur detour, Baral, Meerut Cant, Daurala, Khatauli, Mansurpur, Deoband, Tapari, Kalanaur, Jagadhari, Ambala cant, Sirhind Detour, Doraha	Once in a year for first 3 years	Respective offices of CPMs at Meerut, Ambala and Ludhiana through Accreditted Laboratory	SEMU

8.6 Organizational Framework

The proposed project will be implemented by DFCC through its Environmental and Social Management Unit (SEMU). The SEMU will be coordinating with the field level implementing agencies such as the Engineer (Supervision Consultant), Contractor and field level DFCC officials. Role and responsibilities of important officials is mentioned below.

Table 8.5 : Roles and Responsibilities of Officers

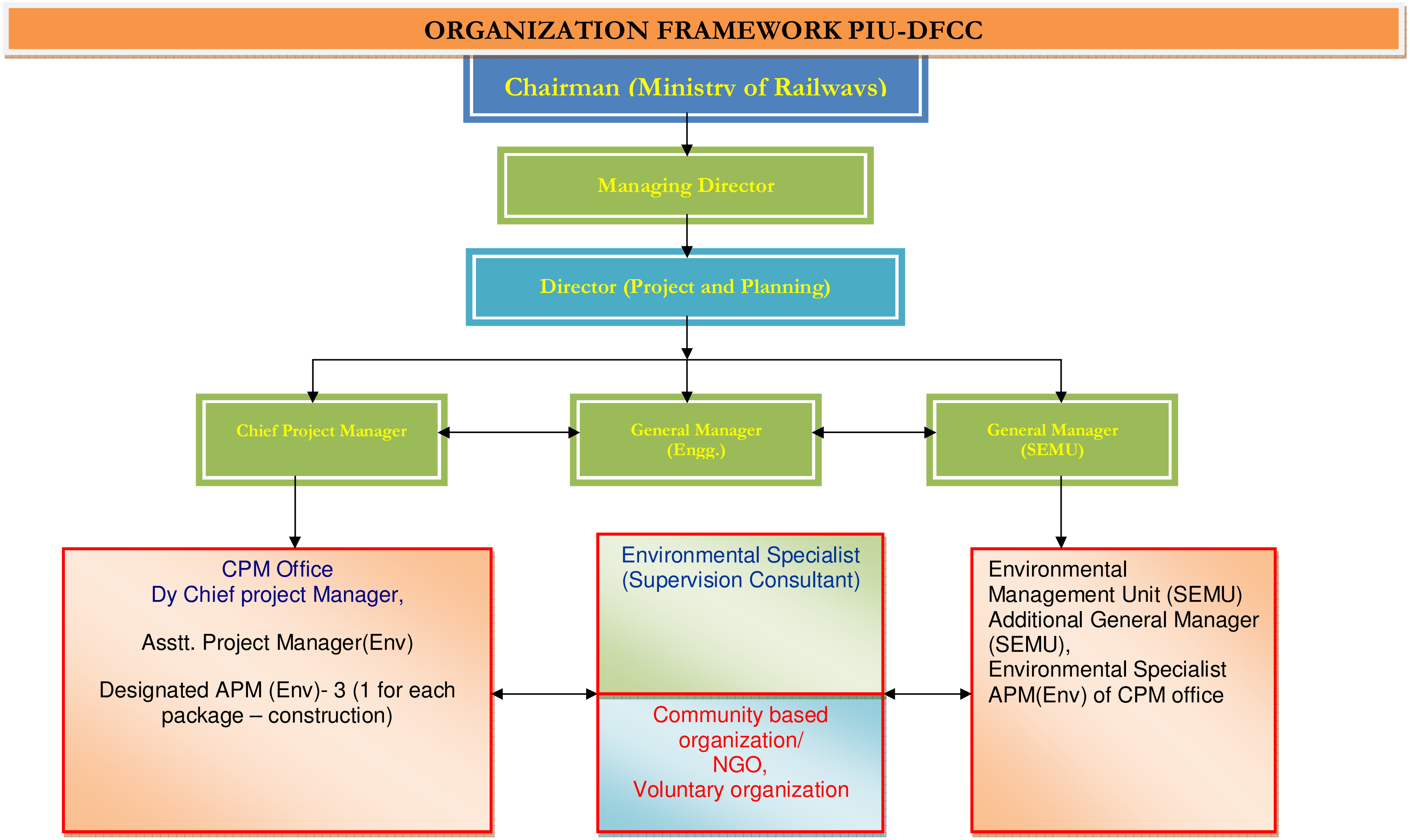
Officer	Responsibility
General Manager (SEMU)	• Overview of the project implementation • Ensure timely budget for the EMP. • Coordination with different state level committee, to obtain regulatory clearances. • Participate in state level meetings • Monthly review of the progress. • Reporting to various stakeholders (World Bank, Regulatory bodies) on status of EMP implementation
Chief Project Managers at Ambala, Ludhiana and Meerut (DFCC)	• Overall responsible for EMP implementation • Coordination with PIU Staff (SEMU & DFCC). • Responsible for obtaining regulatory Clearances • Review of the progress made by contractors • Ensure that BOQ items mentioned in EMP are executed as per Contract provisions.
Engineer (Supervision Consultant)	• Act as an “Engineer” for supervising EMP implementation • Responsible for maintaining quality of EMP envisioned in detail Project Report • Maintaining progress reports on EMP implementation • Periodic reporting to PIU-DFCC about the status of EMP implementation • Work in close coordination with Asst. Project Manager (package unit) and contractor.
Deputy Chief Project Manager	• Conducting need-based site inspection and preparing compliance reports and forwarding the same to the Environmental and Social Management Unit (SEMU) • Programming necessary training program on environmental issues.
Asst. Project Manager (Environment)	• Working as site-representative of Chief Project Manager • Conducting regular site inspection to all onsite and offsite works • Maintaining records of all necessary statutory compliance, to be obtained from contractor. • Maintaining records of EMP implementation including photographic records • Attending environmental and social training programs • Preparing periodic reports on EMP implementation and forwarding to EE • APM (Env) will functionally report to GM/SEMU at DFCCIL HQ
Designated APM (Env)	• Will be responsible for field activity during construction period • Report to APM(Env) of CPM’s office
Environment & Safety Manger of Contractor	• As detailed below

For ensuring that EMP is implemented as per provision in the document, Contractor shall nominate a qualified and experienced Environmental Specialist from the commencement to completion of the project.

The responsibilities of Environment & Safety Manager of Contractor will include the following:

- Directly reporting to the Project Manager of the Contractor;
- Discussing various environmental/social issues and environmental/social mitigation, enhancement and monitoring actions with all concerned directly or indirectly;
- Prepare Contractor's Checklist, traffic management plan and safety plan as part of their Work Program;
- Ensure Contractor's compliance with the ESMF stipulations and conditions of statutory bodies;
- Assist the project manager to ensure social and environmentally sound and safe construction practices;
- Conducting periodic environmental and safety training for contractor's engineers, supervisors and workers along with sensitization on social issues that may be arising during the construction stage of the project;
- Preparing a registers for material sources, labour, pollution monitoring results, public complaint/grievance redress, and as directed by the Engineer;
- Assisting the DFCC on various environmental monitoring and control activities including pollution monitoring; and
- Preparing and submitting monthly/bio-monthly reports to DFCC on status of implementation safeguard measures.
- Will be responsible for getting and maintaining the approvals or clearance for various departments and Environmental officer .

The organisation chart for EMP implementation has been given below:


ORGANIZATION FRAMEWORK PIU-DFCC
Chairman (Ministry of Railways)
Managing Director
Director (Project and Planning)
Chief Project Manager
General Manager (Engg.)
General Manager (SEMU)
CPM Office
Dy Chief project Manager,
Asstt. Project Manager(Env)
Designated APM (Env)- 3 (1 for each package – construction)
Environmental Specialist (Supervision Consultant)
Community based organization/ NGO, Voluntary organization
Environmental Management Unit (SEMU)
Additional General Manager (SEMU),
Environmental Specialist
APM(Env) of CPM office

8.7 EMP Budget

The cost of compliance of environmental issues must be included in the Bill of Quantity for the implementation of EMP, although most of the aspects will be covered under the engineering heads such as -

- Embankment
- Sign boards along construction sites
- Noise barrier
- Underpass for animals
- Culverts for irrigation canals

However, there are issues that are independently covered under the Environmental Budget such as plantation along EDFC, monitoring, enhancement measures, noise barrier, sanitation facility at labour camp, and solid waste disposal at site. The shifting and enhancement cost of sensitive receptors such as temple, majar, school, hospital etc shall be covered in R & R under community development. Mitigation measures proposed in the EMP will be implemented by the contractor. The works to be undertaken by the contractor have been quantified and the quantities included in the respective BOQ items such as earth works, slope protection, noise barriers, road safety features and shrub plantation.

Provisional quantities have also been included for additional measures that may be identified during construction and for site fencing, which will depend on the contractors work methods and site locations. Items and quantities have also been included for enhancement measures.

More general environmental management measures to be followed by the contractor have been included in the specifications and in this EMP. These cannot be quantified and are to be included in the contract rates.

The budgetary provisions for the implementation of the environmental management plan of the project are presented in **Table 8.6**

Table 8.6 : Cost Estimates for Environmental Management

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
A. PRE-CONSTRUCTION PHASE						
1.	Tree Felling Permission	Number	-	5707	-	Covered under regulatory clearances
2.	Forest Clearance and land diversion cost	ha	-	7.4	-	Covered under forest clearances
3.	Forest land Diversion Cost					
4.	Acquisition of land required for acquisition	Ha	-	648.38	-	Covered under project cost
5.	Utility Shifting	-	-	-	-	Covered under regulatory clearances, engineering cost
B. CONSTRUCTION PHASE						
1.	**Mitigation Measures other than Good Engineering practices**					
1.1	Oil interceptors at camps (Minimum 10 camps, per camp 2 oil interceptors at vehicle parking and washing areas)	Number	20,000	20	400,000	Will be provided near storage, vehicle repair section in construction camp
1.2	Soak pits for construction camp @ 2 soakpits at each camp	Number	20,000	20	400,000	
2.	**Tree Plantation and Protection**					
2.1	**Avenue plantation including compensatory plantation**					
2.1.1	Plantation and maintenance of saplings for 3 years(ten Trees per km on eitherside) and compensatory plantation of 17121 trees for 5707 trees to be cut	Number	1,000	4040 (Avenue Plantation)+ 17121 (Compensatory Plantation)=21161	21161000	
2.1.2	Half brick circular tree guard	Number	500	21161	10580500	
3.	**Monitoring of Environmental Attributes during Construction Phase**					
3.1	Monitoring of Air Quality	Per sample	10,000	315	310,0000	
3.2	Monitoring of Water Quality	Per	6,000	315	1890000	

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
		sample				
3.3	Monitoring of Noise Level	Per sample	3,000	300	900000	
3.4	Monitoring of Soil Quality	Per sample	6,000	70	420000	
3.5	Vibrations	Per Sample	30,000	40	120,0000	
C. ITEMS COVERED UNDER THE RAP BUDGET						
1.	Relocation of private properties					Covered under RAP Budget
2.	Relocation of private water points (wells, tanks, water taps and hand pumps)					
3.	Relocation of graveyards, statues, motor sheds					
4.	Relocation of other community assets including temples, majar, mosque, school etc.					
D. OPERATION PHASE						
1.	Monitoring of Noise Level	Per sample	5,000	90	450,000	Initial Three years Monitoring
2.	Monitoring of vibration Level	Per sample	30,000	24	720,000	Initial 3 years Monitoring
3	Monitoring Water Quality	Per Sample	8000	189	1512000	
4	Monitoring of Air quality	Per sample	12000	99	1188000	
5	Monitoring of Soil Quality	Per Sample	8000	42	336000	
3.	Noise mitigation measures in form of noise barrier at sensitive receptors (Construction of barrier of 100 m length at each noise sensitive Receptors, Total 18 Receptors)	m	10,000	1800	18000000	Initial 3 Years maintenance
E. GOOD ENGINEERING PRACTICES						

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
1.	Dust suppression					Covered under contractors quoted rate under construction cost
2.	Erosion control measures (Turfing / Pitching / Seeding & Mulching)					
3.	Provision of cross drainage & side drainage structures					
4.	General borrow area management and maintenance of haul road related to borrow areas					
5.	Air / noise pollution control measures in construction equipments					
6.	Management and disposal of scarified waste bituminous material					
7.	Provision of informatory signs					
8.	Cattle crossings					
9.	Management of quarries					
10.	Redevelopment of borrow area					
11.	Construction camp management cost					
12.	Safety measures for workers					
F. TRAINING & MANPOWER						
1.	Training	Number	200,000	4	800,000	Twice in a year during construction period
2.	Provision of environmental expert	Number	100,000	60	6000000	
G. Total					**INR50057500.00**	
H. Contegencies @ 5%					**INR2502875.00**	
I. Total EMP Budget					**INR 52560375.00 Say INR 5.3 Corers**	
J. Total Budget in US $ (1 US$=INR 50)					**1.06 Millions**	

Annexure- 8.1: EMP Implementation Schedule

Environmental Issue	EMP Component	Time line																					
		Construction Phase					Operation Phase																
		1	2	3	4	5/6	1	2	3	4	5	6	7	8	9	10	11	12	13	~~	20	25	30
Technical Support	Preparation of Environmental guidelines and development of EHS management System																						
Flora and Fauna	Minimization of Tree cutting and Compensatory afforestation (Minimum 1:3) (Plantation and maintenance for one year)																						
	Movement of nesting birds																						
Drainage Pattern, Water logging , Soil Erosion and Borrow Area Management	Monitoring of water logging,																						
	Monitoring of Soil Erosion at bridge approaches, River embankments, corridor embankment, Siltation level in the River																						
	Borrow Area Rehabilitation																						
Land	Compensation against land acquisition																						
Water & Drinking Water Supply	Installation of grease traps at construction sites																						
	Construction of soak pits at construction sites & Rehabilitation sites																						
	Monitoring of Surface Water Quality																						
	Monitoring of Ground Water Quality																						
Air Quality & Dust Management	Water Spraying/ Watering																						
	Monitoring of Ambient Air Quality																						
Construction Safety	Provision of PPEs																						
Health Issues	Health Checkup Camps																						
Tree & noise monitoring	Monitoring of Tree Felling & Plantation																						
	Maintenance of tree (Additional two years)																						
	Provision of additional tree plantation																						
	Monitoring of Noise & Vibration																						
Establishments	Construction Stage, with requisite facilities for sanitation, solid waste management, prevention of soil contamination,																						
Training	Environmental training & Awareness																						
MIS	Establishment and operation																						

Legends

- Critical
- High priority
- Medium priority
- Low priority

Annexure- 8.2 : Training and Awareness
Details of Proposed Training & Awareness Program with Budget

S. No.	Target group	Subject(s)	Method	Time Frame and Estimated Cost	Basis for Costs Estimation	
					Training Material Preparation	Training Delivery
1	All Project Staff of DFCCIL involved in implementation of the project	**Environmental Overview:** Environmental Regulations, sub-project related provisions of various Acts/ Guidelines, process and methodology for EIA EMPs	Lecture cum interaction	Before beginning of the implementation of the sub-project. INR 6.24 Lakhs	@ Rs 2.0 Lacs	Reproduction of Training Material Rs 24,000 (@ Rs. 400 per set for 60 sets) Training Delivery: Honorarium and travel cost of the faculty Rs 2.0 lac (@ 1,00,000 per programme for 2 programmes) Venue and other facility costs Rs 2.0 lacs (@ Rs 1,00,000 per programme with 25 participants in each)
2	EMU staff at site responsible for implementation of EMP, Supervision Consultant's Environmental Specialists and Select NGOs	**Implementation of EMPs:** Basic features of an EMP, Planning, designing and execution of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions – during construction and operation	Workshops and Seminars	Before the construction begins INR 6.24 Lakhs	@ Rs 2.0 Lacs	-do-

3	Environmental officers, design team, Supervision Consultant Construction Contractors' staff	**Environmentally Sound Construction Practices:** Clean construction technology, alternatives materials and techniques for construction, Waste Management and minimization in construction, pollution control devices and methods for construction sites and equipment, Environmental clauses in contract documents and their implications, protection of flora and fauna Environmental monitoring during construction	Workshops and Site visits	Before the construction INR 6.24 Lakhs	@ Rs 3.0 Lacs	-do-
4	SEMU designated officials and Supervision Consultant, NGOs and community representatives	**Monitoring Environmental Performance during Construction:** Air, Water, Soil and Noise, tree survival Monitoring requirement and techniques, Evaluation and Review of results, Performance indicators and their applicability, possible corrective actions, reporting requirements and mechanisms	Lectures, Workshop and site visits	During initial phases of construction INR 5.0 Lakhs	@ Rs 1.5 Lacs	Reproduction of Training Material Rs 24,000 (@ Rs. 400 per set for 60 persons) Training Delivery: Honorarium and travel cost of the faculty Rs 1.6 lac (@ 8,000 per programme for 2 programmes) Venue and other facility costs Rs 1.6 lacs (@ Rs 80000 per programme with 25 participants in each)

5	-do-	**Long-term Environmental Issues in Project Management:** Designing and implementing environmental surveys for ambient air, noise, vibration, biological and water quality surveys, data storage, retrieval and analysis, contract documents and environmental clauses, risk assessment and management, contingency planning and management and value addition	Workshops and seminars	During implementation of the Sub-project INR 5.0 Lakhs	@ RS 1.5 Lacs	- Do -
6	Public /contractors workers	**Awareness programmes** on environmental protection and measures being implemented by DFCCIL and their role in sustaining the measures taken including for noise pollution, air pollution, safety, soil conservation, and tree plantation	Workshops	During construction and initial phase say 4 years of operation 13.0 Lakhs	@ RS 3.0 Lacs includes costs of designing of awareness booklets/material	Material reproduction costs 2.0 lac (RS 200 for 1000 sets) Faculty Lumpsum: Rs 2.0 lac Delivery Lumpsum 6.0 (two hours workshops)
7	DFCCIL project Staff, Supervision Consultant, Engineering Staff of Contractor.	Restoration of sites viz borrow areas, construction Camps, Ocupational health and safety, management systems, tree plantation and sustainability and Reporting Formats/procedure	Lecture/Presentations	before Contractor Demobilization INR 4.3 Lakhs	@ Rs 1.0 Lac	Reproduction of Training Material Rs 10,000 (@ Rs. 200 per set for 50 persons) Training Delivery: Honorarium and travel cost of the faculty Rs 1.6 lac (@ 80,000 per programme for 2 programmes)

						Venue and other facility costs Rs 1.6 lacs (@ Rs 80000 per programme with 25 participants in each)
			Total Training Costs	**Rs 46.02 lacs or Say Rs 46.00 lacs or 4.6 million rupees**		

Annexure- 8.3 : Tree Plantation and Management Guidelines

Preparation of the Plantation Area

For plantation in new areas it always economical and comfortable to plant trees in blocks. The open areas near the DFC proposed project alignment shall be identified and selected. During the selection of the block plantation sites the availability of the water in nearby areas should be taken into consideration as the survival of the tree saplings depends on the availability of water or watering facilities especially in the dry areas.

Preparation of Pits and Sapling Transplantation

The location of each plantation pit shall marked according to the design and distance of the plantation. The size of the plantation pit varies depending upon the species of the plants, height of the saplings. Trees shall be planted on the alternate rows in a straight line for the prevention of the horizontal dispersion of the pollutants. Hence the pit shall be dig accordingly. During the time of placing the tree saplings the roots shall be freed from plastic or any type of cover which is normally use for the transplantation of the tree saplings from the seed bed to the tree plantation pits. This exercise will help the root hairs to reach the soil.

Spacing

For the survivability of the tree species planted spacing between the sapling should be maintained. Spacing which are usually used for teak planting are 2 x 2 m^2, 3 x 1 m^2, 3 x 3 m^2, 4 x 2 m^2 and 4 x 4 m^2, depending on site condition. However, wider spacing of 6 x 1 m^2 can also be adopted sometimes where the survivability is high. Closer spacing is used for straight timber of good quality.

Time of Plantation

As per the normal practices followed under the silvicultural guidelines plantation of the tree sapling to be done only after the first shower during the rainy season. The best time for plantation is after 15 days from the day of first shower during rainy season.

Protection of Tree saplings:

Circular tree guard should be placed after the plantation of the saplings for the protection of these young plants from the ravages of cattle, sheep and goat and other animals. If tree saplings died or damage occur after placing the circular tree guard, timely replacements of damaged plant and thereafter care is important.

Selection of Tree Species

The selection of the tree species to be planted plays a crucial role for higher survivability rate. This is always better to choose the endemic plants of the area where the plantation to be done. In the DFC Khurja to Ludhiana stretch the existing plantation is of mostly the exotic eucalyptus and poplar to the area. Following are the list of some endemic plant species which shall be planted in the near by areas of the proposed DFC Khurja to Ludhiana stretch.

Serial no.	Name
1	Kikar or Babul (*Acacia nilotica)*
2	Siris (*Albizia lebek*)
3	Simul (*Bombax ceiba*)
4	Bauhinia *(Bauhinia purpurea*)
5	Krishnasura (*Delonix regia*)
6	Pipal or Bo Tree (*Ficus religiosa*)
7	Barh or Banyan (*Ficus benghalensis*)
8	Imli or Tamarind (*Tamarindus indica*)

Serial no.	Name
9	Terminalia arjuna
10	Amrood or Guava (*Psidium guajava*)
11	Jack Fruit (*Artocarpus heterophyllus*)
12	Satiana (*Alstonia scolaris*)
13	Pakori (*Ficus rumphii*)
14	Amlakhi (*Phylanthus embilica*)
15	Kadam (*Anthrocephalus cadamba*)

It is recommended to use local species for better survival.

Maintenance (include thinning)

a. **Weeding:** Low pruning at 6 months

b**. Thinning:** Thinning shall start after the stand is 3-4 years old and repeated every 4 years until the stand is 15 years old. Between 15-25 years old, thinning should be conducted every 5 years and after 25 years old, thinning shall be done after every 10 years. When the canopy closes, at about 6 years, 30-40% of the stems shall be thinned to selectively remove suppressed, diseased and badly formed trees.

The Cost of Plantation with calculation tree plantation for this project as sample

The Cost of the plantation with the five year maintenance plan.

Year/ Particulars	Cost of Planting Single Tree(5 year tree maintenance)						Cost of Planting 16723 X 3 nos. of Plants
	1st Year (Rs.)	2nd Year(Rs)	3rd year (Rs.)	4th year (Rs.)	5th year (Rs.)	Total (Rs.)	Cost of Planting 16723 plants
Plantation	2100 including labour and management	600	600	600	600	1500	7,52,53,500
Circular Tree guard	750	Nil	Nil	750	Nil	1500	2,50,84,500
Total=							10,03,38,000

The total cost of plantation will be Rs. 1003 lakh

Annexure- 8.4 : Guidelines For Borrow Earth Management

SELECTION AND REHABILITATION OF BORROW AREAS

Guidelines for selection of borrow pits, amount that can be borrowed and its rehabilitation in line with The Indian Road Congress (IRC):10-1961 shall be followed and are as follows:

- Borrow areas shall not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth shall not exceed 45 cm. The topsoil to a depth of 15cm shall be stripped and set aside. Thereafter, soil may be dug out to a further depth not exceeding 30 cm and used in forming the embankment.
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Ridges of not less than 8m widths will be left at intervals not exceeding 300m. Small drains will be cut through the ridges, if necessary, to facilitate drainage. The slope of the edges will be maintained not steeper than 1:4 (vertical: Horizontal).
- Borrow pit shall be selected from wasteland ;
- Priority shall be given to the borrowing from humps above the general ground level within the road land;
- Priority shall be given to the borrowing by excavating/enlarging existing tanks;
- Borrowing shall be from land acquired temporarily and located at least 500m away from the road;
- Borrowing shall be from mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the road;
- Borrow area near to any surface water body will be at least at a distance of 15m from the toe of the bank or high flood level, whichever is maximum.
- In case of settlements, borrow pits shall not be selected within a distance 800 m from towns or villages. If unavoidable, earth excavation shall not exceed 30cm in depth;
- The haulage distance from site shall not be too far.
- Redevelopment plan shall be prepared by the contractor before the start of work which should be duly agreed upon by land owner.
- Borrow pits shall be backfilled with rejected construction wastes and covered with vegetation.
- Borrow areas might be used for aquaculture in case landowner wants such development.
- Borrow pits located near habitat areas will be re-developed immediately after borrowing is completed. If spoils are dumped, that will be covered with a layers of stockpiled topsoil in accordance with compliance requirements with respect MOEF/SPCB guidelines.

Annexure- 8.5: Guidelines For On Site and Off Site Emergency Management

Many emergencies can occur on any construction site and need to be effectively handled. . The environmental and occupational health and safety aspects and related emergency can includes incidence such as Collapse / subsidence of soil / Fire / Explosion / Gas Leak, Collapse of Building / Equipment and other Occupational Accidents. On site and off site emergency management plan shall be developed to effectively handle them. The following guidelines can be used to develop these plans

Availability of 'On-Site Emergency Plan'

Every contractor shall have a written on-site emergency plan. The contractor should submit a copy of this plan to Technical Division of DFCCIL before the start of the work.

Contractor shall develop the onsite emergency plan considering the potential environmental, occupational health and safety emergency situation at site.

Contractor shall include a list of these potential emergency situations in the on site emergency preparedness & response plan.

Identification of Potential Environmental and Occupational Emergency Situations during construction, operation and maintenance stages

The potential emergency situations have been defined below for guidance purposes. The contractors can follow these for developing site specific on site emergency preparedness plan.

Emergency conditions / situations	Sources
Collapse / subsidence of soil	▪ Civil structures
Bulk spillage	▪ Hazardous substance / inflammable liquid storage ▪ Vehicular movement on highway
Fire and explosion	▪ Inflammable Storage Areas ▪ Gas Cylinder Storage Areas ▪ Electrical Circuits ▪ Isolated Gas Cylinders (LPG / DA) ▪ Welding / Gas Cutting Activity
Electrical Shock	▪ HT line ▪ LT distribution ▪ Electrically Operated Machines / Equipment / Hand Tools / Electrical Cables
Gaseous Leakage	▪ Gas Cylinder Storage Areas ▪ Gas Cylinder used in Gas Cutting / Welding Purposes
Accidents due to Vehicles	▪ Heavy Earth Moving Machinery ▪ Cranes ▪ Fork Lifts ▪ Trucks ▪ Workman Transport Vehicles (cars / scooters / motor cycles / cycles) ▪ Collapse, toppling or collision of transport equipment
Slips & Falls (Man & Material)	▪ Work at Height (Roof Work, Steel Erection, Scaffold, Repair & Maintenance, Erection of equipment, Excavation etc.) ▪ Slips (Watery surfaces due to rain) ▪ Lifting tools & Tackles (Electric Hoist & Forklifts)

Collision with stationary / moving objects	▪ Vehicular movement on highway
Other Hazards	▪ Cuts & Wounds ▪ Confined Space (under & inside machinery etc.) ▪ Hot Burns ▪ Pressure Impacts (Plant contains several Pressure Vessels & pipefitting containing CO2, Air, Water, product & Steam, which can cause accidents & injuries to person around.)

Design of 'On-Site Emergency Plan'

The 'On-site emergency plan' to be prepared by contractor for each railway line shall include minimum the following information :

Name & Address of Contractor
Updation sheet
Project Location
Name, Designation & Contact Numbers of the organization, nearby hospitals, fire agencies etc and key personnel including their assigned responsibilities in case of an emergency.
The roles and responsibilities of executing personnel
Site Layout Diagram
Identification of Potential Emergencies Situations/ preventive measures / control & response measures
Location of Emergency Control Centre (or designated area for emergency control / coordination) with requisite facilities.
Medical services / first aid
List of emergency equipment including fire extinguishers, fire suits etc.

Emergency Control Centre

The emergency control centre shall be equipped with following facilities
Copy of current on-site emergency plan
Display of the name of site emergency controller
Two numbers of artificial respiratory sets
Two numbers of Stretchers
Vehicle for 24 hours (for large construction sites)
Inter personnel/section telephone (2 numbers)
Site layout diagram with entry and exit routes / Assembly points
Directory of internal / external emergency phone Numbers
A set of fire extinguishers (DCP type / Foam Type / CO2)
List of fire extinguishers installed in the construction site including maintenance record
A set of personal protective equipment (PPE)
Two numbers of first-aid boxes with prescribed first-aid medicines
List of competent first-aiders
List of fire trained personnel
Two numbers of blankets
Drinking water
Two numbers of rescue ropes
Two numbers of high beam torches
Two numbers of gas leak detectors
Life boat & jackets (if working in or near water course)

Annexure- 8.6: Guidelines for Debris and Solid Waste Management

Guideline for dumping debris & solid waste material

Management and disposal of construction waste is one of the major issues during construction work of Railways. The following preparations are suggested for disposal of waste material.

1. The debris disposal site should be identified which are preferably barren or low-lying areas away from habitat.
2. Due care should be taken during site clearance and disposal of debris so that public/ private properties are not damage or effected, no traffic are interrupted.
3. All efforts should be made to use debris in railway line construction or any other public utilities.
4. The debris should be stored at site ensuring that existing water bodies and drains within or adjacent to the site are kept safe and free and no blocking of drains occurs.
5. All dust prone material should be transported in a covered truck.
6. Water space should be used during handling of these materials.
7. All liquid waste like oils and paint waste should be stored at identified locations and preferably on a cemented floor. These should be sold off to recyclers.
8. All efforts should be made that no chemical/ oily waste spill over to ground or water bodies.
9. All precautions should be followed for emergency preparedness and occupational health & safety during construction and handling a waste.
10. Adequate traffic control signals and barriers should be used in case traffic is to be diverted during debris disposal. All efforts should be made to ensure avoidance of traffic jam, which otherwise results in air pollution, noise pollution and public unrest.

Annexure- 8.7: Silica Exposure Reduction Strategies

PART 1 - GENERAL APPLICATION

1.1 Description

A. This addendum specifies minimum environmental health and safety equipment, practices and procedures to minimize exposures to airborne silica dust during quarry operations, stone crushing, transport, and site construction. The scope of this section is limited to dust controls and employee protection in these environments.

B. This addendum shall take precedence over overlapping requirements in the Technical Specification unless otherwise stated.

C. This document is an integral part of the contract and the contractor has the responsibility to fully implement it. Any request to deviate from any specified requirement shall be made in writing to the project sponsor.

D. This addendum supplements all local, regional and national laws and regulations concerning the location, environmental emissions, and occupational safety in these operations. If regulatory requirements are more stringent, or require more frequent verification than outlined in this standard, then the regulatory provisions shall take precedence and become the de facto requirement in that jurisdiction.

E. Contractor(s) shall provide a copy of the licensing documentation (NOC/ Consent to Establish) for each facility from where they purchase crushed stone including each quarry, stone crusher mill, and hot mix plant indicating they meet all applicable requirements.

1.2 General Site Requirements Quarries:

- Operator must establish a reliable source of water with adequate capacity and pressure to run all dust suppression systems at the quarry site;
- Operator must establish a reliable source of power for all mechanical equipment at the stone quarry site;
- Residential areas and temporary employee housing must be located a minimum of 100 meters from any quarrying operations;
- Stone drilling, cutting and conveying operations shall be equipped with either continuous wet suppression system or dry dust collectors designed and operated per minimum requirements below.
- Dust controls in quarries must include water fed compressed air drilling equipment, enclosed screens; enclosed transfer points, covered conveyors, and chutes.
- Wet the surface of rock materials with a hose before blasting operations.

1.3 General Site Requirements Stone Crusher Mills and Hot Mix Plants:

A. Contractor shall submit a detailed plan for any temporary stone crusher or hot mix plant sites intended to be utilized for this project. The plan shall show adjacent areas within 100 meters and depict all structures and roadways. All temporary sites must meet all requirements specified in this addendum and must obtain a Consent to Establish/ (NOC) from the applicable authorities.

B. Temporary or permanent stone crusher sites or hot mix plants must meet all of the following requirements:

- Site must be at least 250 meters from National and State Highways and 500 meters from schools, educational institutions and religious places.
- Establish green belt zone as required by applicable local requirements;
- Residential areas and temporary employee housing must be located a minimum of 200 meters from any stone crushing equipment or operations;

- Operator must establish a reliable source of water with adequate capacity and pressure to run all dust suppression systems installed at the stone crusher site;
- Operator must establish a reliable source of electricity for powering all mechanical equipment and pollution controls installed at the stone crusher site;
- Crushing, screening, and conveying operations shall be equipped with either continuous wet suppression system or dry dust collectors designed and operated per minimum requirements below.
- Crushing, screening, and conveying operations must be enclosed with sheet metal or other rigid material. Do not use cloth or plastic enclosures.
- Roadways inside the crusher mill shall be metalled, paved or otherwise treated with chemical suppressants for dust suppression.
- Waste dust materials from stone crushing operations shall be stored in closed containers or closed structures.
- Lorries exiting the site must be cleaned with shovel and broom to minimize dust being tracked off site.
- Minimize drop heights to storage piles;
- Windbreak walls that are at least six times longer than its height shall be in place.
- Regularly remove and safely dispose of waste materials (rock dust) from the plant site in covered lorries;
- Fugitive emissions including emissions from stockpiles, conveyors and other areas shall be minimized as far as practicable. Emissions from these sources shall be substantially free from visible dust emission.

1.4 General Site Requirements Construction Sites:

The following requirements shall be implemented during the following operations:

- Stockpiling;
- Earth moving/ earth works, grading, and leveling;
- Transfer from stock pile to work site;
- Final placement; and
- Laying the track.

- Operator must establish a reliable source of water with adequate capacity and for all dust suppression required at the construction site;
- Regularly remove and safely disposing of waste materials (rock dust) from the site in covered lorries;
- Waste dust materials from stone crushing operations if used for fill shall be covered within 4 hours;
- Minimize spillage of raw materials. Promptly clean up all spillage and accumulations of dust.
- Fugitive emissions including emissions from stockpiles and other areas shall be minimized as far as practicable. Emissions from these sources shall be substantially free from visible dust emission.

1.5 General Environmental Protection:

The Contractor shall take steps to protect the environment and surrounding populations from silica dust hazards. Ensure that the water required for dust suppression operations is sourced from a supply that will not impact the quality or availability of water in the surrounding environment. Follow all State requirements for siting criteria and obtain consent from applicable state pollution control board. Ensure that emissions, surface discharges and site closure practices shall comply with all applicable laws including but not limited to:

• The water (prevention and control of pollution) act 1974; no. 6 of 1974.

• the air (prevention and control of pollution) act, 1981; no. 14 of 1981.

Part 2 - Technical Requirements to Minimize Airborne Dust Emissions

2.1 General

The handling of raw materials, products, wastes or by-products should be carried out as to minimize the release of airborne dust. Use Table 1 below for guidance in employing dust suppression methods.

Table 1: Feasible Control Measures for Open Dust Sources
Fugitive Emission Control Measure

Source	Enclosures	Wet Suppression	Chemical Stabilization	Green Belt	Surface Cleaning	Wind Break Walls
Unpaved roadways and staging areas		X	X			
Storage piles	X	X	X			X
Stone crushing operations	X	X		X	X	X
Paved roadways and staging areas					X	
Exposed areas	X	X	X	X		X
Batch drop operations	X	X				X
Continuous drop operations	X	X				X

2.2 Wet Methods: Water spray Dust Suppression Systems for Stone Crushing Mills

Details of system components for all stone crusher facilities:

A. Minimum number and locations of pressure spray nozzles:

- 1 nozzle on the top of the crusher
- 2 nozzles at the delivery point of crushing material
- 1 nozzle on the bottom of the vibrator screen or rotary screen
- 2 nozzles within the storage hopper
- 1 nozzle at the delivery point of raw materials
- 1 nozzle at the bottom of the dust hopper

B. A water pump with adequate motor horsepower and discharge pressure as required for optimal performance of spray nozzles.

C. Covered water storage tank, with a manhole type maintenance provision. The cover should prevent atmospheric dust from entering the tank. The tank can be located at the ground level. Water from a bore well or other source could be pumped to fill the tank periodically.

D. Centrifugal monoblock type self-priming pump capable of delivering 3 to 5 kg/cm^2 pressure and 72 liters per minute.

E. 100 stainless steel mesh online water filter with two parallel cells. Parallel cells should be set up in order for to allow connections to be reversed such that one cell undergoes backwash cleaning while the other cell is in operation. Only filtered water should be supplied to the spray nozzles.

F. Chemical surfactants or wetting agents may be added to water used in the spraying systems.

G. All spraying systems used for dust suppression shall be maintained in good condition. The flow rate and operating pressure of the spraying liquid/solution shall be sufficient to suppress dust emissions from the corresponding sources. The spraying system shall be able to cover the areas of emission points concerned.

H. All water spray equipment shall be operational during all stone crushing operations at the site.

I. No domestic showers, sprinklers, or other general water spray devices may be substituted for pressure misting nozzles. Nozzles may be hollow cone, solid cone or fan type.

2.3 Dry Methods: Dust Extraction Systems for Stone Crusher Mills/ Hot Mix Plants

Details of system components:

A. Minimum requirements for dry dust capture and collection systems:

- Hood or enclosure to capture emissions;
- Dust collector that separates particulates (e.g. centrifugal dust collectors); and
- Duct to transport particulates in air stream from dust collector to air pollution control device (e.g. baghouse).

B. Capture hoods shall be installed over all crusher units and screens. Enclosures shall surround all sources of dust to the extent possible.

C. Dust collector shall be connected in-line via an enclosed duct to a cyclone and baghouse for dust removal.

D. Air handling system shall be a suitable size to prevent the escape of untreated airborne dust. Maintain minimum airflow as per design. A minimum draft velocity of 1 meter/ second shall be maintained through all open hoods.

E. Inspect bag filters routinely and at least once per month for damage and clean, repair or replace as needed.

2.4 Dust Containment Enclosures for Stone Crusher Mills and Hot Mix Plants:

Particulate emissions shall be controlled by installing dust containment enclosures at the following locations:

A. Primary crusher discharge area

Enclosure shall cover discharge areas to all conveyor belts or secondary crusher.

B. Vibratory screen

All vibratory screens shall be totally enclosed. Screen houses shall be rigid and reasonably dust tight with self-closing doors or close-fitted entrances and exits for access. Where conveyors pass through the screen house, flexible covers should be installed at entries and exits of the conveyors to the housing.

C. Conveyor belts (optional)

The enclosures should be complete from all the four sides and roof. There should not be any open windows/openings etc. Any opening should be kept closed during operation. The gaps should be sealed using gaskets or wool type packing etc. Crusher enclosures shall be rigid and be fitted with self-closing doors and close-fitting entrances and exits. Where conveyors pass through the crusher enclosures, flexible covers should be installed at entries and exits of the conveyors to the enclosure.

D. Inlet hopper

The inlet hopper shall be enclosed on three sides.

E. Rotary dryer

The plant rotary dryer in a hot mix plant.

Malfunctioning or breakdown of equipment leading to abnormal emissions shall be dealt with promptly. In any case, the abnormal emission due to equipment failure shall be stopped as soon as practicable. The dust collection system shall be routinely inspected and maintained in good condition and shall be used as required. The owner shall conduct an inspection of the dust control system at least once per month.

2.5 Minimize Fugitive Dust From Roadways and Stock Piles

Minimize fugitive dust emissions from all sites where crushed rock is stored. Particulate emissions from unpaved roads and stock piles shall be controlled with the application of suitable compounds to minimize the control of dust. Petroleum-based products, waste oils or other waste products shall never be used for this purpose. Acceptable compounds for this purpose include:

- Acrylic polymers;
- Solid recycled asphalt;
- Chloride compounds (calcium chloride and magnesium chloride);
- Lignin compounds (lignin sulfate and lignin sulfonate powders);
- Natural oil resins (soybean oil); and
- Organic resin emulsions.

Contractor shall provide a product information sheet prepared by the manufacturer or distributor indicating the chemical composition, application instructions, and other environmental, safety and health considerations 30 days in advance of its intended application to Engineer's Representative. The product information shall be reviewed and approved in writing before the contractor proceeds to apply it on the project site.

2.6 Minimize Fugitive Dust From Heavy Equipment and Road Transport Vehicles

Minimize fugitive dust emissions from all vehicles when loading, unloading and operating vehicles on project sites, staging areas, or stone crusher mills. Settled dust and particulate emissions from lorries used to transport stone or waste products generated in stone crushing operations, and other heavy construction vehicles, shall be minimized in accordance with the following practices:

Lorries shall be filled with the material using wet methods. Load waste fine materials and powders onto tankers or closed trucks through a lengthy sleeve attached to the spout to minimize drop height and dust release.

Lorries once filled with stone or other waste materials shall be covered before leaving the site. A single layer impermeable tarp shall be placed over the entire load and secured with rope or other tension bar.

Designate a decontamination area that is required to be used by all vehicles before exiting the site. This area shall be covered with an impervious tarp. Use wet methods to wipe all accessible exterior surfaces of vehicles and tires.

Impose strict speed limits for all vehicles operating on service roads, loading areas, or staging areas.

2.7 Minimize Fugitive Dust during Rock Quarry Operations

Particulate emissions shall be controlled during drilling, blasting, loading, and hauling with wet methods using surfactants applied in either water or foam spray.

Dust controls for stone drilling shall use water fed into the compressed air to suppress the dust.

2.8 Work Practices for Reducing Employee Exposures

This section pertains to all activities with potential for dust exposure to workers employed in quarries, stone crusher units, hot mix plants, and construction sites.

Use wet methods where feasible to reduce dust emissions from working surface or equipment.

Use a gentle spray or mist to moisten settled dust particles. When washing large quantities of dust from a surface, increase the water force only after pre-wetting all the dust with a gentle spray. Use only the minimum amount of water needed to get the job done without creating runoff.

Rewet surfaces as necessary to control dust.

Part 3 - Technical Requirements for Worker Medical Surveillance

3.1 General

This section pertains to workers employed in quarries, stone crusher units, and hot mix plants.

3.2 Medical Monitoring

Medical monitoring shall be conducted for each worker before the start of work and at least at annually thereafter. Examination shall as a minimum meet requirements as set forth below:

Examination

1. The employer shall ensure that all medical examinations and procedures are performed by a licensed physician, and are provided at no cost to the employee and at a reasonable time and place.
2. Persons employed under the licensed physicians may administer the pulmonary function testing, chest x-ray or other testing procedures required by this section if adequately trained by an appropriate academic or professional institution.
3. A physical examination directed to the pulmonary system, including a chest x-ray to be administered and pulmonary function tests of forced vital capacity (FVC) and forced expiratory volume at one second (FEV(1)). Interpretation and classification of chest roentgenograms shall be conducted in accordance with ILO classification system. Interpretation of the chest x-ray shall be conducted under the ILO Classification of Radiographs of Pneumoconiosis by a reader trained under this protocol. Evaluate chest x-ray for possible tuberculosis because people exposed to silica have increased susceptibility.

Report from Medical Examination: A report must be submitted from all medical examinations conducted within the last 12 months to document compliance with this medical surveillance requirement for each worker employed in quarries and stone crusher units. Submit, at a minimum, for each worker the following:

Name and Employee Identification Number

Physician's Written Opinion from examining physician including at a minimum the following:

- Whether worker has any detected medical conditions that would place the worker at an increased risk of material health impairment from exposure to silica.
- A statement that the worker may wear a negative pressure respirator or any recommended limitations on the worker or on the use of personal protective equipment such as respirators.
- Statement that the worker has been informed by the physician of the results of the medical examination and of any medical conditions that may result from dust exposure.

3.3 Record Keeping

1. The employer shall establish and maintain accurate records of medical surveillance to include the physician's written opinion on each employees health status.
2. Records shall be maintained for at least the duration of the contract period.
3. A copy of the each employee's records must be provided to the affected employee who has undergone the medical surveillance stipulated above within 30 days of the date of the examination.

Part 4 - Requirements for Employee Training

4.1 General

A. This section pertains to all workers employed in quarries, stone crusher units, hot mix plants, and any construction workers using powered tools or equipment to cut, grind, core, or drill concrete or masonry materials. The training provided under this section shall be provided to workers at no cost to these employees and in a language understood by workers at each training program. The course shall be taught by an environmental health and safety specialist with adequate education, experience and training.

B. Incorporate general information about silica dust hazards in all orientation and site training sessions covering health or safety aspects.

4.2 Training Topics

The employer shall provide training on the following topics to all employees prior to their assignment to jobs where the employer will be conducting these operations during this project:

A. The potential health hazards of exposure to airborne silica dust including silicosis, tuberculosis, lung cancer, chronic obstructive lung disease (COPD) and decreased lung function.
B. Methods used by the employer to control employee exposures to airborne silica dust including wet or dry methods for stone crushing, drilling, cutting, local exhaust ventilation systems, and isolation of the process from employees by means of distance, enclosure, or other means, as applicable.
C. Proper use and maintenance of dust reduction systems, including the safe handling and disposal of waste materials.
D. The importance of good personal hygiene and housekeeping practices when working in proximity to silica dust including:
   - Not smoking tobacco products; appropriate methods of cleaning up before eating, and appropriate methods of cleaning clothes.
   - Avoiding, to the extent practical, activities that would contribute significantly to exposure to airborne dusts.

Part 5 – WORKER PROTECTION

5.1 General

Contractors shall supply respirators and other specified safety equipment to all workers employed in quarries, stone crusher units, hot mix plants, and any construction workers using powered tools or equipment to cut, grind, core, or drill concrete or masonry materials as described below:

A. Do not eat, drink, smoke, chew gum or smoke tobacco in the work area. To eat, drink, chew, or smoke, workers shall follow the procedures described below and leave the work area.

B. Provide workers with a clean source of water for a facility to wash hands and face with soap and water. This should be done before eating, smoking or drinking and at the end of the day before going home. Hand washing facilities shall be set up adjacent to the work area.

C. Engineering and work practice controls must be used whenever the possibility exists that employees may be exposed to silica including during stone crushing and construction operations.

D. The use of compressed air, dry sweeping, or any cleaning method that would cause elevated silica dust air concentrations are prohibited.

5.2 Respiratory Protection

Minimum Respiratory Protection: Require that the minimum level of respiratory protection used be Respirator Class FFP3 under European standard EN 143 or N99 under the U.S. National Institute for Occupational Safety and Health (NIOSH) classification. Respirators shall be single use disposal respirators for dusts or reusable half-face air-purifying respirators with high efficiency particulate air filters.

Require that a respirator be worn by anyone in a Work Area at all times during any operation. Do not allow the use of surgical masks or other types of disposable respirators not specified above for any purpose.

Fit testing shall be conducted on any reusable air-purifying respirator assigned to the worker.

Only assign respirators to workers medically approved to wear negative pressure respirators as per the physicians written opinion following an annual medical examination as per the requirements in Part 3 of this addendum.

5.3 Protective Equipment

Do not allow workers to leave the work place wearing any clothing or equipment worn during the work shift. Provide the following:

A. Eye Protection: Provide eye protection as needed for the type of work being performed.

B. Shoes: Provide shoes to all workers and require that they be worn at all times in the Work Area.

C. Hearing protection: Provide all workers at all quarries, stone crushing sites, and hot mix plants and all other workers exposed to loud noise with ear plugs or other suitable hearing protection.

Part 6 - EMISSION AND AMBIENT AIR LIMITS

6.1 General

Contractors shall conduct all required emissions monitoring as required to prove compliance with all applicable State Pollution Control Board Regulations and the limits specified within this section. This section applies to all permanent and temporary stone crushing mills and hot mix plants.

6.2 Suspended Particulate Matter (SPM)

The Suspended Particulate Matter (SPM) at a distance of 40 meters from a stone crusher unit in a cluster should be less than 600 microgrammes per cubic metre (ug/Nm^3).

The concentration of total particulate matter in any contained emissions to air, for example the bag filter exhaust air outlet, shall not exceed 150 microgrammes per cubic metre (150 ug/Nm^3). The introduction of dilution air to achieve the emission concentration limits shall not be permitted.

Monitoring of the 24-hour average concentration of the total suspended particulate and/or respirable suspended particulate in ambient air shall be conducted at the site boundary and/or any other locations to be agreed by the Authority. SPM sampling shall conform to the United State Environmental Protection Agency's Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere

(High-volume Method) and shall be conducted at a frequency of not less than once every 6 months.

Part 7 – Chain-of-custody for Crushed Stone

7.1 General

Contractor shall maintain records of suppliers for each load of crushed stone brought to the construction site with the procedures as outlined below. Such records shall be collected at a central location at least monthly during the duration of the project and be available for inspection by Engineer's Representative.

7.2 Supplier Validation

Contractor shall maintain records of all suppliers and all internally sourced supplies of crushed stone brought to the construction site to include:

- Name of supplier;
- Location of stone crusher operation;
- Location and name of the quarry;
- Proof of registration and consent from the applicable Mining Department;
- Proof of registration and consent for operation from applicable Pollution Control Board;
- The supplied material size and quantity (by weight or volume);
- Date and specific location material was brought to site.

Part 8 – Restoration of temporary stone crusher sites

8.1 General

This section applies to the removal of any temporary stone crusher sites established and used during the duration of the project. During operation all temporary operations shall meet the requirements specified in Parts 1 and 2 above.

8.2 Equipment removal

Temporary equipment shall be cleaned before being taken down and prepared for off site transport. Clear off all temporary structures and garbage.

8.3 Site restoration

Remove all debris and visible accumulations of dust from ground surfaces. Cover all soil surfaces with vegetation or pavement to reduce exposure to residual sil.

Chapter 9. Conclusions and Recommendations

9.1 Conclusions

Based on EIA study completed following conclusions is drawn:

The project is unlikely to cause significant environmental impacts. The DFC project involves construction of embankment (404.36 Km long) parallel to existing IR track and on detours routes, bridges, RoBs, RUBs and rail over rail flyovers. As per findings of detailed EIA, the environmental impacts are largely temporary in nature and can be mitigated with minimal residual impacts. The project involves land acquisition, diversion of reserved and protected forests' land, shifting of physical cultural structures and borrowing of earth. Most major impacts are associated with these activities.

The project corridor does not pass through or is located nearby any (i) National Park, Wild Life Sanctuary, or other ecologically sensitive or protected areas, or (ii) Archeologically Protected Monument. The project corridor however, passes through one of the reserve forests. The land use pattern around the alignment is predominantly agricultural. There will be change in land-use pattern and landscape in the detours' area.

The project was initially categorised in environmental category 'A' by ADB. The project design changes by DFCCIL and detailed Environmental Assessment placed the project in Category 'B'. However, considering the magnitude of the project, DFCCIL and World Bank decided to treat it as category 'A' in terms of all environmental assessment, planning and disclosures.

The EIA study was carried out between May 2009 to May 2010 by the ADB appointed PPTA consultants and their study was based on primarily and secondary base line information. The environmental study covered the project area, as well as the area of direct and indirect impacts. The environmental assessment report was prepared in accordance with relevant applicable laws and regulations of the Government of India; and in conformity with the Environmental Policy of the ADB, 2009 and harmonised with World Bank safeguard policies defined under its operational manual.

The DFCCIL appointed **M/s Engineering and Technological Services, Delhi** to update the EIA study done by ADB PPTA consultants so as to be consistent with World Bank Safeguard Policy and incorporation of changes in project design after the year 2010. This updation of the EIA has been done by incorporating the changes of project features and ground truthing of environmental data.

9.2 Potential Negative Impacts, Mitigation, Management and Monitoring

The significant impact during construction is mainly associated with minor increase in dust borne air pollution, increased noise level, nuisance due to movement and operation of vehicles, establishment of temporary facilities and hindrance in accessibility to common property resources. The mitigative measures have been suggested to eliminate or minimise the impacts. Some of the measures suggested include:

The compensatory afforestation shall be undertaken as per forest clearance conditions.. The compensatory afforestation will be taken up at vacant land of RoW and at stations and residential complexes.

Key measures suggested to control increased noise level during construction include provision of portable noise barriers and measures such as regulating construction timings near sensitive locations. Operation stage mitigation includes multilayered plantation and reduction of wait time at crossings. Sitting and management of temporary construction facilities i.e. construction camp, workers camp, hot mix plant, batching plant, dumping sites, shall be done in an environmentally acceptable manner as mentioned in EIA The noise barrier walls have been recommended at noise sensitive receptors where noise levels are expected to exceed the regulatory standards. The noise barrier wall will also be planned

A proper traffic management plan shall be in place well before the start of construction. Access to community structures/resources shall not get affected during any stage of the project.

Soil erosion along embankment slope, bridge approaches, River/canal banks shall be checked regularly as per EMoP suggested in EIA. Dismantled material shall be reused to the extent possible. Leftover debris shall be disposed off in an environmentally acceptable method and at designated sites as per the guidelines suggested in the EIA.

Borrow area shall be rehabilitated as per EMP. IRC: 10-1961: guidelines shall be followed regarding identification; usage and rehabilitation of borrow area.

All CPRs will be relocated first before dismantling the existing ones.

9.3 Post EIA Surveillance and Monitoring

While an EIA is meant to provide a comprehensive understanding of the environment status of the area under the study, post EIA surveillance is the means to ensure that the significant impacts identified are adequately mitigated as per the proposed mitigation plan. The Environmental Management Plan provides a detailed monitoring plan. Air, surface water quality, ground water quality, noise and vibrations, soil erosion, drainage pattern, water logging, tree survival rate monitoring and reporting along with the follow up actions in case of deviation from the norms has been detailed out. The frequency has been set in consideration to the likely impacts.

9.4 Irreplaceable Resources

There are no other environmentally sensitive resources found in the project area that are likely to be affected due to the project.

9.5 Public Consultations

Although, there is displacement of people, still the project received unanimous support and consent from all local people. As such, people have no issue with the development of additional railway track. However, issue of long wait period at crossings and associated air pollution due to idling of vehicle is an issue raised by some of the people. Very few people raised issues of noise and vibration. People have suggested of making adequate provision of cross drainage structures and safe passage to cross the track.

9.6 Recommendations

The EIA study recommendations are as follows:

This EIA should be updated if their are changes in project design, alignment of DFCC (especially detours) or any major changes in the structures.

For effective implementation of the project in an environmentally sustainable manner, it is recommended to develop environmental guidelines and EHS management system supported by Environmental Management Information software/system. Performance indicators may also be developed as part of these guidelines to monitor and assess the effectiveness of the mitigation measures.

Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. Awareness programme for contractor and workers shall also be organised for effective implementation of EMP.