डेडीकेटेड फ्रेट कोरीडोर

Dedicated Freight Corridor Corporation of India Ltd.

DRAFT ENVIRONMENTAL ASSESSMENT

FOR

PILKHANI- SAHNEWAL SECTION

OF

EASTERN DEDICATED FREIGHT CORRIDOR

October 2014

Prepared By

Engineering and Technological Services, Delhi

CONTENTS

Executive Summary

List of Tables

List of Maps

List of Figures

List of Annexures

Part II: Strip Maps (Separate Volume-2)

Abbreviations

ACF	Assistant Conservator of Forest
ADB	Asian Development Bank
AIA	Advanced Informed Agreement
AIDS	Acquired Immune Deficiency Syndrome
BOXN	Air braked box wagons
CBR	California Bearing Ratio
CDM	Clean Development Mechanism
Ch	Chainage
CITES	Convention on 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
GOH	Government of Haryana
GOI	Government of India
GOP	Government of Punjab
GOUP	Government of Uttar Pradesh
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
IVI	Importance Value Index
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
PM_{10}	Particulate Matter less than 10 micron
POP	Persistent Organic Pollutants
PPE	Personal Protective Equipment
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
SEIAA	State Environment Impact Assessment Authority
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

1. Introduction

Ministry of Railways established "Dedicated Freight Corridor Corporation of India Limited (DFCCIL)" as a Special Purpose Vehicle for construction, operation and maintenance of the dedicated freight corridors. This is 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 having total length of 1483 km. The total length of EDFC works out to 1839 Kms. The present EIA study pertains to development of **Pilkhani to Sahnewal** (Ludhiana) section of the Eastern Dedicated Freight Corridor covering about **175 km** in length.

2. Objective of the Assignment

The prime objective of the EA study is 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.

3. Scope of Environmental Assessment

The scope of current assignment includes environmental assessment of Pilkahi-Sahnewal section based on Environmental management framework of DFCCIL prepared during EIA of Bhaupur-Khurja section of EDFC.

4. Project Description

The project section from Pilkhani to Sahnewal covers three states starting Pilkhani in Uttar Pradesh passing through Haryana and finally terminating at Sahnewal near Ludhiana city in Punjab covering districts of Saharanpur, Yamunanagar, Ambala, Patiala, Fatehgarh Sahib and Ludhiana.

The DFC rail lines are generally co-planned adjacent to existing rail line except at detours (Ambala, Rajpura and Sirhind) and grade separations (Ambala, Shambhu, and Sirhind). Under this project, an electrified single line of 175 km between Pilkhani and Sahnewal is proposed to be constructed with no surface crossing.

4.1 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 is given in **Table-1** below:

Table-1: Lengths in Parallel and Detour Sections Pilkhani- Sahnewal Section of EDFC

Section	Length in Parallel Section (km)	Length in Detour Section (km)	Total Length (km)
Pilkhani- Sahnewal (Ludhiana)	162.21	12.79	175.00

5. Environmental Laws and Regulations

Current regulations of Government of India do not require railway project to seek for Environmental Clearance from the Ministry of Environment and Forests (MoEF) and do not require Environmental Impact Assessment (EIA) studies. However, considering the magnitude of activities that are envisaged as part of EDFC, DFCCIL has undertaken an Environmental Assessment (EA) and prepared an Environmental Management Plan (EMP) to mitigate potential negative impacts of the project. Environmental Management Framework (EMF) of DFCCIL developed during earlier EA of Bhaupur-Khurja remains valid for this current Pilkahi-Sahnewal section also.

5.1 Key Environmental Laws and Regulations

Following **Table-2** presents key environmental laws and regulations promulgated by the Government of India and relevant to the Pilkahi-Sahnewal Section of EDFC.

Table 2: Environmental Regulations and Legislations

S. No.	Act/Rules	Purpose	Applicability	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	To provide environmental clearance to new development activities following environmental impact assessment	Railway projects are not included in the Notification of 14th Sep, 2006 and EC under this Act is not applicable. However, as per MoEF's amended notification dated 9.9.2013 mining of minor minerals through borrow / quarry areas of <5 Ha, which will be used in project, require prior environmental clearances	MoEF/SEIAA
3	Notification for use of fly ash,1999	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 Engineering designs	MoEF
4	The Forest (Conservation) Act 1927 The Forest (Conservation) Act. 1980 The Forest (conservation) Rules, 1981	To check deforestation by restricting conversion of forested areas into non-forested areas	Applicable, Forest land is involved in the project.	MoEF and state Forest Department
5	MoEF circular (1998) on linear Plantation on roadside, canals and railway lines modifying the applicability of provisions of forest (Conversation) Act, to linear Plantation	Protection / planting roadside strip as avenue/strip plantations as these are declared protected forest areas.	Applicability of Forest conservation act to Roadside strip Plantations	MoEF and state forest department
6	Air (Prevention and Control of Pollution) Act, 1981	To control air pollution by specifying the emission standards.	Emissions from construction machinery and vehicle should be checked time to time.	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
7	Water Prevention and Control of Pollution) Act , 1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards	Various parameters in Effluents from construction sites and workshops are to be kept below the prescribed standards	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
8	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.	DG sets at construction sites and workshops should be provided with acoustics enclosures.	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab

S. No.	Act/Rules	Purpose	Applicability	Authority
9	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act,2010	Conservation of cultural and historical remains found in India	No, as ASI monuments are not affected, but for chance find, if any, to be surrendered to the Competent Authority.	Monuments Authority of India
10	Public Liability and Insurance Act 1991	Protection form hazardous materials and accidents.	Shall be taken as per requirements	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
11	The Explosives Act 1884	Safe transportation, storage and use of explosive material	Respective Authorization shall be obtained from CCE	Chief Controller of Explosives (CCoE)
12	Minor Mineral and concession Rules	For opening new borrow pits & quarry.	Quarry Licenses shall be obtained by Contractors.	District Collector
13	Central Motor Vehicle Act 1988 and Central Motor Vehicle Rules 1989	To check vehicular air and noise pollution and authorisation to drive vehicle	All vehicles in Use shall obtain Pollution Control Check certificates and shall be driven by personnel with proper licence.	Motor Vehicle Department
14	The Mining Act	The mining act has been notified for safe and sound mining activity.	Quarry Licenses shall be obtained by Contractors.	Department of mining, GoUP, GoH , GoP
15	Hazardous waste (Management , Handling & Tran boundary) Rules, 2008	Management and storage of hazardous waste.	Applicable	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab / MoEF
16	The Railway (Amendment) Act, 2008	Land acquisition	Applicable	GoI
18	The Petroleum (Amendment) Rules, 2011	Use and storage of petroleum products	Applicable	CCOE /DC

5.2 The project is proposed to be funded by the World Bank. This will require project to comply with World Bank Operational Policies. The description of World Bank policies and relevance to the project is presented below:

5.3 The World Bank Operational Policies

The operational policies of the Bank, both triggers and non-triggers with details of their applicability to the Project are provided in the following **Table.-3.** 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-3: 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 4.11	Physical Cultural Resources	Yes	Risk to cultural properties	Adequate mitigation measures if affected	EMP & RAP prepared
3.	OP 4.36	Forestry	Yes	Diversion of forest land	To be carried out as per Forest (conservation) Act, 1980	Not Applicable
4.	IFC Performa-nce	Labour & Occupational Health	Yes	Labour and construction camp	Compliance of IFC Standards	EIA & EMP prepared; Safety &

Sl. No.	Safeguard Policy	Subject Category	Triggered	Triggered By	Mitigation Measures	Documentation
	Standards					Occupational Health measures during construction will be adequately covered in Contract document & DFCCIL SHE manual will be referred.

Since this is a large scale linear 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 making 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.

6. Baseline Environment

The existing environmental conditions have been studied based on primary and secondary data collection and analysis. For effective analysis, the entire alignment is divided into two stretches i.e. Pilkhani to Ambala and Ambala to Sahnewal and in core zone (within 100 m) and buffer zone (7 km either side).

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-4**:

Table-4: 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	The Protected Forest land diversion is 175 Ha. in railway land along existing IR track.
	Tree cover	Poplar, Eucalyptus, Mango, Neem and Shisam are the most dominant species observed. Approximately **28617** trees need to be cut.	All along the alignment
2.	Archaeological Monuments	No monument falls within 300 m of proposed track	-
3.	National Park, Wildlife Sanctuary, Wetland	None	-
4.	Water Bodies	The surface water quality largely conforms to the CPCB prescribed standards while the groundwater quality conforms to the drinking water standards (BIS: 10500). The alignment passes through over exploited blocks of Jagadhari, Mustafabad, Rajpura, Sirhind and	Crossing Rivers – Yamuna, Markanda, Tangri and Ghaghhar Crossing Canals – Western Yamuna Canal, Bhakra Canal

S. No.	Components	Environmental Features	Remarks
		Khanna, critical blocks of Barara and Doraha and semi-critical blocks of Saharanpur district	
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%).	-
6.	Socio-Economic	Agriculture Dominated Area. Presence of large no of industries, Plots affected: 2341 Structures affected 324 Small & marginal farmers: 2341 PAPs : 3051	-

7. Public Consultation and Disclosure

The proponents consulted are of the view that the proposed project activities are not likely to cause any significant environmental impacts. Public consultations were organised in 2009-10 & again in 2011-12. 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 PAPs, provided adequate compensation is paid. Summary of views & concerned expressed during PCM are as follows:-

- Impact on environment, forest, national park/ wildlife sanctuary, afforestation policy
- Air/ water / soil pollution and noise / vibration issues
- Access through level crossings, underpasses, FOB, traffic congestion, drainage
- Possibility of accident due to DFC alignment's close proximity to habitation
- Loss of livelihood due to land acquisition, job to landless families

During discussions, project proponent DFCCIL clarified and explained proposed measures to be taken in design stage, construction phase as well as operation phase to either eliminate or reduce the issues to acceptable level. Participants were satisfied with response of project authority & Consultants. The main 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 favoured the project.

All the concerns of public consultations have been addressed in Resettlement Action Plan and Environmental management Plan.

8. 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 Ambala, Rajpura and Sirhind were evaluated with respect to land use change, rehabilitation and resettlement, ecological aspects, environmental impacts, traffic management, public acceptability, and technical feasibility.

The Detour alignments proposed by DFCCIL were found best suited and acceptable from environmental perspective.

Table-5 : Detour length details

Detour	Length (km)
Ambala	4.39
Rajpura	4.00
Sirhind	4.40
Total	**12.79**

8.1 Social Impact

Total 355 Ha land needs to be acquired, out of which 325 Ha is private land, and balance 30 Ha is Govt. land. Detailed Resettlement Action Plan (RAP) report has been prepared in separate cover.

9. Potential Impacts

The project is unlikely to cause significant environmental impacts. The environmental impacts will be temporary during construction and EMP provides mitigation measures. Brief details of identified potential impacts associated with this project are given below:

a) Diversion of 175 Ha. protected forest on railway land;
b) Cutting of about 28617 trees;
c) Earth work of 0.18 million m^3 in cutting, 0.73 million m^3 in embankment and 0.1 million m^3 of ballast;
d) Increased noise & vibration levels in Sensitive Receptors (SRs) located close to the alignment; 13 SRs within RoW are proposed for noise barrier/ relocation.
e) Health & safety issues during construction activities;
f) Alignment passes over one perennial river Yamuna, three major rivers & Yamuna canals.
g) Compensatory afforestation shall be undertaken as per the forest clearance conditions and the conditions of tree felling as laid down by the State Government.
h) Access to community structures/resources shall not get affected during any stage of the project.
i) 34 CPRs. to be relocated.

10. Measures for the Mitigation of Environmental Impacts

Mitigation measures have been proposed for countering potential impacts. These are as follows:

a) Compensatory afforestation against protected forest land acquired as per condition of MoEF while granting permission;
b) Plantation of about 80,000 trees along the alignment;
c) Dust suppression measures are proposed during earthwork.
d) Permission will be obtained from concerned authority for quarrying and necessary conditions complied with;
e) Noise suppression & suitable noise barriers are proposed for sensitive receptors; 17 sensitive receptors will require either relocation or noise barrier. However, all sensitive receptors within RoW required re-location.
f) Vibration control measures during design stage of track and locomotive & rakes besides vibration suppression measures like plantation are proposed for the identified sensitive receptors;
g) Relocation of affected CPRs;
h) Occupational Health & safety measures for workers during construction activities and at labour camps;

i) Water quality of only perennial river Yamuna & other canals crossing the DFC alignment will be monitored and maintained;
j) Suitable drainage will be provided.
k) Discharge of wastewater during construction phase will be as per EMP and suitable oil catch pits will be provided where necessary.

11. Environmental Management Plan

Environmental Management Plan describes specific mitigation measures. These include following:

i. About 28617 trees along the alignment will be felled. Plantation would be taken up as per the statute.
ii. Afforestation against about 175 Ha. protected forest land to be diverted;
iii. Rehabilitation plan for borrow areas/quarry sites;
iv. Noise barriers of various degrees or relocation for 13 number of sensitive receptors;
v. Borrow area management plan to control degradation of surrounding landscape for excavation work following of standard IRC-10:1961;
vi. Specific safety and silicosis exposure reduction strategy during construction;
vii. Soil protection measures;
viii. Temporary drainage during construction;
ix. Permission will be obtained for tree cutting with suitable compensation;
x. Crossing passage for wildlife near forest area, ponds will be provided for wildlife in forest area, if required;
xi. Measures to be taken for archaeologically important chance finds, if any, as per ASI Act.
xii. Estimated cost for Environmental Management is Rs. 9338 million including land acquisition cost**.**
xiii. Silicosis Exposure Reduction Strategy is given for reference.
xiv. DFCCIL has a Social and Environmental Management Unit (SEMU) headed by General Manager (SEMU) for EDFC, supported by a GM/Env. & Environmental Consultant. Field unit is headed by Chief Project Manager (CPM), supported by Deputy CPM and designated APM/Env. SEMU together with the field unit will ensure implementation of EMP during pre-construction, construction and operation phases.

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 airfreight 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 MT in 2007-08, 833 MT in 2008-09 and 888 MT 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 in favour of 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 proposed 175 km single track electrified Pilkhani - Sahnewal portion of EDFC has been undertaken. The section will be electrified.

The environmental assessment of Khurja-Ludhiana section was initially undertaken by EQMS India Private Ltd., as per safeguard policy of Asian Development Bank. Later, it has been decided for funding by the World Bank. The EA findings were reviewed & updated after field survey & further PCM for Pilkhani- Sahnewal section by **M/s Engineering and Technological Services, Delhi**. The aim of updating of the EA is to verify the ground data and make EA report to meet the World Bank safeguard policy. The location of EDFC in India map and alignment map for the Pilkhani- Sahnewal section is shown in Map 1 and Map 2.

1.3. Objective of the study

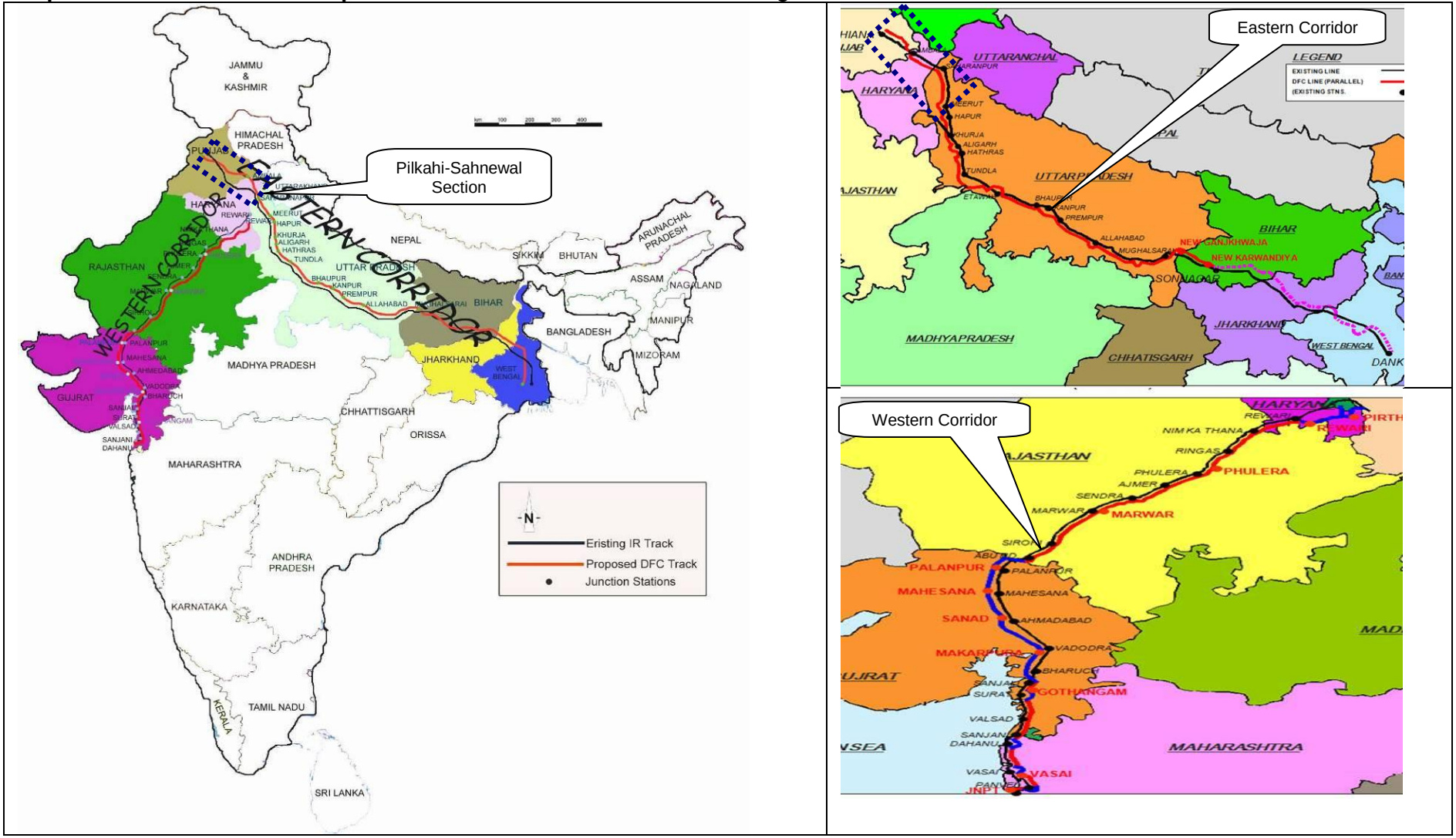
The prime objective of the EA study is to identify the likely environmental impacts and their magnitude during various stages (design, construction and operation) of the project and develop cost effective mitigation and monitoring measures along with institutional mechanism to enhance the environmental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



डेडीकेटेड फ्रेट कोरीडोर

Map 2: Proposed Pilkahi-Sahnewal Section of the Eastern DFC

1.5. Extent of the EIA Study

The EIA has been updated after site visits, verification of data, and interaction with DFCCIL officials at Ambala and Ludhiana and by updating the design changes made after preparation of EIA report by the previous consultants.

The EIA study covered all activities proposed for the development of Pilkhani –Sahnewal 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 ten chapters, consistent with the World Bank operative directive-4.01. This includes the following chapters:

Chapter 1: Introduction,
Chapter 2: Project Description,
Chapter 3: Policy, Legal, & Administrative Framework
Chapter 4: Environmental Profile of the Project Influenced Area
Chapter 5: Baseline Environmental Profile
Chapter 6: Analysis of Alternatives
Chapter 7: Environmental Impact Assessment
Chapter 8: Measures for the Mitigation of Environmental Impacts
Chapter 9: Public Consultation & Disclosures
Chapter 10: Environmental Management Plan

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. In addition, 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. Seven kilometres on either side of the alignment is considered as the general impact zone. The immediate 100-meter corridor centred along the proposed corridor 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 km on either side 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 Pilkahi-Sahnewal section (about 175 km), the entire length has been divided into two sub sections of about 86 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 Ambala and Ludhiana, 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 protected monuments, Socio-economic details, regulatory compliance	Primary data collection; Department of Forests/ District Forest Office, Department of Fisheries; Census Report, Govt. of India, IMD Regional Offices, and IMD Delhi/Pune, State Pollution Control Boards, Indian Agricultural Research Institute, Central Ground Water Authority, Archaeological Survey of India, rehabilitation and Social Impact assessment report	Project description, impact assessment and mitigative actions, management plan, and environmental benefit analysis
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 by the previous Consultants and ETS has further re-assessed the data in during their study. There is no significant change in the data.

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. Interaction was also done 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 9.

The consultations were carried out first during 2009-10 and again in December 2011-January 2012.

Chapter 2. Project Description

2.1. Size and Location of the Project Section

The project section (Pilkahi-Sahnewal) is part of eastern DFC and covers three states starting from Pilkhani. In Uttar Pradesh passing through Haryana and finally terminating at Sahnewal near Ludhiana city in Punjab covering districts of Saharanpur, Yamunanagar, Ambala, Fatehgarh Sahib, Patiala and Ludhiana.

The Indian Railways chainage of 187.500 to the north of Pilkhani station is the point at which this section of corridor study commences. The Pilkahi-Sahnewal section ends at Sahnewal, 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 Sahnewal station (**Figure 2.1 and Figure 2.2**)

Traffic to destinations in northern India and originating in the eastern region pass through Saharanpur/Ludhiana. The route from Pilkhani to Sahnewal passes through two divisions of northern railway (zone) viz. Pilkhani - Sahnewal under Ambala division and Sahnewal station under Firozpur division as shown in **Table 2.1**

Table 2.1 : Features of Existing Pilkhani-Sahnewal Section

Section	Zonal Railway	Division	Electrification/Single-Line
Pilkhani (187.50Km) to Sahnewal (360.20 Km)	Northern	Ambala	Electrified; Single

Source: CPM Office, Ambala

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

Table 2.2: Alignment of DFC

Railway Km (IR chainage)	Position of DFC Track	Location of DFC w.r.t. IR Track (Facing Sahnewal from Pilkhani)
Km 187.50 to 259.5	Parallel to Existing Track	Left
Km 259.5 to 262.5	Ambala Detour	Left
Km 262.5 to 284.10	Parallel to Existing Track	Left
Km 284.10 to 288.10	Rajpura Detour	Left to Right
Km 288.10 to 315.25	Parallel to Existing Track	Right
Km 315.25 to 319.65	Sirhind Detour	Right to Left
Km 319.65 to 360.20	Parallel to Existing Track	Left

The legth in Parallel section adds to 162.21 km, Detour section works out to 12.79 km and the Total length adds to 175 km.

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 of IR.

Figure 2.1 : Alignment View of Pilkahi-Sahnewal (Sahnewal) DFC With Respect to Existing IR track

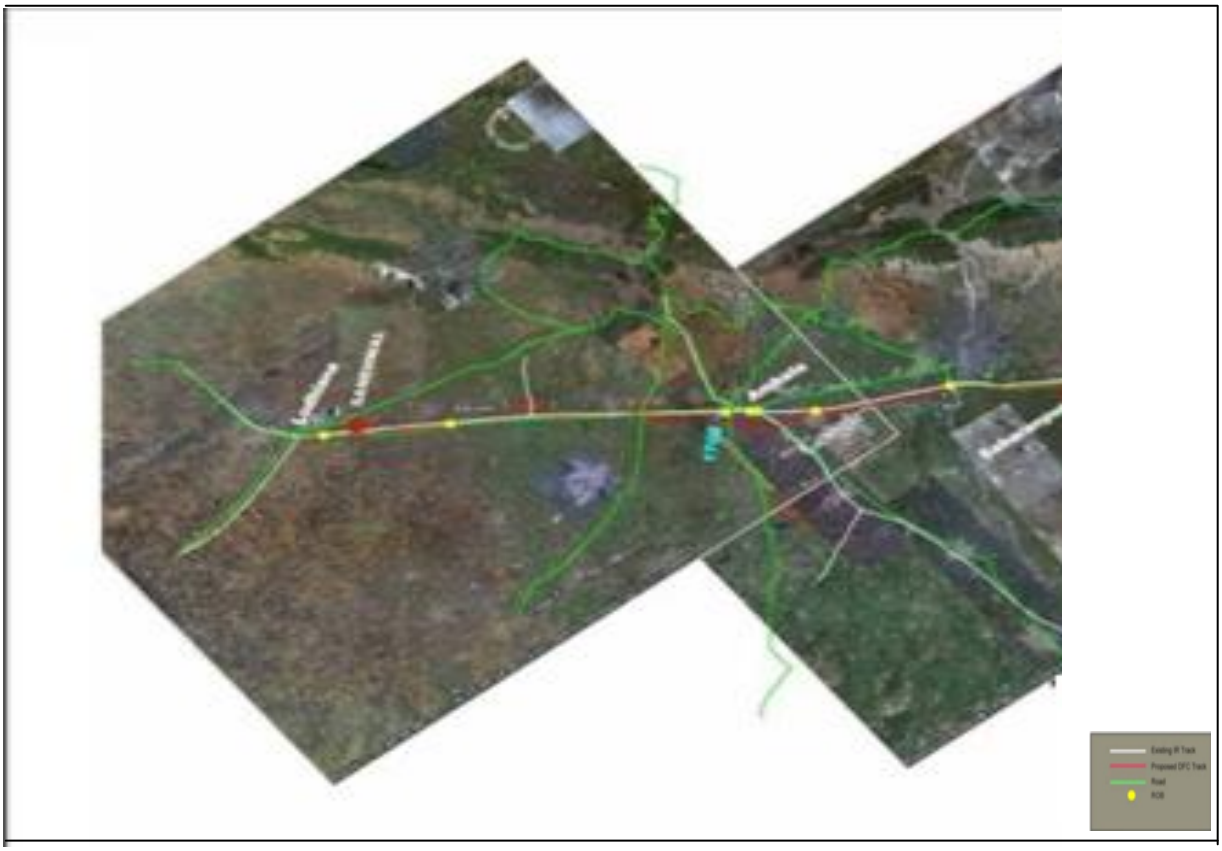
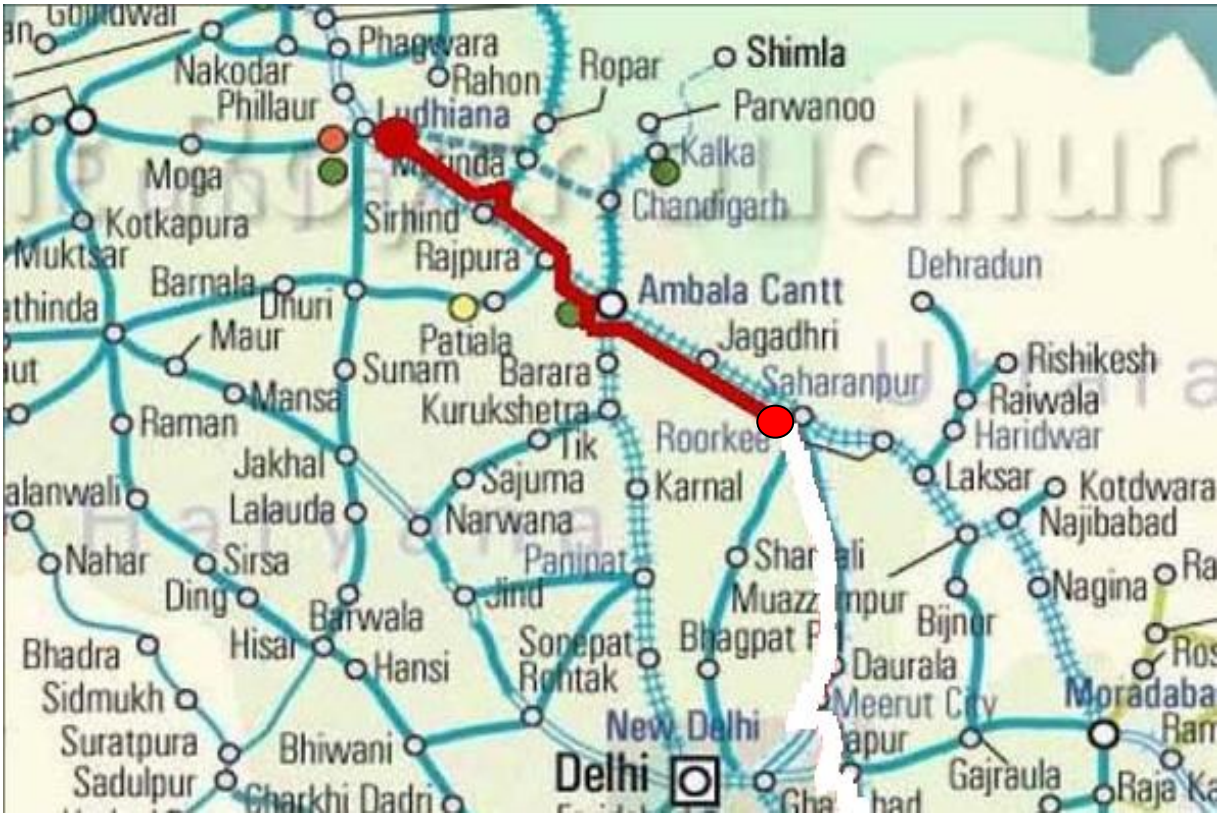


Figure 2.2 : Location and Route Map of Pilkhani – Sahnewal DFC



2.2. Need of the Project

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 heterogeneous 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 dedicated freight corridors along a part of its network.

2.2.1. Pilkhani - Sahnewal 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 2 to 2.5 passenger services are added on the route but the demand is still unfulfilled. Recently 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 this section, it has already reached its existing capacity (**0**). 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 2.3: Rail Capacity and Utilization (Pilkahi-Sahnewal), 2009

S. No	Section	Capacity With Maintenance Block	Freight Trains	Total Trains	Estimated % Utilization
1	Saharanapur-Jagadhari	54	14	48	89%
2	Jagadhari-Ambala Cantt	54	12	46	85%
3	Ambala Cantt-Rajpura	74	29	87	118%
4	Rajpura-Sirhind	74	23	69	93%
5	Sirhind-Sahnewal/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 will connect it with eastern India bypassing congested Delhi metropolitan area. This section between Pilkhani to Sahnewal 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 Pilkhani - Sahnewal section is shown in **0**.

Table 2.4: Traffic Projection for 22.9 t and 25 t Axle load (Pilkahi-Sahnewal 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 (Pilkhani Sahnewal 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
2031/33	-	67	72	60
2036/37	-	-	78	66

Note: Figures above are for the Khurja – Kalanaur section of which Pilkahi-Sahnewal section is a part.
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 (**05**). 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 04.

Table 2.5: 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 help in gaining CDM benefits by reduction in 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.

2.3. Project Components and Activities

The EDFC is planned adjacent to existing railway line except at detours and grade separations. Under this section of EDFC project, an electrified single line of 175 km between Pilkhani and Sahnewal 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 Pilkhani to Sahnewal will be single line 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.

2.3.1. Standards Criteria and Salient Features

The performance requirement applied to the route by DFCCIL and salient features are given in **0.**

Table 2.6: Standards Criteria and Salient Features of Pilkhani Sahnewal DFC

Description	Details
Rout length (km)	175 km
Parallel:	162.21 km
Detour:	12.79 km
No. of Detour	3 (Ambala Cantt., Rajpura & Sirhind)
No. of Rail Fly Overs	4 (Ambala, Shambhu-Shambhu, Rajpura, Sirhind)
Gradient	
Ruling Gradient	1 in 200 (Compensated)
Steepest Gradient in yards	1 in 1200 (1 in 400 in Exceptional Cases)
Standard of Construction	
Gauge	1676mm
Rails	60 Kg 90 UTS Rails
Sleeper	PSC, 1660 Nos./km for main line & 1540 Nos./ km for loop line & sidings
Points & Crossings	60 kg rail, 1 in 12 curved swithches with CMS crossings on fan shaped PSC sleepers layouts.
Ballast	300mm Machine Crushed
Design Speed	100 kmph
Design Axle load	Freight Traffic with 25 Tonnes axle load on formation of 32.5 Tonnes
Formation	
Bank width for single line	8.10 m.
Slope on Embankment	2H:1V
Cutting Width for Single line	7.50m (Excluding side drains)
Earthwork	C.B.R. > 5
Earthwork for Top 1m	C.B.R. > 8
Slope of cutting (ordinary soil)	1:1
Blanketing thickness	60cm

Description	Details
Curves	
Maximum degree of curvature	2.5 degree
Grade Compensation on curves	at the rate of 0.04% per degree of curvature
Track Centres (Minimum)	
Between two tracks of DFC	6m & 6.25m
Between railway track and DFC	6.0 m minimum and 7.925m recommended and in general.
Bridges	
Standard of Loading	25 tonnes axle load on formation of 32.5 tonnes, 15 tonnes/m trailling load (DFC Loading)
Number of Important Bridges	4 Nos.
Number of Major Bridges	44 Nos.
Number of Minor Bridges	133 Nos.
Number of Rail Flyovers	4 (Ambala, Shambhu-Rajpura, Sirhind=2)
Road Crossings	
Number of level crossings	77 Nos.
No. of LC having TVU <25000	12 Nos.
No. of LC having TVU >25000 <50000	12 Nos.
No. of LC having TVU >50000 <100000	18 Nos.
No. of LC having TVU >100000	35 Nos.
Total	77 Nos.
ROB /RUB's sanctioned prior to 2013-14/commissioned/under const.	10 Nos.
ROB's sanctioned during 2013-14	32 Nos.
RUB's sanctioned during 2013-14	23 Nos.
L-xings where ROB as well RUB have been sanctioned during 2013-14	2 Nos.
L-xings where no decision has been taken	10 Nos.
Level Crossings where State Governments has agreed for cost sharing for construction of ROBs.	6 Nos.
Balance L-Xings proposed as ROB but not sanctioned	6 Nos.
Balance L-Xings proposed as RUB but not sanctioned	2 Nos.
Balance L-Xings proposed for closure but not sanctioned	2 Nos.
Junction Stations	5 Nos. (Pilkhani,Kalanaur,Rajpura, Sirhind and Sahnewal)
Other Yards of IR infringing DFC	10 Nos (JUD, JUDW, DZP, DOKY, UMB, SDY, GVG, KNN, DOA, CHA).
DFC Crossing Stations	14 Nos. (New Pilkhani, New Kalanaur, New Jagadhari Workshop, New Darazpur, New Barara, New Kesri, New Dukheri, New Ambala city, New Shambhu, New Sarai Banjara, New Sirhind, New Mandi Gobindgarh, New Khanna, New Chawapail)
Land	
Private Land	324.97 Hectares.
Government Land	30.37 Hectares.
Total Land	355.34 Hectares. Say, 355 Ha.

2.3.2. 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 depth is proposed to be 300mm.

2.3.3. 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 Ambala, 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. 6).

The space requirements between two EDFC tracks and between IR & EDFC track are considered as minimum of 6.00 m and maximum of 7.925 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 **07.** The total length of Pilkhani- Sahnewal section of EDFC is 175.00 km.

Table 2.7: Project Chainage with Location of Detours

Northern Railway Stations	Location	IR Chainage (km)
1	Pilkhani	188.510
2	Sarsawa	194.080
3	Kalanaur	204.560
4	Jagadhri	210.930
5	Jagadhri Workshop	215.810
6	Darazpur	220.570
7	Mustafabad	228.410
8	Barara	237.210
9	Tandwal	242.560
10	Kesri	248.900
11	Dukheri	254.450
1	**Start of Detour (Approx)**	259.500
12	**Ambala Cantt Jn.**	261.930
1A	**End of Detour (Approx)**	262.500
13	Ambala City	269.480
14	Shambu	279.090
2	**Start of Detour**	284.100
2A	**End of Detour**	288.100
15	**Rajpura Jn.**	289.840
16	Sarai Banjara	299.250
17	Sadoo Garh	307.410
18	**Sirhind Jn.**	315.220
3	**Start of Detour (Approx)**	315.250
3A	**End of Detour (Approx)**	319.650
19	Mandi Govind Garh	324.790
20	Khanna	333.100
21	Chawapail	343.900
22	Doroha	353.310

Northern Railway Stations	Location	IR Chainage (km)
23	**Sahnewal**	360.540
	Dahandari Kalan	368.360
	Ludhiana Jn.	375.650

Source: PPTA Feasibility Study, 2009

Table2.8 : **District-wise length of Pilkhani – Sahnewal section**

S. No.	District	Length (KM)
1	Sahranpur (U.P.)	14.872
2	Yamuna nagar (Haryana)	29.280
3	Ambala (Haryana)	42.439
4	Patiala (Punjab)	27.480
5	Fatehgarh Saheb (Punjab)	27.100
6	Ludhiana (Punjab)	33.141

2.3.4. 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.

2.3.5. 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.

2.3.6. 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 2.1**)

2.3.7. Right of Way (RoW) and Embankment Formation

RoW: Since the alignment will run parallel to the existing IR track and maximum effort will be to use the existing railway land to minimise the land acquisition, the RoW varies 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 construction of service road.

Formation and earthwork profile: The formation width for independent (non-integrated but parallel with existing IR track) is 7.6 m with side slopes of 2:1. Extra width of formation shall have to be provided on curves to accommodate extra width of ballast and extra clearance of stocks.

For higher axle loads, RDSO guidelines recommend provision of increase in blanketing thickness to the extent of 450 mm over and above and 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 600 mm blanketing. Mechanical compaction at optimum moisture content is proposed. Near bridge approaches stone pitching and other protective measures are proposed.

Earthwork: The total quantity of the earthwork required for embankment on this corridor will be 73, 42,282 m^3. The quantity of blanket material estimated is 10,45,795m^3. The earthwork formation may be independent or integrated with existing IR. The cross section profile of both type of earthwork is shown in **Figures 2.2**, and **Figure** 2.4. It may be mentioned that cross sections shown are schematic and not to the scale. The formation width for single line is 7.6m (Excluding side drains). Initially it was planned 8.5 m for single track.

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:1h 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 allotted for tree plantation. The land acquisition has been planned chainage wise 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. Number of trees will depend on compensatory afforestation against no. of trees to be felled. However, tentative number of trees to be planted is 80,000. There are options like planting trees on other available Railway land f 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: Two major stations will require demolitions and reconstruction as given below:

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

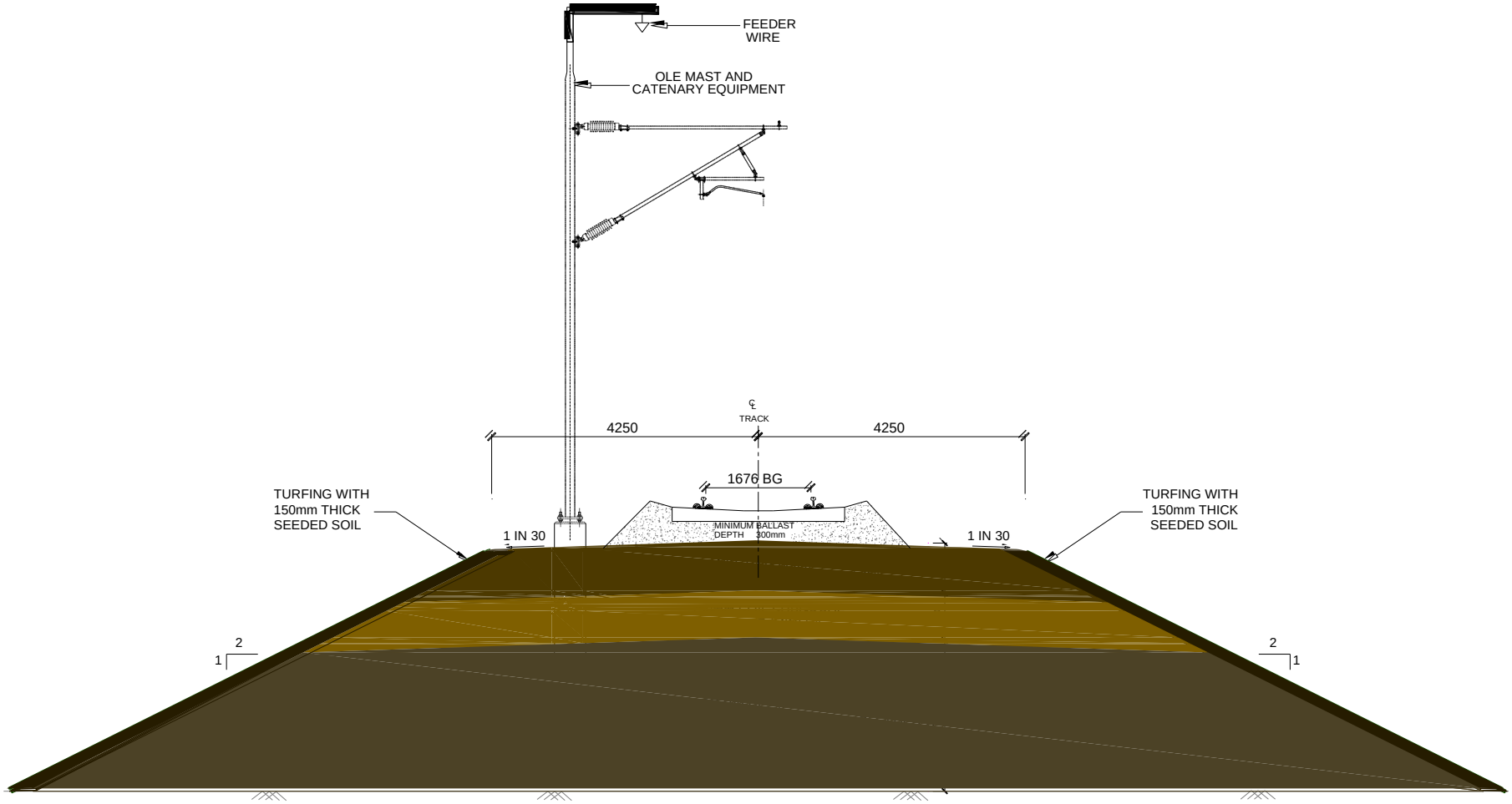
Jagadhri workshop station**:** Clearance of special structures required.

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*:* About 34 such structures are likely to be shifted due to the construction of Pilkhani-Sanhewal section of EDFC. Details of the same are given in further sections.

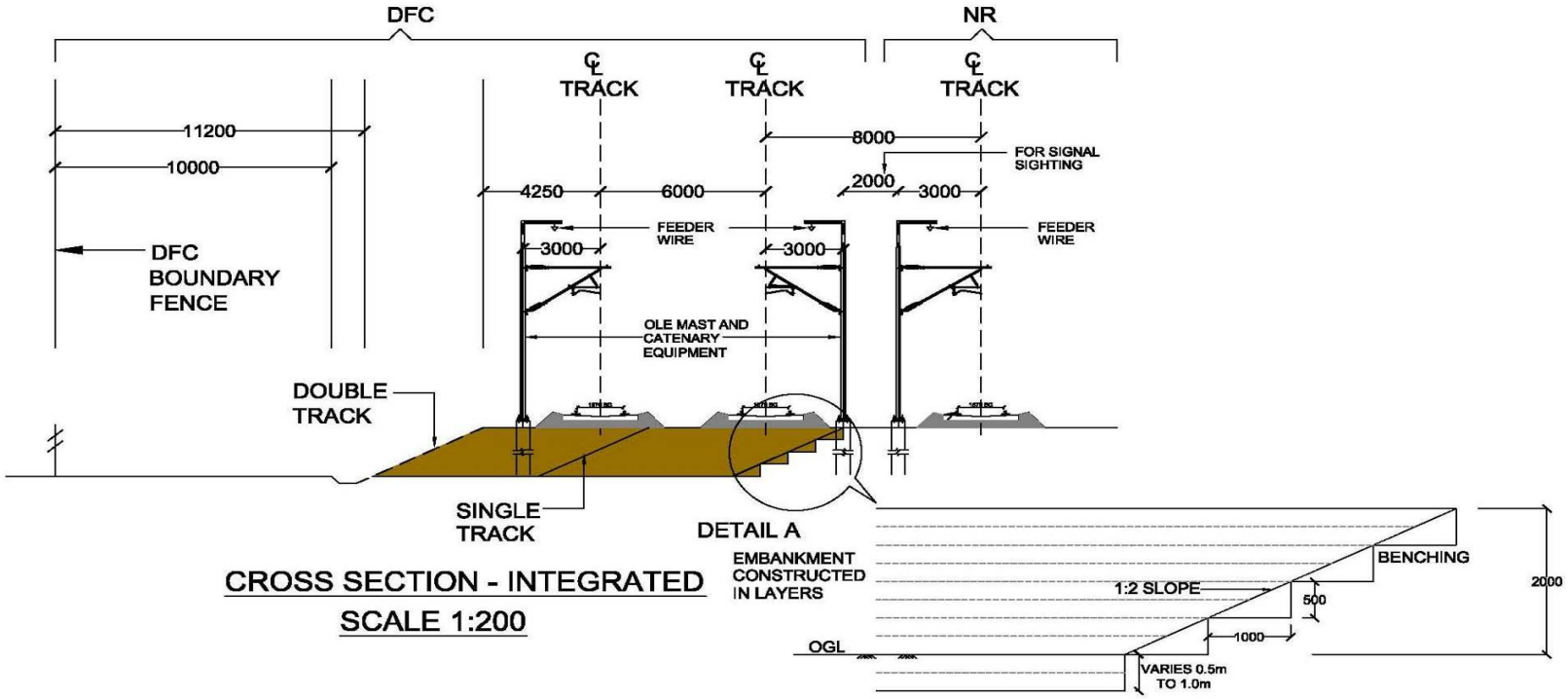
.

Figure 2.3 : Earthwork Profile Single Independent Line



EARTHWORK PROFILE IN EMBANKMENT
(SINGLE LANE)
SCALE 1:65

Figure 2.4 : Earthwork Profile Widening to Single Integrated line



2.3.8. 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.

2.3.9. Land Requirement

The EDFC will be constructed primarily on the available land along the existing track of IR. However, additional land 355.34 hectares will be acquired for the same. The private and Government land requirement is given below:

Table 2.9 : Land requirement

S. No.	Section	Private Land (Ha)	Government Land (Ha)	Total Land (Ha)
1	Pilkhani- Sahnewal (Ludhiana) Section	324.97	30.37	355.34 Say, 355 Ha.

2.3.10. 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 indicated in **Annexure- 2.2.** Photographs of sites for proposed Junction & Crossing stations are given as **Figure 2.6 to 2.16**.

Five junction stations are proposed at Pilkhani, Kalanaur, Rajpura, Sirhind and Sahnewal. The purpose and interconnections proposed at these junctions are briefed at **0.**

Table 2.10 : Junction Stations Location and Purpose

S. No.	Junction Station	Interconnections
1.	Pilkhani	Traffic of IR and DFCC shall be interchanged at this station. Mainly traffic coming from Moradabad side as Saharanpur yard is being affected upon passing of DFCC. Goods siding at Saharanpur and ballast siding at Khan alampura are also proposed to be relocated to this station . Surface crossing has been planned at this station.
2.	Kalanaur	The traffic that has to be transferred from the corridor at Kalanaur is Coal for Reliance powerhouse. Number of trains to be transferred is about 3.5 trains per day. Surface crossing has been planned at this station.
3.	Rajpura	The main traffic that has to be transferred from the 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

S. No.	Junction Station	Interconnections
		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 traffic of Mandi-Gobindgarh and Khann IR stations is proposed to be transferred to the existing lines at Sirhind for onward movement 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 from 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 2500 m length is proposed to be provided at every 10 km of the alignment.

2.3.11. Grade separation/Rail over Rail Flyover

To eliminate flat junctions and to minimise the adjacent Indian Railways network operations affecting those of the freight corridor and vice versa, rail over rail flyover at three locations are provided in **Fig. 2.5** (a,b,c). The grade separator cum rail-over-rail flyover is likely to be multi-span viaduct crossing not only other rail routes but also other obstructions in close proximity such as nalas and highways. The details of the same are given below:

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 Ambala (rail-over-rail flyover), to allow the corridor to pass over National Highway (NH)-1.

On the south approach to Rajpura (rail-over-rail flyover), to allow the corridor to pass over 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 2.5 : (a) Grade Separation / Rail Over Rail Flyover Locations at Ambala

Figure 2.5 (b) for RFO at Rajpura

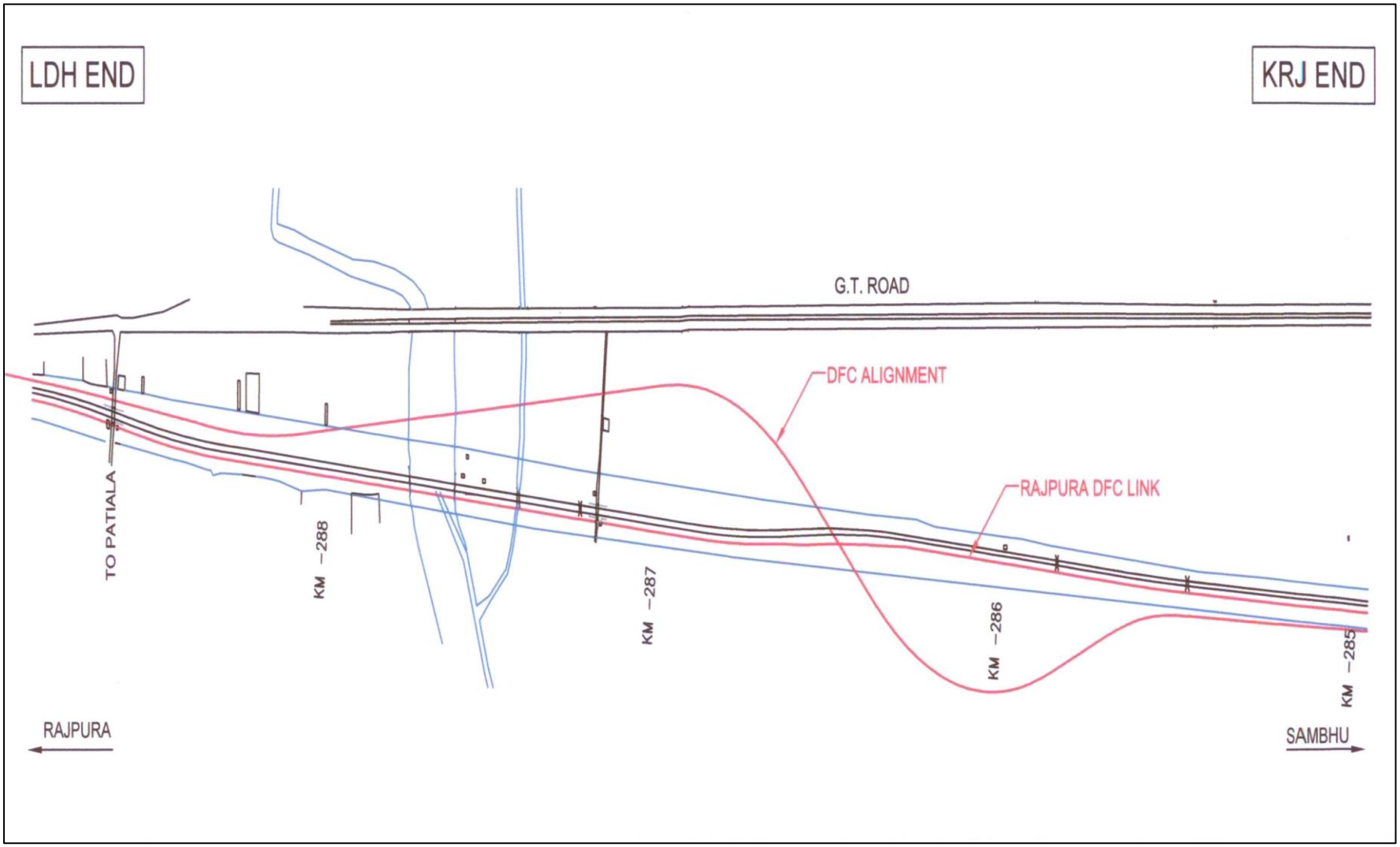
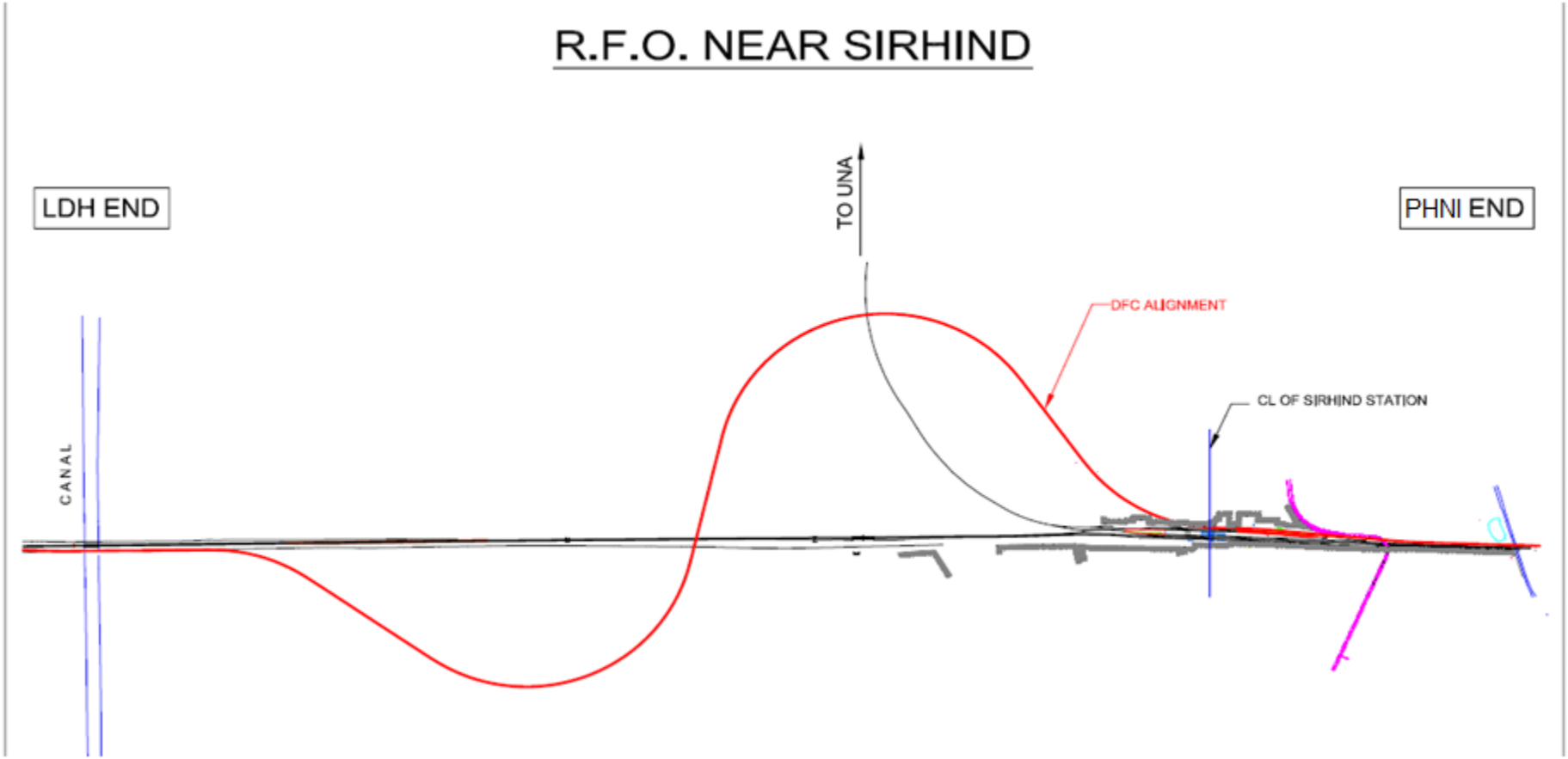


Figure 2.5: (c) Grade Separation / Rail Over Rail Flyover Locations At Sirhind



2.3.12. Yards/Depots

The proposed location for maintenance depot is at km 346. However, it is recommended by consultants that further consideration be given for provision of more depots. The suggested locations are km 220, km 300 and km 346.

2.3.13. Crew Changing Points

At an average speed of 50 km per hour, a train can run 175 km in 4 hours on the 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. Considering these factors, the crew originating/ changing point is proposed at Kalanaur along this alignment.

2.3.14. Level Crossings

There are 77 level crossings in the entire section of the proposed corridor making it roughly one level crossing every 2.5 km. The location, chainage, TVUS and type of crossings is given at **Annexure 2.3.** 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) where traffic vehicle units (TVU's) are more than 100,000. Where TVU is less than 1,00,000, LC is to be replaced by RUB.

Some 46 level crossings are required to be upgraded based on the railway board's norms and existing TVUs or replaced with ROB/RUB. There are 25 unmanned level crossings. In a high-speed freight corridor, 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 is one level crossing with TVUs of less than 1500, which could be considered for closure. Now State Government has agreed for closure of it. The chainage wise locations of rail crossings have been given in **Annexure-2.3**.

2.3.15. 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 2.11: Summary Bridges Structure Detail

Structure type	Number
Important Bridges	4
Minor Bridges	133
Major Bridges	44
ROBs /RUBs	
a) ROB/RUBs under construction	10
b) ROBs sanctioned during 2013-14	32
c) RUB's sanctioned during 2013-14	23

Source: Feasibility Report

Minor bridges: There are 133 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 44 major bridges and 4 important bridges 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 chainage wise locations of minor bridges, major bridges and important bridge structures on rivers (Yamuna, Sahasra dhara, Markanda and Tangari) are given in **Annexures- 2.4, 2.5 and 2.6** 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: 50 ROBs are required of which 10 ROBs are already sanctioned prior to 2013-14 that are either commissioned or under construction.34 ROBs have been sanctioned during 2013-14 & balance under consideration. About 5459 sq. M of land area is required for one ROB. 27 new RUBs are proposed, mostly at detours or grade separation approach.2 RUB's are already commissioned, 23 sanctioned during 2013-14 & balance are under consideration. The chainage wise locations of ROBs and RUBs are given in **Annexures 2.7** and **2.8** respectively**.**

2.3.16. Signalling

For the single line section, proposals are for three line crossings stations at every 10 km between Pilkhani and Sahnewal 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.

2.3.17. 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 for the safety of train movement and driver's safety.

Telecommunication

Two 24 Fibres, 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.

2.3.18. 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 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. 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.

2.3.19. Residential Facilities and Labour Camps

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

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

2.4. Construction Material Source

The main construction material required for the project is earth material, cement, ballast, stone chips and sand etc. All these materials are locally available. Mining of minor minerals shall be undertaken after obtaining environmental clearance from the MoEF/SEIAA. Earth will be borrowed preferably from government wasteland or private non-agricultural land. The availability of wasteland 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 2.1.**

2.5. Project Implementation Schedule and Cost

The project is likely to be completed in about 3 years' time.

2.6 Green initives

Opportunity will be explored for energy conservation, rain water harvesting and utilisation of solar energy.

- Harnessing of solar energy can be fruitfully implemented in staff quarters, station & substation buildings as well as for street lighting.
- Water conservation procedures will be adopted in staff quarters & stations.
- Rain water harvesting can be implemented in staff quarter complex, stations.
- Feasibility of such initiatives will be considered during design stage.

Figure 2.6 : Junction Point Sahnewal

Figure 2.7 : Location of New Pawa Chahal Crossing Station

Figure 2.8 Site for New Khanna Crossing Station

Figure 2.9 : Site for New Govindgarh Crossing Station

Figure 2.10 Location of Rajpura Junction Point

Figure 2.11 : Proposed Location for New Shambhu Crossing Station

Figure 2.12 : Location for New Sarai Banjara Station and Crossing Station

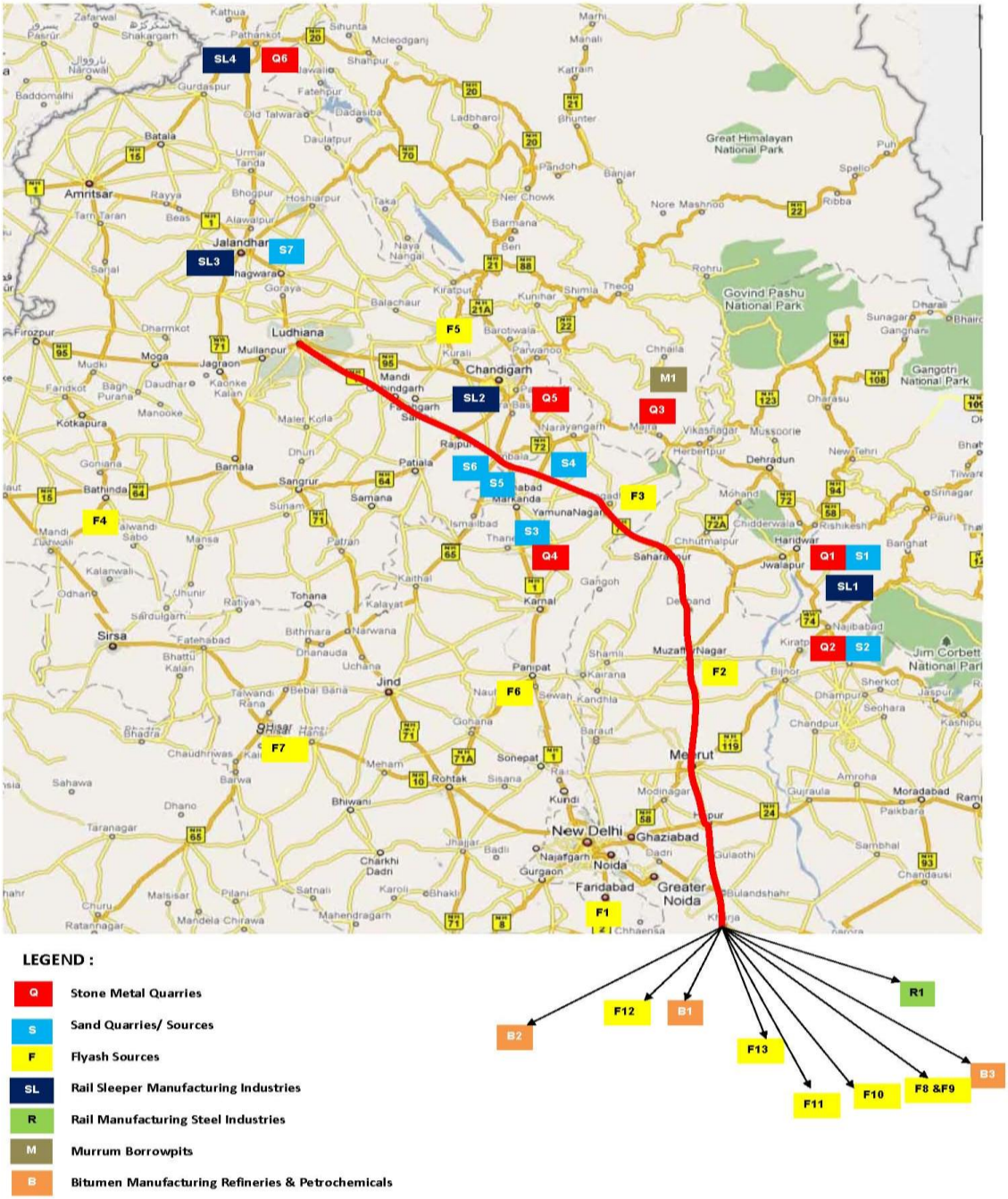
Figure 2.13 : Site for Proposed Sadhugarh Station and MTEK Siding

Figure 2.14 : Site for New Sirhind Crossing Station

Figure 2.15 : Site for New Govindgarh Crossing Station

Figure 2.16 : View of Rajpura Junction Station

Figure 2.17 : Key Map Showing Construction Material Sources



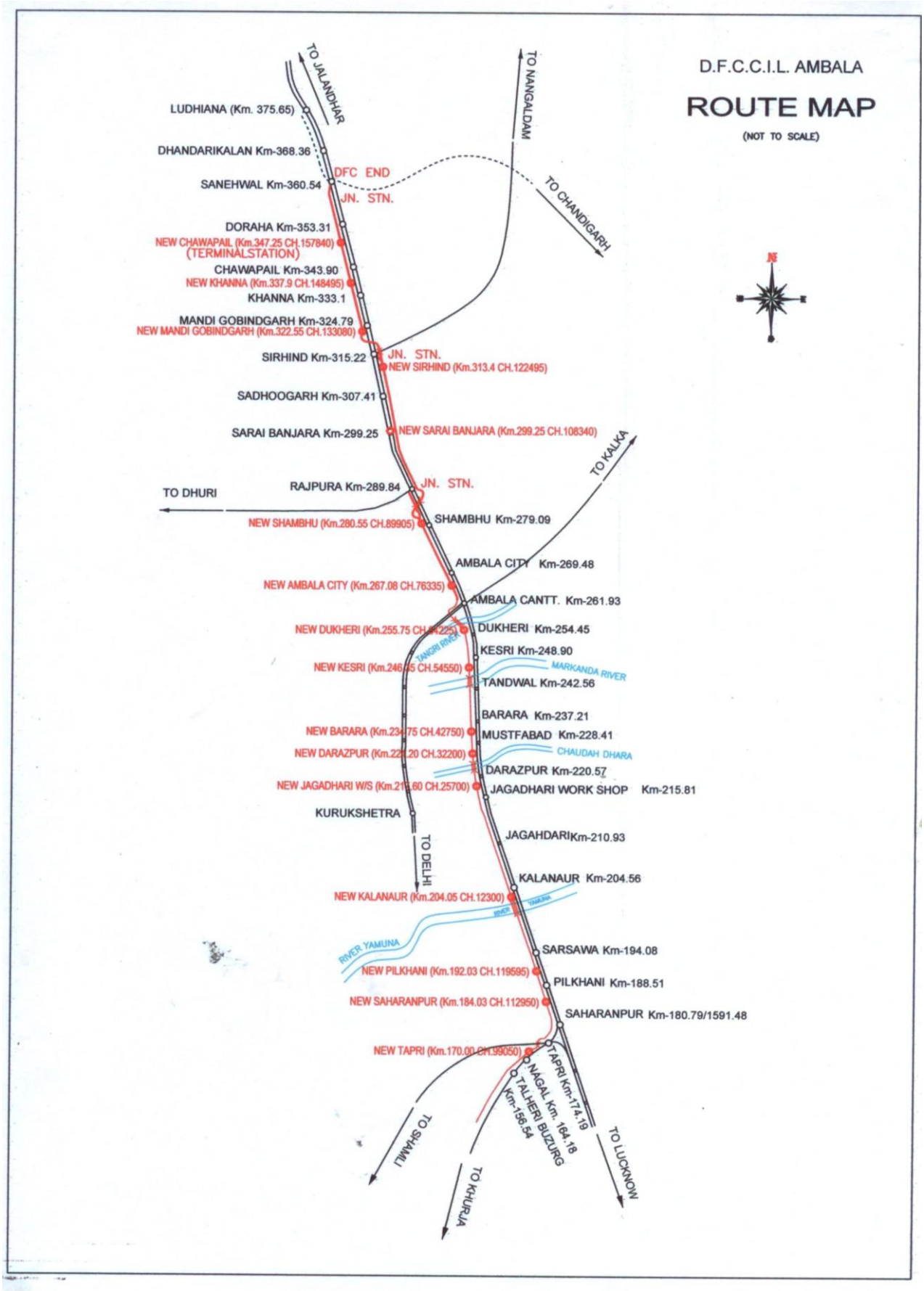
डेडीकेटेड फ्रेट कोरीडोर

Annexure- 2.1: 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			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			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 7	Ambala Ghaggar River Sand Source on LHS is located at a distance of 2.00 km from Project DFC		Ambala Town	2.00
6.	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

S. No	Quarry / Source No.	Name of Quarries / Sources	DFC Chainage (Km)	Location	Lead Distance (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			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, Chhattisgarh	375.650	Ludhiana City	1500.00

Annexure- 2.2: List of Junctions and Train Stations



Annexure- 2.3: Level Crossing Details

Pilkhani to Sahnewal 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 Manned	Manned	Inter Locking		
1	439	90A/C/T	189/13-15	189.81	Philakhni	Sarsawa		M	1	94940	ROB Sanctioned.
2	440	91/C/E	192/1-3	192.06	Philakhni	Sarsawa	UM			19380	Within DFCCI station, Sanctioned RUB.
3	441	92/C/T	194/19-23	195.00	Sarsawa	Kalanaur		M	1	197910	ROB UNDER CONST.
4	442	93/C/E	196/7-9	196.44	Sarsawa	Kalanaur		M		36210	RUB sanctioned.
5	443	94/C/E	197/3-5	197.19	Sarsawa	Kalanaur		M		28390	RUB sanctioned
6	444	95/C/E	198/13-15	198.81	Sarsawa	Kalanaur		M		38976	RUB sanctioned
7	445	96/C/E	200/15-17	201.00	Sarsawa	Kalanaur		M	1	75240	RUB Sanctioned.
8	446	97/C/E	208/21-23	209.00	Kalanaur	Jaghadri		M	1	533232	ROB Recommended
9	447	97A/C/T	210/23-25	211.00	Kalanaur	Jaghadri		M	1	53226	ROB Sanctioned
10	448	98/B/T	211/37-39	212.00	Jaghadri	Jaghadri Ws		M	1	336200	ROB Sanctioned
11	449	99/C/E	213/15-17	214.00	Jaghadri	Jaghadri Ws		M	1	64534	ROB Sanctioned
12	450	100/C/T	215/27-29	216.00	Jaghadri Ws			M	1	116424	ROB Sanctioned
13	451	101/C/E	217/9-11	217.56	Jaghadri Ws	Darazpur		M		28056	RUB sanctioned
14	452	102/C/E	219/3-5	219.19	Jaghadri Ws	Darazpur		M		31504	RUB sanctioned
15	453	103/C/T	220/13-15	220.81	Darazpur			M	1	25200	RUB sanctioned
16	454	104/C/E	221/26-28	222.00	Darazpur	Mustafabad		M	1	28336	RUB sanctioned
17	455	105/C/E	223/12-14	223.75	Darazpur	Mustafabad	UM			16800	RUB sanctioned
18	456	106/C/E	225/21-23	226.00	Darazpur	Mustafabad	UM			22680	RUB sanctioned
19	457	107/C/T	228/3-5	228.19	Mustafabad			M	1	59220	ROB Sanctioned
20	458	108/C/E	230/3-5	230.19	Mustafabad	Barara	UM			6568	RUB sanctioned
21	459	109/C/E	233/3-5	233.19	Mustafabad	Barara		M	1	178437	ROB Sanctioned
22	460	110/B/E	236/8-10	236.50	Mustafabad	Barara		M	1	361438	ROB Commisioned
23	461	111/C/T	236/18-20	237.00	Barara	Tandwal		M	1	452850	ROB Recommended
24	462	112/C/E	237/33-35	238.00	Barara	Tandwal		M		66575	ROB Sanctioned
25	463	113/C/E	240/1-3	240.06	Barara	Tandwal		M		6959	RUB sanctioned
26	464	114/C/E	241/5-7	241.33	Barara	Tandwal		M		3063	RUB sanctioned

New LINE NO.	S No. old	LC no. / Class/ Traffic/ Eng.	Location (Km)	Converted to decimal chainages	BETWEEN STATION		Level Crossing			TVUs	Remarks
							Un Manned	Manned	Inter Locking		
27	465	115/C/E	242/23-25	243.00	Barara	Tandwal		M		23536	RUB sanctioned
28	467	117/C/T	248/7-9	248.44	Tandwal	Kesri		M	1	232117	ROB/RUB Sanctioned
29	468	118/C/E	250/9-11	250.56	Kesri	Dukheri		M		25471	ROB Recommended
30	469	119/C/E	253/1-3	253.06	Kesri	Dukheri	UM			1245	RUB sanctioned
31	470	120/C/T	254/27-29	255.00	Dukheri	Ambala Cantt		M	1	45637	RUB sanctioned
32	471	121/C/E	258/3-5	258.19	Dukheri	Ambala Cantt		M		4695	RUB sanctioned
33	472	122/C/E	260/0-1	260.00	Dukheri	Ambala Cantt		M	1	130031	RUB by DFC
34	473	124/C/E	265/18-20	266.00	Ambala Cantt	Ambala City		M	1	119982	ROB/RUB Sanctioned
35	474	126/A/T	269/12-14	269.75	Ambala Cantt	Ambala City		M	1	480359	ROB Recommended
36	475	127C/T	270/26-28	271.00	Ambala City			M	1	96886	ROB Sanctioned
37	476	128/C/E	272/7-9	272.44	Ambala City	Sambu		M	1	170168	RUB sanctioned
38	477	129/C/E	274/13-15	274.81	Ambala City	Sambu		M	1	70446	ROB Sanctioned
39	478	130/C/E	276/5-7	276.33	Ambala City	Sambu		M	1	155052	ROB Sanctioned
40	479	131/C/T	279/19-21	280.00	Sambu	Rajpura		M	1	299463	ROB Commisioned
41	480	132/C/E	282/5-7	282.33	Sambu	Rajpura		M	1	196868	ROB Sanctioned
42	481	133/C/E	283/31-284/1	284.00	Sambu	Rajpura		M	1	162336	ROB Sanctioned
43	482	134/C/E	287/3-5	287.19	Sambu	Rajpura		M	1	4032	RUB Recommended
44	483	134A/C/E	288/15-17	289.00	Sambu	Rajpura		M	1	251832	ROB Sanctioned
45	484	137/C/E	293/21-23	294.00	Rajpura	Sarai Banjara		M	1	50400	ROB Sanctioned
46	485	138/C/E	296/21-23	297.00	Rajpura	Sarai Banjara		M	1	110967	ROB Sanctioned
47	486	139/C/T	299/29-31	300.00	Rajpura	Sarai Banjara		M	1	190368	ROB Sanctioned
48	487	140/C/E	302/25-27	303.00	Sarai Banjara	Sadhoo Garh		M	1	74304	ROB Sanctioned
49	488	140A/C/E	304/5-7	304.33	Sarai Banjara	Sadhoo Garh		M	1	74166	ROB Sanctioned
50	489	141/C/T	306/23-25	307.00	Sarai Banjara	Sadhoo Garh		M	1	122670	ROB Sanctioned
51	490	142/C/E	309/5-7	309.33	Sadhoo Garh	Sirhind Jn.		M	1	33558	RUB sanctioned
52	491	143/C/E	311/15-17	312.00	Sadhoo Garh	Sirhind Jn.		M	1	132616	ROB Sanctioned
53	492	144/C/E	312/27-29	313.00	Sadhoo Garh	Sirhind Jn.		M	1	1106931	ROB Recommended
54	493	145/B/T	314/15-17	314.00	Sadhoo Garh	Sirhind Jn.		M	1	1181142	ROB Commisioned
55	494	146/C/T	315/27-29	316.00	Sirhind Jn.	Mandi Govindgarh		M	1	35196	RUB on DFC Detour.
56	495	147/C/E	317/15-17	318.00	Sirhind Jn.	Mandi Govindgarh		M	1	474371	RUB on DFC Detour.

New LINE NO.	S No. old	LC no. / Class/ Traffic/ Eng.	Location (Km)	Converted to decimal chainages	BETWEEN STATION		Level Crossing			TVUs	Remarks
							Un Manned	Manned	Inter Locking		
57	496	148/C/E	318/9-11	318.56	Sirhind Jn.	Mandi Govindgarh		M		9885	RUB on DFC Detour
58	497	150/C/E	321/17-19	322.00	Sirhind Jn.	Mandi Govindgarh		M		78800	ROB Sanctioned
59	498	151/C/T	325/3-5	325.19	Mandi Govindgarh	Khanna		M	1	500746	ROB Recommended
60	499	152/C/E	326/3-5	326.19	Mandi Govindgarh	Khanna		M	1	50160	RUB commissioned
61	500	153/C/E	327/9-11	327.56	Mandi Govindgarh	Khanna		M	1	372498	ROB Sanctioned
62	501	154/C/E	331/13-15	331.81	Mandi Govindgarh	Khanna		M	1	345530	ROB Recommended
63	502	155/B/T	332/17-19	333.00	Mandi Govindgarh	Khanna		M	1	708500	ROB in progress
64	503	157/C/E	336/21-23	337.00	Khanna	Chawapail		M		140553	ROB Sanctioned
65	504	158/C/E	337/29-338/1	338.00	Khanna	Chawapail		M		182952	ROB Sanctioned
66	505	159/C/E	341/7-9	341.44	Khanna	Chawapail		M		135154	ROB Sanctioned
67	506	160/C/E	342/13-15	342.81	Khanna	Chawapail		M	1	88020	ROB Sanctioned
68	507	161/C/T	343/15-17	344.00	Khanna	Chawapail		M	1	640134	ROB Commisioned
69	508	162/C/E	345/27-29	346.00	Chawapail	Doraha		M		78692	ROB Sanctioned
70	509	163/C/E	348/29-31	349.00	Chawapail	Doraha		M		119583	ROB Sanctioned
71	510	164/C/E	351/9-11	351.56	Chawapail	Doraha		M		35432	RUB sanctioned
72	511	164B/C/T	352/23-25	353.00	Chawapail	Doraha		M	1	50140	ROB Sanctioned
73	512	164A/B/E	353/35-354/1	354.00	Doraha	Sahnewal		M	1	602988	ROB Sanctioned
74	513	165/C/E	354/17-19	355.00	Doraha	Sahnewal		M		96480	ROB Sanctioned
75	514	166/C/E	356/19-21	357.00	Doraha	Sahnewal		M		1526	RUB sanctioned
76	515	167/C/E	357/21-23	358.00	Doraha	Sahnewal		M	1	191840	ROB Sanctioned
77	516	C168/C	359/5-7	359.33	Doraha	Sahnewal		M	1	112666	ROB Recommended

Annexure- 2.4: List of Minor Bridge Structures

Pilkhani- Sahnewal Section

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
1	233	187/21-23	1	3.05	Minor	RCC Slab
2	234	189/11-13	1	0.91	Minor	RCC Slab
3	235	189/13-15	1	3.66	Minor	RCC Slab
4	236	189/15-17	1	0.6	Minor	RCC Slab
5	237	190/11-13		1x6.1	Minor	Slab
6	238	193/13-15	3	3.05	Minor	Arch
7	239	194/1	1	0.45	Minor	RCC Slab
8	240	195/10-11	1	3.04	Minor	RCC Slab
9	243	198/21-23	1	3.05	Minor	GIRDER
10	244	200/2-3	1	3.05	Minor	GIRDER
11	246	204/31-34	1	5.9	Minor	RCC Slab
12	247	207/3-5	4	1.18	Minor	TRINGULAT
13	248	207/3-5		1x6.00x2.761	Minor	RCC Box
14	249	209/5-7	1	3.04	Minor	Hume pipe
15	250	210/15-16	2	3.05	Minor	PRC SLAB
16	252	210/12-13	1	0.61	Minor	Arch
17	252-A	211/4-5	1	0.61	Minor	TRINGULAT
18	252-B	211/37-39		1x6.00x2.761	Minor	RCC Box
19	253	212/33-35		2x4.00x2.177	Minor	RCC Box
20	253-B	213/4-5	1	1	Minor	GIRDER
21	254	213/7-9	2	3.04	Minor	RCC HUME PIPE
22	256	216/3-4		2x6.00x1.200	Minor	RCC Slab
23	257	216/6-7	1	3.69	Minor	GIRDER
24	258	218/9-11		2x6.00x1.200	Minor	RCC Slab
25	261	221/9-11	1	2.52	Minor	GIRDER
26	264	225/5-7		1x6.00x2.449	Minor	RCC Box
27	270	230/19-21		2x4.00x2.986	Minor	RCC Box
28	271	231/1-3		2x6.00x2.518	Minor	RCC Slab
29	272	232/19-21	1	0.62	Minor	GIRDER
30	273	233/7-9		2x6.00x1.460	Minor	RCC Slab
31	274	233/21-23	1	0.6	Minor	Hume pipe
32	275	235/2-3		1x6.00x1.425	Minor	RCC Slab
33	277	236/5-6		1x6.00x1.596	Minor	RCC Slab
34	278	237/9-10	1	1.98	Minor	PRC SLAB
35	279	238/15-17	1	3.04	Minor	GIRDER
36	284	245/9-11	1	3.66	Minor	PSC SLAB
37	285	247/11-13	2	0.9	Minor	TRINGULAT
38	287	248/7-8	2	1.83	Minor	Arch
39	292	254/2-3	1	3.05	Minor	GIRDER
40	1-D-2	---		1x3x3	Minor	Box
41	1-D-6	---		1x3x3	Minor	Box
42	1-D-7	---		1x2x2	Minor	Box
43	1-D-8	---		1x4x4	Minor	Box
44	301	264/9-10		2x6.1	Minor	PSC Slab
45	301	264/33-36		2x6.1	Minor	Slab
46	303	267/6-7	1	1.52	Minor	PSC SLAB
47	305	268/21-23	1	2.44	Minor	Arch
48	306	268/23-25	1	1.14	Minor	RCC Slab
49	308	269/5-6	2	0.91	Minor	TROUGH PL.
50	309	269/35-37	1	0.91	Minor	Arch

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
51	310	270/5-7	1	3.05	Minor	GIRDER
52	311	270/27-29	1	3.05	Minor	RCC
53	311-B	271/5-7		1x1	Minor	Hume Pipe
54	311-A	270/13-14	1	1.83	Minor	RCC Slab
55	312	271/20-22	1	2.44	Minor	Arch
56	317	278/14-16	1	3.05	Minor	PRC SLAB
57	318	280/12-14	1	1.52	Minor	PRC SLAB
58	319	280/18-20	1	1.21	Minor	RCC Slab
59	320	281/2-4	1	1.52	Minor	Arch
60	321	281/14-16	2	0.91	Minor	Hume pipe
61	322	282/27-29	2	2.67	Minor	Arch
62	323	285/13-15	2	3.05	Minor	Arch
63	2-D-1	---		1x3.05	Minor	Slab
64	324	285/26-28		1x3.05	Minor	Slab
65	2-D-2	---		1x3.05	Minor	Slab
66	2-D-5	---		1x6x4	Minor	Box
67	324A	287/5-8		1x6x4	Minor	Box
68	324B	287/11-14		1x6x4	Minor	Box
69	2-D-6	---		1x6x4	Minor	Box
70	325-B	289/8-10	1	1.22	Minor	PSC SLAB
71	325-A	291/4-8		1x1.2x1.2	Minor	Box
72	326	291/15-17	1	3.05	Minor	COMP GIRDER
73	327	291/27-25	2	3.05	Minor	GIRDER
74	328	291/31-34		2x9.15	Minor	Slab
75	329	293/13-15	4	3.05	Minor	BOX CUL
76	330	294/3-5	3	2.9	Minor	RCC T-BEAM SLAB
77	332	295/7-9	1	3.05	Minor	PRC SLAB
78	333	295/14-16	2	3.05	Minor	PRC SLAB
79	333-A	295/13-15	1	0.6	Minor	BOX CUL
80	334	297/21-24		4x3.05	Minor	Slab
81	335	298/33-35	2	3.04	Minor	Hume pipe
82	335-A	298/34-36	1	0.6	Minor	RCC BOX CULVERT
83	336	299/31-33	2	3.04	Minor	Hume pipe
84	337	300/7-9	2	3.04	Minor	Hume pipe
85	340	301/27-30		2x9.15	Minor	Slab
86	341	302/13-15	5	3.04	Minor	PRC SLAB
87	342	303/11-13	2	3.05	Minor	RCC T-BEAM SLAB
88	343	303/25-27	2	3.04	Minor	Arch
89	344-A	304/5-7	1	0.46	Minor	PRC SLAB
90	345	304/9-11	2	3.04	Minor	PRC SLAB
91	346	304/17-19	1	3.04	Minor	Hume pipe
92	347	305/4-5	1	3.04	Minor	BOX CUL
93	349	305/21-23	2	3.04	Minor	PRC SLAB
94	350	306/3-5	2	3.04	Minor	RCC T-BEAM SLAB
95	352	307/5-7	1	3.04	Minor	BOX CUL
96	353	307/24-26	2	3.04	Minor	PRC SLAB
97	353-A	309/2-4	1	0.91	Minor	PRC SLAB
98	354	309/17-19	1	3.04	Minor	PRC SLAB
99	355	310/8-5	2	1.52	Minor	PRC SLAB
100	355-A	310/21-23	1	2.44	Minor	PRC SLAB
101	356	311/15-17	1	3.04	Minor	Arch
102	356-A	312/5-7	1	1.2	Minor	BOX CUL
103	357	312/27	1	2.45	Minor	BOX CUL

S.No	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge
104	358	313/19-21	1	1.52	Minor	Hume pipe
105	358-A	313/27-29	1	0.53	Minor	RCC Slab
106	362	320/25-27	2	3.04	Minor	RCC BOX
107	363	321/27-29	1	0.6	Minor	PRC SLAB
108	364	323/23-25	1	3.04	Minor	PRC SLAB
109	365	325/25-27	1	0.61	Minor	Arch
110	365-A	326/1-3	1	0.8	Minor	PRC SLAB
111	366	328/15-17	2	3.04	Minor	Arch
112	366A	328/1-3		2x3.00x1.37	Minor	Box Culvert
113	367	332/1-3	1	0.6	Minor	BOX CUL
114	368	332/15-17	1	0.61	Minor	BOX CUL
115	369-A	334/17-19	1	0.46	Minor	TROUGH
116	369-A1	334/16-18	1	0.46	Minor	TROUGH
117	370	336/23-25	1	3.04	Minor	CI Pipe
118	371	338/3-5	1	3.04	Minor	PRC SLAB
119	372	340/7-9	1	3.04	Minor	PRC SLAB
120	373	340/17-19	1	3.04	Minor	PRC SLAB
121	374	341/3-5	1	0.45	Minor	PRC SLAB
122	375	341/13-15	1	3.04	Minor	BOX CUL
123	376	343/25-27	1	0.6	Minor	TROUGH
124	376-A	345/4-6	1	0.6	Minor	RCC Slab
125	377	348/25-27	1	0.6	Minor	Arch
126	378	348/31to349/1	1	1.1	Minor	GIRDER
127	379	349/15-17		1x0.3	Minor	Hume Pipe
128	380	350/19-21	1	0.6	Minor	RCC HUME PIPE
129	381	351/1-3	1	0.91	Minor	Hume pipe
130	382	351/15-17	1	0.61	Minor	Hume pipe
131	383	352/21-23	1	0.91	Minor	Hume pipe
132	384	353/33-35	1	3.05	Minor	TROUGH
133	386	359/23-26		3x2	Minor	Box

Annexure- 2.5: List of Major Bridge Structures

Pilkhani- Sahnewal Section

SN	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comments (Foundation)	Remarks
1	241	196/29-01	1 up	22.86	Major	GIRDER		KALA NALA
2	242	197/22-35	2+1 up	12.2+25.8	Major	GIRDER	WELL	BUDHI YAMUNA
3	251	210/21-23	1 up	60.9	Major	TRINGULAT	WELL	WESTERN YAMUNA CANAL
4	255	214/21-23	2	7.62	Major	PRC SLAB		
5	259	219/17-19	1 up	22.86	Major	GIRDER	WELL	RAKSHI NALA
6	260	221/5-7	3 up	12.04	Major	GIRDER	WELL	LUNDA NALA
7	263	224/9-11	3 up	12.19	Major	GIRDER	WELL	CHATANG NALA
8	265	226/17-19	1+2 up	6.09+7.93	Major	GIRDER	OPEN	TEEN DARA
9	266	227/1-2	16 up		Major	PRC SLAB	OPEN	SOLAN DARA
10	267	227/23-25	10 up	2.52	Major	RCC SLAB	OPEN	
11	268	228/25-27	2 up	22.88	Major	GIRDER	WELL	SARASWATI NALA
12	269	229/23-27	15 up	6.09	Major	PRC SLAB	OPEN	DAULAT PUR BR.
13	276	235/28-32	15 up	6.1	Major	PRC SLAB	OPEN	
14	280	238/25-27	6 up	5.94	Major	PSC SLAB	OPEN	
15	281	239/19-21	4 up	5.94	Major	PSC SLAB	OPEN	
16	282	243/9-11	3	5.94	Major	PSC SLAB		
17	286	247/11-13	3 up	6.1	Major	PSC SLAB	OPEN	
18	289	251/5-7	5 up	6.1	Major	PSC SLAB	OPEN	
19	290	253/1-3	1 up	22.86	Major	GIRDER	OPEN	
20	291	253/12-13	1 up	22.86	Major	GIRDER	OPEN	
21	293	256/5-7	1 up	30.48	Major	TRINGULAT GR.	OPEN	CHOWA NALA
22	299	263/21-23	6 up	2.58	Major	RCC SLAB	OPEN	
23	300	264/6-7	3 up	6.1	Major	PSC SLAB	OPEN	
24	302	266/10-11	4+3+2 up	4X6.10+3 X1.895+2 X3.00	Major	PSC SLAB+BOX	OPEN	
25	304	267/25-27	3 up	6.1	Major	RCC SLAB	OPEN	
26	312 New	271/19-21		3x4x2	Major	Box		
27	313	273/22-30	8 up	22.86	Major	GIRDER	WELL	
28	314	275/8-10	5+2+1 +3 up	6.10+3.25 +1.966+3. 25	Major	PRC SLAB	OPEN	
29	314A	275/1-8		8x(2x4x2)	Major	Box		
30	314B	275/11-18		8x(2x4x2)	Major	Box		

SN	Bridge No.	Location	No. of Span	Span Length (M)	Classification of Bridge	Type of Bridge	Comments (Foundation)	Remarks
31	315	277/8-10	4 up	6.1	Major	PRC SLAB	OPEN	
32	316	278/4-6	4 up	6.1	Major	PRC SLAB	OPEN	
33	322-A	283/11-13	4 up	2X18.3+2 X12.20	Major	GIRDER	OPEN	
34	2-D-7	---		4x30.5	Major	Through Type Steel Truss		
35	325	287/16-20	8+5	8X8.23+5 X12.20	Major	GIRDER	OPEN	
36	331	294/13-17	15 up	6.09	Major	PRC SLAB	OPEN	
37	338	300/17-19	8 up	6.09	Major	PRC SLAB	OPEN	
38	339	301/19-21	8 up	6.09	Major	PRC SLAB	OPEN	
39	344	304/1-3	8 up	6.09	Major	PRC SLAB	OPEN	
40	348	305/15-17	2	7.92	Major	RCC Slab		
41	351	306/11-13	5 up	6.09	Major	PRC SLAB	OPEN	
42	3-D-4	---		4x18.3	Major	PSC Girder		
43	361-A	319/25-27	6 up	6.09	Major	PRC SLAB	OPEN	
44	385	354/0-1	2+2+2 up	2X24.23+ 2X21.34+ 2X24.08	Major	GIRDER	WELL	SIRHIND CANAL

Annexure- 2.6: 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- 2.7: List of ROBs

S.No.	Bridge No.	Location	Classification of Bridge
1	90A/C/T	189/13-15	ROB
2	92/C/T	194/19-23	ROB
3	97/C/E	208/21-23	ROB
4	97A/C/T	210/23-25	ROB
5	98/B/T	211/37-39	ROB
6	99/C/E	213/15-17	ROB
7	100/C/T	215/27-29	ROB
8	107/C/T	228/3-5	ROB
9	109/C/E	233/3-5	ROB
10	110/B/E	236/8-10	ROB
11	111/C/T	236/18-20	ROB
12	112/C/E	237/33-35	ROB
13	117/C/T	248/7-9	ROB
14	118/C/E	250/9-11	ROB
15	122/C/E	260/0-1	ROB
16	124/C/E	265/18-20	ROB
17	126/A/T	269/12-14	ROB
18	127C/T	270/26-28	ROB
19	129/C/E	274/13-15	ROB
20	130/C/E	276/5-7	ROB
21	131/C/T	279/19-21	ROB
22	132/C/E	282/5-7	ROB
23	133/C/E	283/31-284/1	ROB
24	134A/C/E	288/15-17	ROB
25	137/C/E	293/21-23	ROB
26	138/C/E	296/21-23	ROB
27	139/C/T	299/29-31	ROB
28	140/C/E	302/25-27	ROB
29	140A/C/E	304/5-7	ROB
30	141/C/T	306/23-25	ROB
31	143/C/E	311/15-17	ROB
32	144/C/E	312/27-29	ROB
33	145/B/T	314/15-17	ROB
34	150/C/E	321/17-19	ROB
35	151/C/T	325/3-5	ROB
36	153/C/E	327/9-11	ROB
37	154/C/E	331/13-15	ROB
38	155/B/T	332/17-19	ROB
39	157/C/E	336/21-23	ROB
40	158/C/E	337/29-338/1	ROB
41	159/C/E	341/7-9	ROB
42	160/C/E	342/13-15	ROB
43	161/C/T	343/15-17	ROB

S.No.	Bridge No.	Location	Classification of Bridge
44	162/C/E	345/27-29	ROB
45	163/C/E	348/29-31	ROB
46	164B/C/T	352/23-25	ROB
47	164A/B/E	353/35-354/1	ROB
48	165/C/E	354/17-19	ROB
49	167/C/E	357/21-23	ROB
50	C168/C	359/5-7	ROB

Annexure- 2.8: List of New RUBs

Pilkhani-Sahnewal Section

S.No.	Bridge No.	Location	Classification of Bridge
1	91/C/E	192/1-3	RUB
2	93/C/E	196/7-9	RUB
3	94/C/E	197/3-5	RUB
4	95/C/E	198/13-15	RUB
5	96/C/E	200/15-17	RUB
6	101/C/E	217/9-11	RUB
7	102/C/E	219/3-5	RUB
8	103/C/T	220/13-15	RUB
9	104/C/E	221/26-28	RUB
10	105/C/E	223/12-14	RUB
11	106/C/E	225/21-23	RUB
12	108/C/E	230/3-5	RUB
13	113/C/E	240/1-3	RUB
14	114/C/E	241/5-7	RUB
15	115/C/E	242/23-25	RUB
16	119/C/E	253/1-3	RUB
17	120/C/T	254/27-29	RUB
18	121/C/E	258/3-5	RUB
19	128/C/E	272/7-9	RUB
20	134/C/E	287/3-5	RUB
21	142/C/E	309/5-7	RUB
22	146/C/T	315/27-29	RUB
23	147/C/E	317/15-17	RUB
24	148/C/E	318/9-11	RUB
25	152/C/E	326/3-5	RUB
26	164/C/E	351/9-11	RUB
27	166/C/E	356/19-21	RUB

Chapter 3. Policy, Legal & Administrative Framework

3.1. Introduction

This chapter presents a review of the existing environmental, forest related regulations and statutory acts/ rules applicable to this project. This chapter also outlines various issues related to the framework in place for environmental clearance of projects with reference to the Government of India and the State Governments of Uttar Pradesh, Haryana and Punjab

3.2. Government of India requirements

3.2.1. Environmental Clearance Requirements

As per MoEF notification dated 14 September 2006 and its amendments Railway project does not require environmental clearance.

3.2.2. Forest Clearances

The proposed project requires 175 ha of forest land diversion UP, Haryana and Punjab. To divert any type of forests land for non-forestry activity permission from forest department need to be undertaken as per Forest (Conservation) Act, 1980.

3.3. State Level Clearance Requirements

Besides, the MoEF environmental clearance requirements, the project requires clearance from some of the state level agencies as discussed below.

3.3.1. State Pollution Control Board (SPCB) Requirements

Projects require obtaining No Objection Certificate (NOC) from State Pollution Control Boards in Uttar Pradesh, Haryana and Punjab in pursuant to the Water (Prevention and 'Control of Pollution) Act of 1974, the Cess Act of 1977 and the Air (prevention and Control of Pollution) Act of 1981. In the present project context it needs to obtain NOC from Uttar Pradesh Pollution Control Board (UPPCB), Haryana State Pollution Control Board (HSPCB) and Punjab Pollution Control Board (PPCB).

3.3.2. Tree felling permissions

Project requires cutting trees for which permission from District Magistrate office and Forest Department are required.

3.3.3. Permissions/Clearances

The Indian legislations and environmental regulations are given in **Table 3.1**.

Table 3.1 Summary of Applicable and other Environmental Legislation

S. No.	Act/Rules	Purpose	Applicability	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	To provide environmental clearance to new development activities following environmental impact assessment	Railway projects are not included in the Notification of 14th Sep, 2006 and EC under these acts is not applicable. However, as per MoEF's amended notification dated 9.9.2013 mining of minor minerals	MoEF

S. No.	Act/Rules	Purpose	Applicability	Authority
			through borrow / quarry areas of <5 Ha, which will be used in project, require prior environmental clearances	
3	Notification for use of fly ash,1999	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	The Forest (Conservation) Act 1927 The Forest (Conservation) Act. 1980 The Forest (conservation) Rules, 1981	To check deforestation by restricting conversion of forested areas into non-forested areas	Applicable, protected forest land is involved in the project.	MoEF and State Forest Department
5	MoEF circular (1998) on linear Plantation on roadside, canals and railway lines modifying the applicability of provisions of forest (Conversation) Act, to linear Plantation	Protection / planting roadside strip as avenue/strip plantations as these are declared protected forest areas.	Applicability of Forest conservation act to Roadside strip Plantations	MoEF and State Forest Department
6	Air (Prevention and Control of Pollution) Act, 1981	To control air pollution by specifying the emission standards.	Emissions from construction machinery and vehicle should be checked time to time.	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
7	Water Prevention and Control of Pollution) Act, 1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards	Various parameters in Effluents from construction sites and workshops are to be kept below the prescribed standards	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
8	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.	DG sets at construction sites and workshops should be provided with acoustics enclosures.	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
9	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act,2010	Conservation of cultural and historical remains found in India	If any historical remains are found, would be notified/ surrendered to the Competent Authority.	Monuments Authority of India
10	Public Liability and Insurance Act 1991	Protection form hazardous materials and accidents.	Shall be taken as per requirements	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab
11	The Explosives Act 1884	Safe transportation, storage and use of explosive material	Respective Authorization shall be obtained from CCE	Chief Controller of Explosives (CCoE)
12	Minor Mineral and	For opening borrow pits,	Quarry Licenses shall	District Collector

S. No.	Act/Rules	Purpose	Applicability	Authority
	concession Rules	quarry.	be obtained by Contractors.	
13	Central Motor Vehicle Act 1988 and Central Motor Vehicle Rules 1989	To check vehicular air and noise pollution and authority to drive vehicles	All vehicles in Use shall obtain Pollution Control Check certificates and driven by licensed persons	Motor Vehicle Department
14	The Mining Act	The mining act has been notified for safe and sound mining activity.	Quarry Licenses shall be obtained by Contractors.	Department of mining, GoUP, GoH, GoP
15	Hazardous waste (Management , Handling & Transboundry) Rules, 2008	Management and storage of hazardous waste.	Applicable	State Pollution Control Boards of Uttar Pradesh, Haryana & Punjab / MoEF
16	The Railway (Amendment) Act, 2008	Land acquisition	Land acquisition is involved	GoI
17	The Petroleum (Amendment) Rules, 2011	Use and storage of petroleum products	Applicable	CCOE /DC

3.4. 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. The DFCCIL shall ensure that other legislations like Child Labour (prohibition and Regulation) Act; 1986, Minimum Wages Act; 1948, The Factories Act; 1948, The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 etc. are followed. Details of applicable statutory rules & regulations during construction stage are also given in DFCCIL's SHE Manual, which forms part of the contract document.

3.5. The World Bank Safeguard Policies

The EIA 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 safeguard policies of the World Bank are given below.

Table 3.2 :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 4.11	Physical Cultural	Yes	Risk to cultural properties	Adequate mitigation	EMP & RAP prepared

Sl. No.	Safeguard Policy	Subject Category	Triggered	Triggered By	Mitigation Measures	Documentation
		Resources			measures if affected	
3.	OP 4.36	Forestry	Yes	Diversion of forest land	To be carried out as per Forest (conservation) Act, 1980	Not Applicable
4.	IFC Performance Standards	Labour & Occupational Health	Yes	Labour and construction camp	Compliance of IFC Standards	EIA & EMP prepared; Safety & Occupational Health measures during construction will be adequately covered in Contract document & DFCCIL SHE manual will be referred.

Environmental Categorization and Need of Environmental Assessment

According to 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.

3.6. 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. Reserve Forest areas have 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 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.

3.7. 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-3.3**.:

Table 3.3 *:* **Summary of Clearances Requirements**

Sl. No	Type of clearance	Statutory Authority	Applicability	Project stage	Time required	Responsibility
1	Forest Clearance	State Environment & Forest dept. and MoEF regional office	Diversion of Forest land	Pre construction	6-8 months	DFCC
2	Tree felling permission in Private/Govt Land	Forest department/ Revenue Dept	Felling of trees	Pre construction	1 month	DFCC
3	NOC And Consents Under Air , Water, EP Acts & Noise Rules of SPCB	State Pollution Control Boards of Uttar Pradesh, Punjab and Haryana	For establishing plants	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
4	NOC And Consents Under Air , Water, EP Acts & Noise rules of SPCB	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
5	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
6	Explosive license	Chief Controller of Explosives	Storage of Explosive materials	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
7	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
8.	Ordinary earth excavation, borrow pits	Dept. of Geology and Mines, GoUP, GOH and GoP. State Env. Dept.	Ordinary earth, borrow pits	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
9	Quarry lease deeds and license	Dept. of Geology and Mines, GoUP, GOH and GoP.	Quarrying and borrowing operations	Construction (Prior to work initiation)	2-3 months	Concessionaire / Contractor
10	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

Other regulations related to the welfare and organisation of labour need to be adhered.

3.8. Conclusion

Review of environmental regulations clearly indicates that the subject DFC project does not require any environmental clearance. However, clearance 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
- Borrow pits to be opened after obtaining NOC from SEIAA of State Govt. Environment Dept.
- 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 deeds
- Site SHE Plan and EMP have to be developed by the contractor based on DFCCIL SHE Manual & EMP respectively.

Chapter 4. Environmental Profile of the Project Influenced Area

4.1. Introduction

This section presents the environmental profile of the project influence area and its salient features. The objective of the profile is to ascertain the environmental sensitivity of the project, and identify the likely impact zones of the project.

Considering the nature of the project alignment, an area of about 7.0 km on either side of the corridor has been considered for studying the profile. The environmental features such as reserved forest, sanctuaries / national parks, rivers, lakes and ponds, religious structures, archaeological monuments, natural habitats, schools, irrigation canals along with other sensitive receptors were mapped in the profile through detailed field inventories and presented on the topo sheets (on a scale of 1:50,000) of Survey of India.

In addition to the above, the detailed walk through surveys were carried out to map specific environmental features within the Right of Way (RoW) of the proposed alignment. These features were presented on strip maps. Sections below, presents the details of both these surveys. 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.

4.2. Methodology

The methodology followed in the preparation of the environmental profile of the project influence area and strip maps comprised the following:-

- Collection of Toposheets (scale 1:50000 & 1:250000 of Survey of India from Survey of India and demarcation of the proposed alignment on the toposheets.
- Field reconnaissance of the proposed alignment through detailed walk through surveys
- Mapping of sensitive receptors such as schools, religious structures, hospitals etc.
- Interactions with local villagers and resource persons to understand the importance of various sensitive features and other local resources (if any).

The data collected from the above tasks was mapped on the detailed Kilometer wise strip maps and topo sheets on a scale of 1:50,000.

4.3. Environmental Profile of Project Influence Area

The environmental profile of the influence area (within 7.0 km on either side of the proposed alignment) presented in **Annexure-4.1**, indicates that

- The alignment generally runs through plain areas of Indo-Gangetic plains and is devoid of sensitive environmental features
- At many of the locations, Western Yamuna canal and its distributaries criss-crosses the alignment. Other canals and their distributaries within 7 km buffer zone include Bhakra Canal and Sihind Canal.
- The alignment also crosses through Yamuna, Markanda, Tangri and Ghaghhar rivers. Out of these, Yamuna is the only perennial river.

In addition to the above, no sensitive features such as wild life sanctuaries, wet lands, etc. were observed within the project influence area.

4.4. Environmental Features within Project RoW

The environmental features within the right of way (RoW) of the project were recorded through the kilometre wise strip maps, as presented in **Annexure 4.1**, indicate that the proposed alignment,

- does not pass through any national park, wild life sanctuary, reserve forest or sensitive natural resources
- does not affect wetlands
- however, the proposed alignment will require to acquire Protected Forest (PF) land in the districts of Yamunanagar, Ambala, Patiala, Fatehgarh, Ludhiana and PF lies in railway land along the existing IR track.

Considering dense settlements and developments along the existing railway line near Ambala town, the project proposes a detour at the location.

The project alignment runs through Yamuna, Markanda, Tangri and Ghaghhar Rivers of which Yamuna is the only perennial river.

The alignment also crosses the Western Yamuna canal and its distributaries, Bhakra Canal and Sirhind Canal. The impacts on the canals however are mitigated in the design by providing adequate cross drainage works at all the locations.

Physical cultural resources shifting: About 34 such structures are likely to be shifted due to the construction of Pilkhani-Sahnewal section of EDFC.

The proposed alignment is expected to involve the cutting of 28617 trees. Most of these tree species comprise common species such as neem, Poplar, mango, eucalyptus, etc., and doesn't involve cutting of any sensitive / endangered species.

4.5 Sensitive Receptors

Summary of sensitive receptors within 100m either side of the proposed Pilkhani-Sahnewal section of EDFC is presented in Annexure 4.1.

Annexure 4.2 presents number and types of trees within the RoW.

Annexure 4.1: List of Important Features

Summary of Important Features Along the Corridor (KM 188-195)	
Type of Feature	**Numbers within 100m**
Religious Structure	1
School/College	1
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 196-204)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	3
Summary of Important Features Along with Corridor (KM 205-213)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	1
Summary of Important Features Along with Corridor (KM 214-222)	
Religious Structure	15
School/College	2
Hospital	1
Water Bodies	0
Summary of Important Features Along with Corridor (KM 223-231)	
Religious Structure	3
School/College	1
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 232-240)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 241-248)	
Religious Structure	2
School/College	1
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 249-257)	
Religious Structure	3
School/College	0
Hospital	0
Water Bodies	0

Summary of Important Features Along with Corridor (KM 258-266)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 267-275)	
Religious Structure	2
School/College	1
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 276-284)	
Religious Structure	2
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 285-293)	
Religious Structure	3
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 294-302)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 303-311)	
Religious Structure	7
School/College	2
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 312-320)	
Religious Structure	1
School/College	1
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 321-329)	
Religious Structure	1
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 330-338)	
Religious Structure	1
School/College	0
Hospital	0
Water Bodies	0

Summary of Important Features Along with Corridor (KM 339-347)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 348-356)	
Religious Structure	1
School/College	0
Hospital	0
Water Bodies	0
Summary of Important Features Along with Corridor (KM 357-360.2)	
Religious Structure	0
School/College	0
Hospital	0
Water Bodies	0

Summarising,

(i) Religious structure : 42
(ii) School / college : 9
(iii) Hospital : 1
(iv) Warwebody : 4
Total : 56

Annexure 4.2
Number of Trees within RoW

Block Section	Location (Rly. Km)		No. of Tree with Girth more than 30 cm. at Height of 1.37mt. from G.L.
	From	To	
AMBALA-PILKHANI SECTION			
PKY-SRE	187/7-9	191/9-11	737
PKY- SSW	192/0-1	197/15-17	1105
SSW-KNZ	198/7-9	201/15-17	1621
Yamuna Bridge KM 203 to 203/9-11 in Block Section Kalanour	KM 203 to 204 (L/S)		494
Yamuna Bridge KM 203 to 203/9-11 (Road Side) in Block Section Kalanour.	KM 203 to 204 (L/S)		275
Railway Colony in Yard Kalanour	204	205	102
Yard Kalanour	203/9-10	205/11-13	3444
204 to 205 (in Kalnour Band Road Side) in Yard Kalanour	204	205	205
Kalanaur-Jagadhari	205/11-13	206	488
Kalanaur-Jagadhari	206	209/33-35	3789
Yard Jagadhari	209/33-35	211/3-5	1205
Yard Jagadhari	211/3-5	211/37-39	24
Jagadhari/ Jagahdhari Workshop	211/37-39	214/9-11	707
JUD-JUDW (Railway Boundary on upside)	214/0-1	214/9-11	92
Yard Jagahdhari Workshop	214/9-11	215/13	501
Jagahdari Workshop	215/13	216/23-25	139
JUDW-DZP	216/23-25	218/29-31	800
JUDW-DZP	218/29-31	220/1-3	1059
JUDW-DZP	220/1-3	220/5-7	193
DZP-MFB	221/11-13	222/01-03	568
DZP-MFB	222/1-3	225/19-21	4679
Darazpur – Mustfabad	225/23-25	227/11-11A	260
Station Yard at MFB	228-19	228/37	344
MFB-RAA1	227/11-11A	233/1-3	1268
RAA	236/17	237/3	117
TDW	242/9	242/31	61
KES	249/7	248/29	62
KES-DOKY	249/23-25	250/7-9	167
Doky-UMB	254/11	254/25	146
Ambala Cantt. to Ambala City excl. Stn Yard	264/35	268/19	26
Ambala Station Yard	272	274	182
Ambala City Rly. Stn. LHS	269/15-17	269/29-31	8
Sub Total			**24868**

Block Section	Location (Rly. Km)		No. of Tree with Girth more than 30 cm. at Height of 1.37mt. from G.L.
	From	To	
AMBALA - SAHNEWAL SECTION			
Ghagar River to Gobindgarh	284/7	284/13	331
Shambu Rly. Line	273/29	277/21	93
Shambu-Rajpura Rly Stn.			140
Shambu Rly. Line	279/19	287/10	467
Shambu Rly. Line			43
Sarai Banjara – Sadhugarh	301/8-10	306/18-20	45
Sadhugarh – Sirhind	308/18-20	314/8-10	37
Defence Bund Sirhind LHS			34
Defence Bund Sirhind RHS			18
Sirhind- Gobindgarh	317/12-14	323/10-12	116
Gobondgarh-Khanna	325/29-31	327/15-27	42
Doraha- Sahnewal	353/33	359/13	93
Chawapail-Doraha	344/27-29	352/7-9	215
Khanna-Chawapail	334/0-1	342/21-23	277
Gobindgarh-Khanna	328/1-3	331/11-13	35
STATION YARDS			
Sadhugarh Rly. Stn	306/22-24	307/32-34	154
Sirhind Rly. Stn.	300/2-4	301/8-20	49
Govindgarh Rly. Stn.	324/17-19	325/1	54
Chawaoail Stn.	343/9-11	344/17-19	804
Khanna Stn.	332/21-23	334/1	104
Doraha Stn.	352/25-27	353/11-13	37
Sambhu Rly. Stn.	278/11-13	279/27-29	430
Rajpura Rly. Stn.			100
Sarai Banjara Rly. Stn.	299/4-6	299/10-12	10
Sahnewal Rly. Stn.	359/1-3	359/33-35	21
Sub Total			**3749**
Grand Total			**28617**

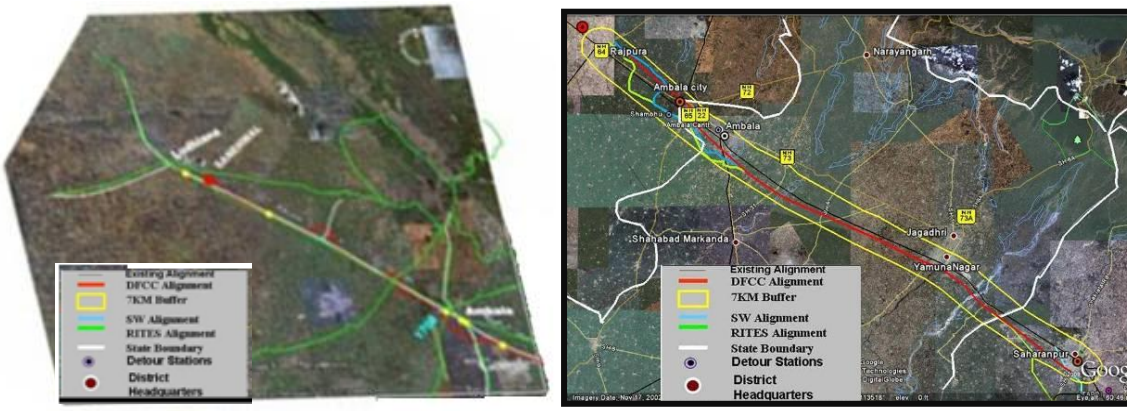
Chapter 5. Baseline Environmental Profile

5.1. 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 175.00 km (**Figure 5.1**). The chapter assesses the relevant physical, biological and socio-economic components of the environment along the proposed EDFC section. The data related to the study area has been compiled 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-Sahnewal Section Pilkhani-Rajpura Section

Figure 5.1 : Study Area Map

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

Ch. 187+500 to Ch. 274 km in UP & Haryana (one stretch),
Ch. 274 to 360 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 5.1** below.

Table 5.1 : 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	Districts of Yamunanagar, Ambala, Patiala, Fatehgarh, Ludhiana
	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 **28617** trees need to cut.	Mango in U.P., Poplar in Haryana and Punjab are the most dominant.
2.	Archaeological Monuments	None within 300 m of proposed track	Yes. The list is enclosed in Section 4.4.8
3.	Water Bodies	Crossing Rivers – Yamuna, Markanda, Tangri and Ghaghhar Crossing Canals – Western Yamuna Canal	Rivers within 7 km – Kali, Yamuna, Markanda, Tangri and Ghaghhar Canals – Western Yamuna Canal, Eastern Yamuna Canal, Bhakhra canal, Sirhind canal.
4.	Ground water	The alignment passes through Over exploited blocks of Jagadhari, Mustafabad, Rajpura, Sirhind and Khanna. Critical blocks of Barara and Doraha. Semi-critical block of Gulaothi.	Same as in core zone
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 cultural resources	Physical-Cultural resources getting affected – 34	To be reconstructed on a similar pattern.
7.	Social	Poverty – highest in U.P. followed by Haryana and least in Punjab Indigenous – none HIV/AIDS – none	

5.2. Physical Environment

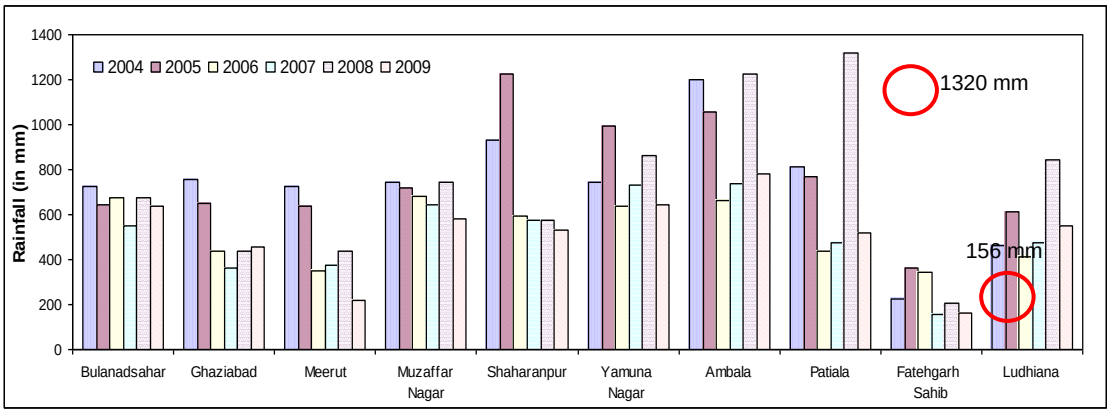
5.2.1. Meteorology and Climate

The entire stretch from Pilkhani (Uttar Pradesh) to Sahnewal (Ludhiana) passes through six districts namely 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 5.2**

Table 5.2 : Details of Meteorological Data Collected for the Project Area

Parameter	Stations	Duration	Source
Rainfall	1. Saharanpur 2. Yamunanagar 3. Ambala 4. Fatehgarh Sahib 5. Patiala 6. Ludhiana	Last five years (2005 – 2010)	India Meteorological Department, Delhi
Wind Speed and Direction Temperature Humidity	1. Ambala 2. Patiala 3. 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 5.2**

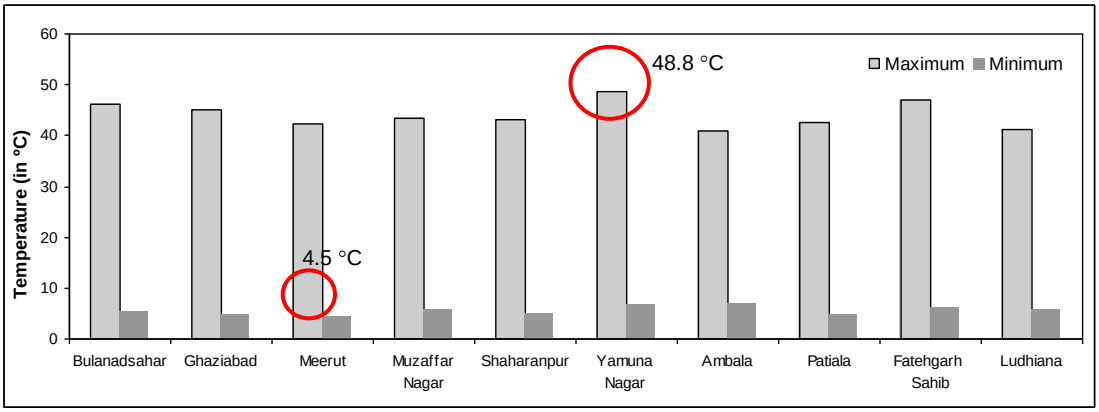


Source: India Meteorological Department (IMD), Delhi

Figure 5.2 : Average Annual Rainfall in the study area (2004-2009)

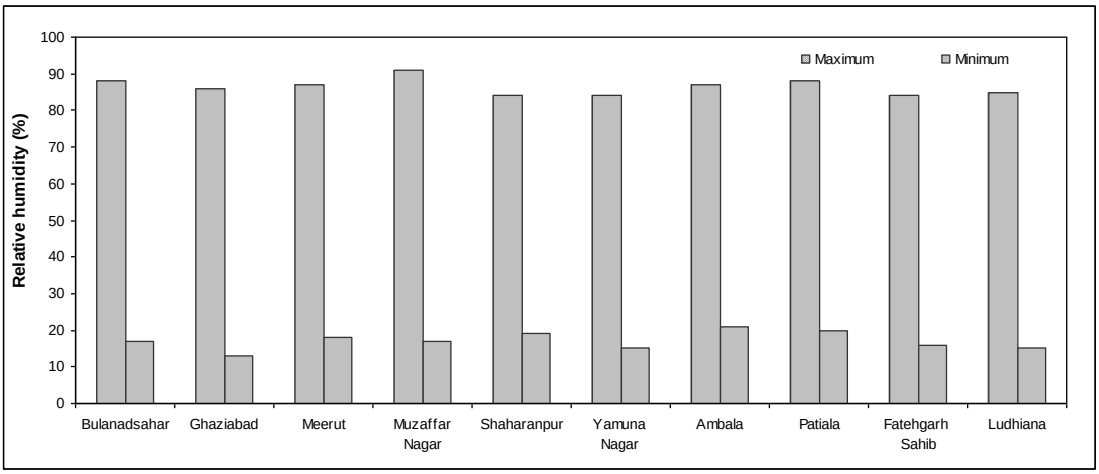
Wind: The wind speed & direction in the project districts is found to be varying at different locations in each season. The wind data for Ambala and Ludhiana indicate winds are mostly low (< 8 km/hr). The predominant wind direction in the project area is during the year 2009-10 are west, north-west and 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 5.3 & Figure 5.4**.



Source: India Meteorological Department, Delhi

Figure 5.3 : Annual Average Temperature in the Study Area 2008-09



Source: India Meteorological Department, Delhi

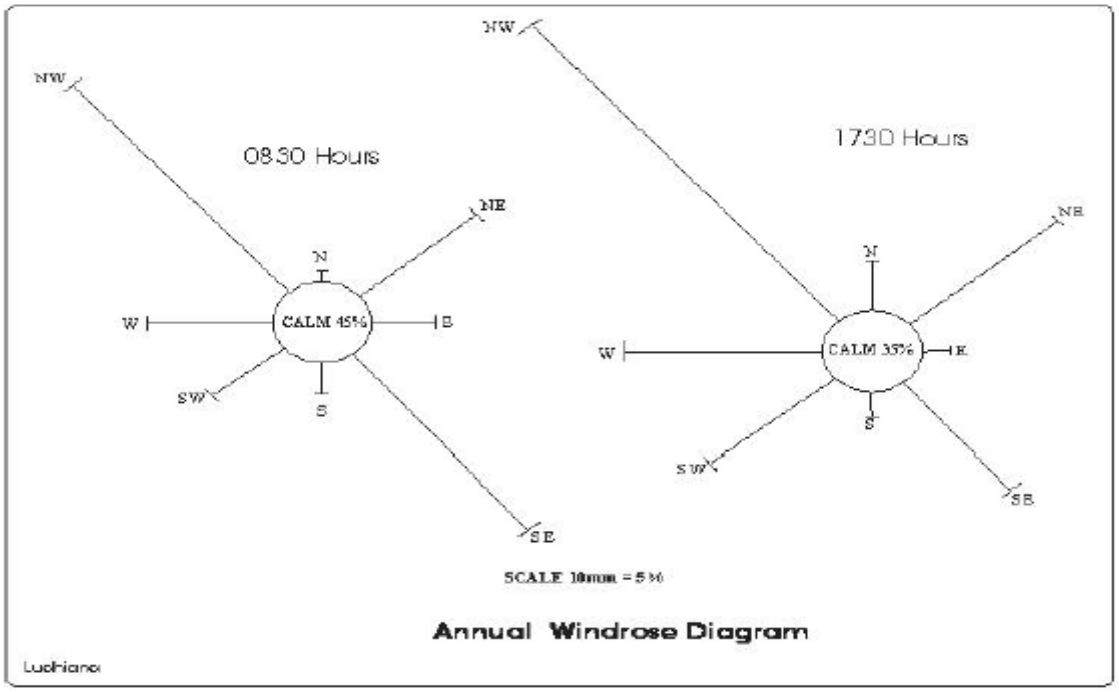
Figure 5.4 : Annual Average Relative Humidity in the Study Area in 2008-10

The conclusions of the above analysis are shown in **Table 5.3** 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.

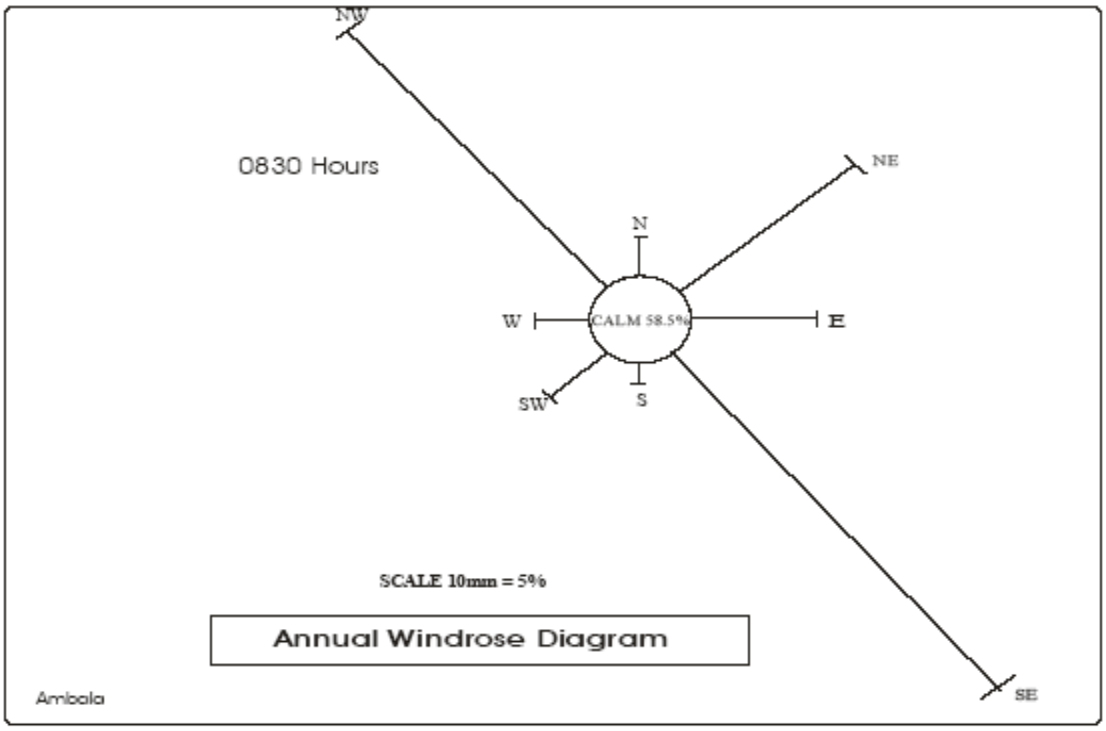
Table 5.3 : Summary of Meteorological Variations in Different Sections

Parameters	Ch. 201 – 300 km (Ambala)	Ch. 301 – 360 km (Ludhiana)
Rainfall (range in mm)	637 – 1228	156 – 1320
Wind Speed (range in kmph)	5 – 8	2 – 5
Wind Direction (16 point compass)	SE and NW	SE and NW
Temperature (°C)	6.1 – 39.6	6.2 – 40.3
Humidity (%)	26 – 84	26 – 84

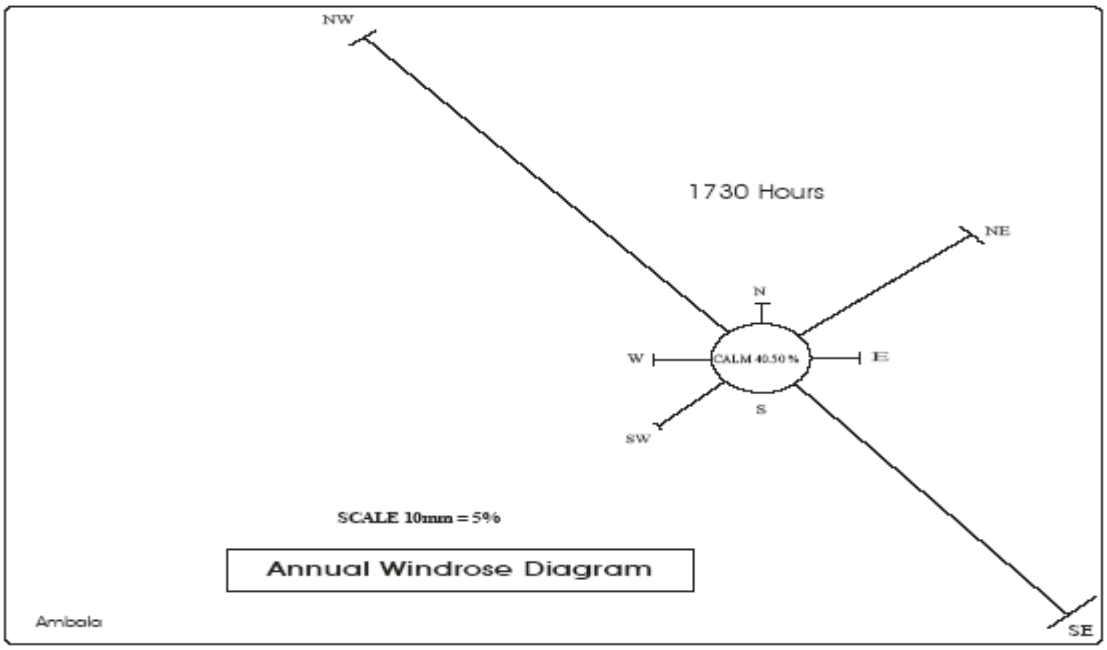
The windrose diagrams of Ambala and Ludhiana are given below:



Wind Rose Diagram for Ludhiana IMD Observatory



Wind Rose Diagram for Ambala (8.30 AM) IMD Observatory



Wind Rose Diagram for Ambala (5.30 PM) IMD Observatory

5.2.2. 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 ($PM_{2.5}$), respirable suspended particulate matter (RSPM i.e. PM_{10}), 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 - 5.1**.

The air quality results reveal that except the particulate matter (SPM and PM_{10}) all other pollutants are well within the prescribed standards. The dust levels (SPM and RSPM) are found to be quite high at locations like 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, $PM_{2.5}$, 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 Sirhind

Air Sampling at Mandi Gobindgarh

A summary of the ambient air quality is shown in **Table 5.4** 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 – 360 km sections. Location wise and date wise detailed results presented in **Annexure-5.2**.

Table 5.4 : Summary of Air Quality Variations during Winter Season

Parameters	Ch. 187+800 – 300 km (Pilkhani- Ambala)	Ch. 301 – 360 km (Ambala- Ludhiana)
SPM ($\mu g/m^3$)	200 – 356	225 – 421
$PM_{2.5}$ ($\mu g/m^3$)	21 – 33	21 – 45
RSPM (PM_{10}) ($\mu g/m^3$)	134 – 222	118 – 250
SO_2($\mu g/m^3$)	12 – 28	12 – 53
NO_X($\mu g/m^3$)	10 – 25	13 – 33

5.2.3. 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 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- 5.3**. The schematic layout for noise and vibration measurements has been shown in **Figure-5.5.**

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 that 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 Railway noise and vibration measurements were carried out simultaneously using` noise and vibration level meters 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 5.5** for each passing train in one direction. The figure reveals that the noise levels exceed the prescribed standards during both 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

Ambient Sensitive Receptors
(Source: JICA Study Report)

Figure 5.5 : Schematic Layout of Noise and Vibration Measurement Sites

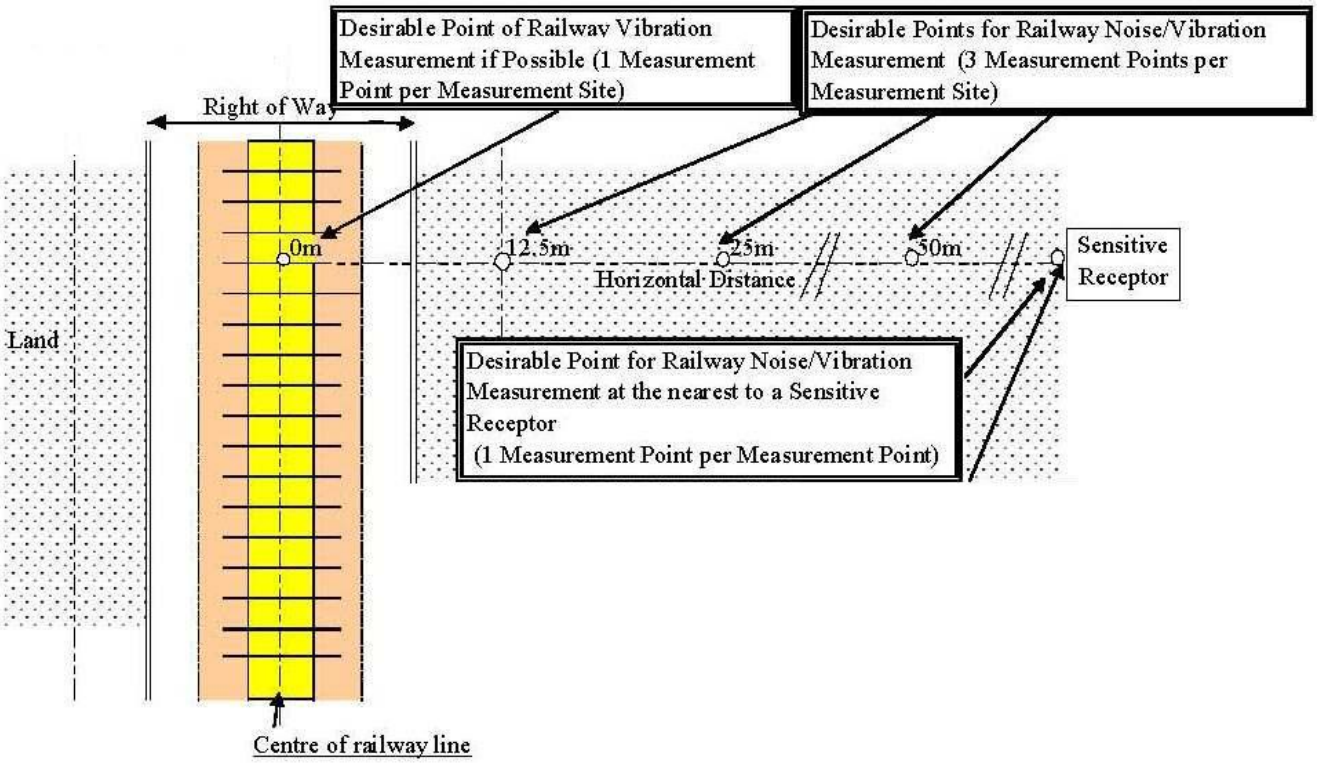
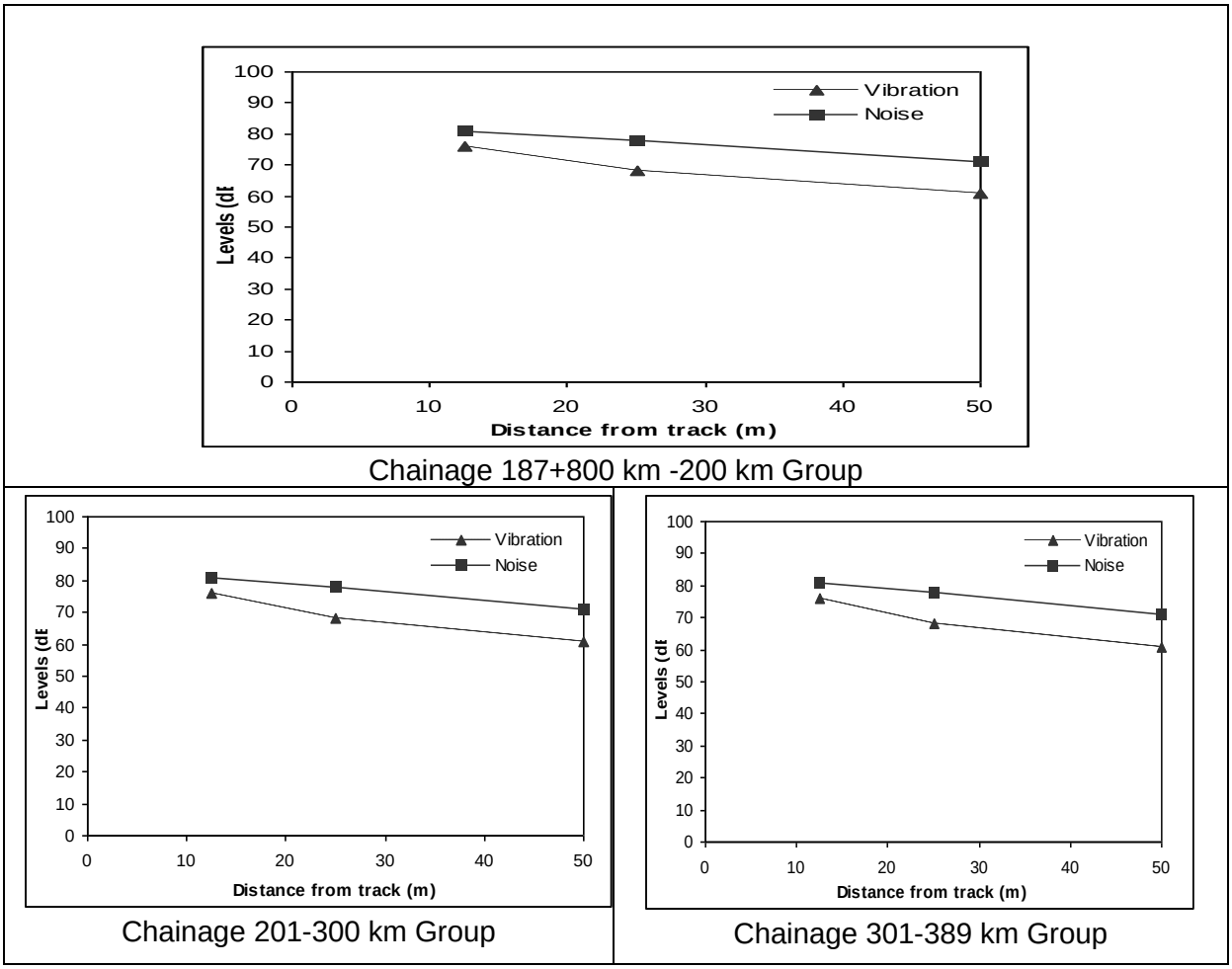


Table 5.5 Ambient Noise Level along the Corridor

S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
1.	Pilkhani (km 188+00)	Buffer	Rural	47.3	34.5	72	44.3	Noise level is within the prescribed limit of CPCB
2.	Asian Group of College, Darazpur(km 220+570)	Core	Residential	51.9	39.2	78	41.2	Noise level is within the prescribed limit of CPCB
3.	High School, Mustafabad (Chainage- 228+000km)	Core	Commercial	68.6	60.7	71	49	High due to commercial activities and road & railway traffic
4.	Barara (km 237+210)	Buffer	Rural	49	41.3	77	50.1	Noise level is within the prescribed limit of CPCB
5.	Kesri Railway Station (km 246.35)	Core	Rural	54	49	72	35	Noise level is within the prescribed limit of CPCB
6.	Angel's Public School, Ambala(km 267+000)	Core	Sensitive	78	60.3	78.2	49.1	Due to heavy commercial activities as well as road & train traffic the noise level is very high
7.	Pashupati Kusht Ashram Society, Ambala (268+000)	Core	Commercial	77	57	81	46.3	Due to heavy commercial activities as well as road & train traffic the noise level is very high
8.	Rajpura (km 289+500)	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; it's in buffer zone.
9.	Sirhind Station (km 315+220)	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.
10.	Om Prakash Bansal School, Mandi Gobindgarh (km 324+790)	Core	Sensitive	48.3	33.5	76.7	29.3	Noise level is within the prescribed limit of CPCB
11.	Robin Model School, Khanna(km 332+300)	Core	Sensitive	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 to existing railway track
12.	Sanjivani College of Nurshing, Chawa Pail (km 343+900)	Core	Sensitive	57	43	82	32.5	Daytime noise level is high due to heavy train traffic

S. No.	Locations	Zone-Core/Buffer	Category	Parameters (in dB(A))				Remarks
				Leq Day	Leq Night	Lmax.	Lmin.	
13.	Primary School Chawa Pail (km 344+000)	Core	Sensitive	48	32.7	80.1	28.5	Noise level is within the prescribed limit of CPCB
14.	Sultanpur, Doraha (km 353+000)	Buffer	Residential	47.5	34.5	66.2	28.5	Noise level is within the prescribed limit of CPCB
15.	Near AryaputriSenior Sec. School, Doraha (km 353+200)	Core	Sensitive	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 5.6**.The monitoring at 30 different locations divided into three different chainages groups was conducted as per the Japanese standard (JIS Z 8735). The maximum value of vibration is found to be mainly close to the track that 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.



Source: Field Monitoring

Figure 5.6 : 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 5.7**. 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 that were located more than 25 m from the track. The vibration monitoring data has been given in **Table-5.6.**

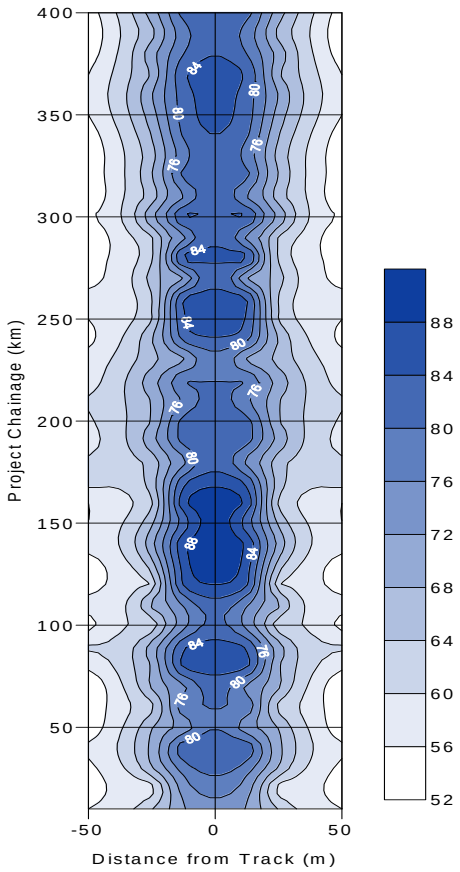


Figure 5.7 : Isopleths of Ground Vibration from the Centre of Track

Vibration Monitoring Along the Alignment

Table 5.6 : 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	Saharanpur	Urban	Near Railway station crossing Lx88/C/E	Dehradun	Freight	32	20	42	94.5	62	60.1	54.6
2		Urban	Near Mosque 180+790	Jammu	Freight	46	15	50	58.7	69	67.3	61.8
3		Urban	Near Temple at 185+200	Delhi	Passenger	18	20	30	120.0	68	65.2	59.9
4		Semi-urban	Near Yamuna Bridge at Lx96/C/E	Jammu	Freight & Passenger	6	15	11	99.0	70	67.2	61.9
5	Jagadhri	Urban	Near Lx100C/T	Jammu	Paschim Express Amritsar Banda	15	20	20	96.0	60	57.2	51.9
6	Barara	Urban	Residential Location at Ch. 237+210 km	Jammu	Freight	65	18	44	43.9	70	67.2	61.9
7	Ambala	Urban	Temple near Ch. 306.3 km	Jammu	Passenger	10	20	11	79.2	60	57.2	51.9
8		Urban	At Lx126/A/T near NH 65	Delhi	Passenger	16	20	22	99.0	66	63.2	57.9
9		Semi-urban	At Lx129/C/E near proposed work access points	Meerut	Passenger	17	20	22	93.2	71	68.2	62.9
10		Rural	Near NH 1	Jammu	Freight	33	13	62	87.9	66.9	64.1	58.8
11		Rural	At Lx133/C/E near Ghagghar Sarai village	Jammu	Passenger	9	20	9	72.0	62.1	59.3	54
12		Semi-urban	Near proposed new flyover at Ch. 269+000	Meerut	freight	32	15	61	102.9	61.5	58.7	53.4

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
13	Rajpura	Urban	Near Railway station	Jammu	Passenger	12	20	19	114.0	60.8	58	52.7
14		Semi-urban	At Lx137/C/E	Jammu	Engine	2	20	1	36.0	58.2	55.4	50.1
15		Semi-urban	Near temporary construction site at Ch. 287+500	Delhi	Passenger	15	20	20	96.0	59.4	56.6	51.3
16		Rural	Near Briklins at Lx139/C/T	Delhi	Passenger	15	20	19	91.2	60.6	57.8	52.5
17		Rural	Near Sadhugarh railway station	Meerut	Freight	46	15	52	61.0	57.9	55.1	49.8
18	Sirhind	Rural	Near Temple at Km 356.3	Jammu	Passenger	5	20	6	86.4	57.8	55	49.7
19		Rural	Near Bhakhra Canal at Lx150/C/E crossing	Jammu	Engine	2	20	1	36.0	54.8	52	46.7
20	Mandi Gobindgarh	Urban	Temple at Ch. 315+500	Delhi	Passenger	22	20	25	81.8	62.9	60.1	54.8
21		Urban	Temple at Ch. 368 km	Delhi	Passenger	13	20	17	94.2	62.8	60	54.7
22		Semi-urban	Open area at Lx153/C/E	Jammu	Freight	35	15	61	94.1	65.9	63.1	57.8
23	Khanna	Semi-urban	Near Mosque and School at Ch. 333+500	Jammu	Passenger	13	20	12	66.5	62.6	59.8	54.5
24		Semi-urban	Near Gurudwara at Ch. 333+500 km	Rajpura	Passenger	13	20	20	110.8	73.4	70.6	65.3
25		Rural	Near Ch. 335+00	Ambala	Passenger	8	20	9	81.0	68.8	66	60.7
26	Between Doraha & Chawa Pail	Rural	Temple at Ch. 348+000	Rajpura	Freight	35	15	60	92.6	74.7	71.9	66.6

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
27	Between Doraha & Chawa Pail	Rural	Gurudwara at Ch. 350	Ambala	Passenger	13	20	27	149.5	57.8	55	49.7
28	Between Doraha & Chawa Pail	Semi-urban	Near temporary construction at Ch. 351+200	Ambala	Passenger	13	20	12	66.5	54.8	52	46.7
29	Doraha	Semi-urban	Aryaputri School at Ch. 353+000 km	Rajpura	Passenger	20	20	20	72.0	54.8	52	46.7
30	Sahnewal	Semi-urban	Near Cremation ground at Ch. 358+500 km	Ambala	Passenger	24	20	22	66.0	60.3	57.5	52.2
									Max.	**74.7**	**71.9**	**66.6**
									Min.	**54.8**	**52**	**46.7**
									Average	**64.75**	**61.95**	**56.65**

5.2.4. 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 (**Figure5.8**). 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. However, 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.

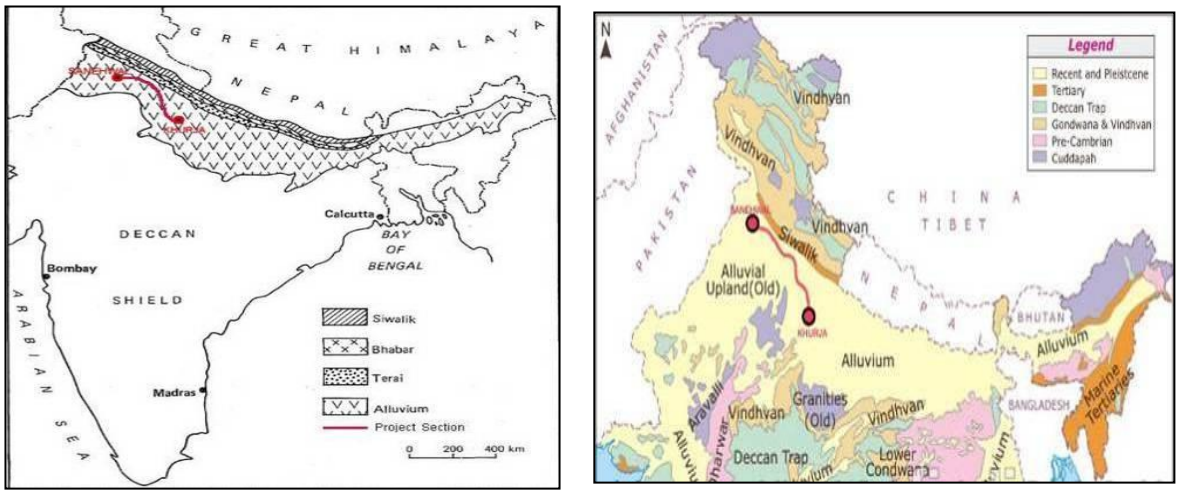


Figure 5.8 : Hydro geologic Unit in Great Indian Sedimentary Basin

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.

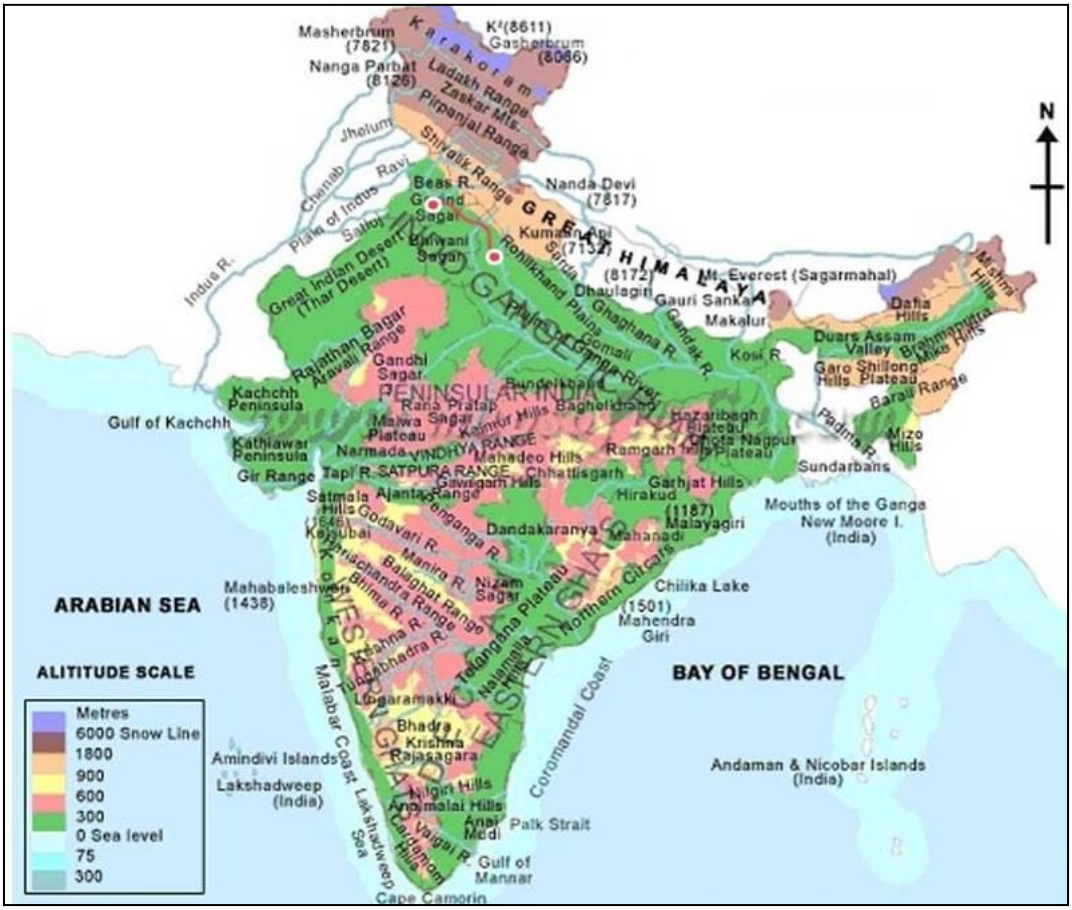


Figure 5.9 : Topographical Map of Indian Region

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 5.9**) of the alignment are as above:

The Saharanpur District and further (until 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 5.10**)

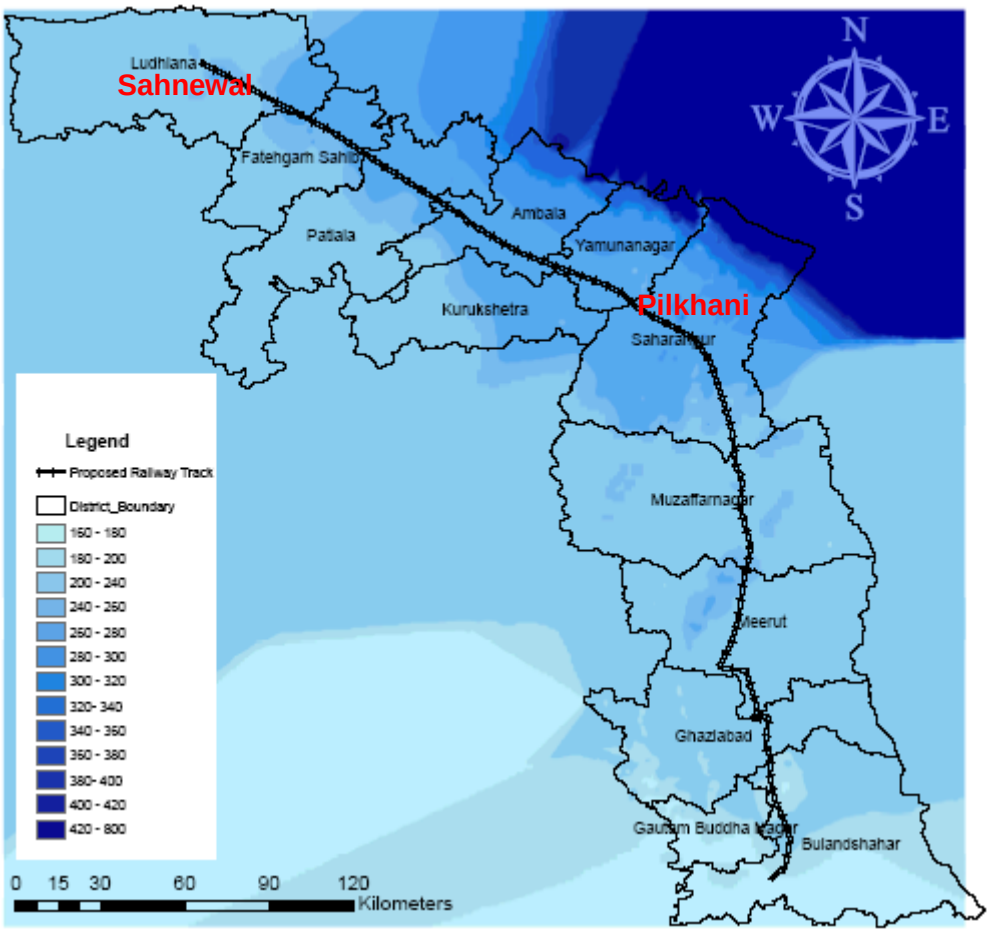


Figure 5.10 :Elevation Map of the Alignment of Pilkhani- Sahnewal

A summary of the elevation level in the core and buffer zone is given in **Table 5.7**. 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 360 is almost flat while there are in-homogeneities in the surface between the other two stretches.

Table 5.7 : Summary of Elevation Levels in the Core and Buffer Zone of the Proposed Alignment

Parameters	Ch. 187+500 – 300 km (Pilkhani- Ambala)	Ch. 301 – 360 km (Ambala- Sahnewal)
Core Zone (in m)	270 – 270	270 – 270
Buffer Zone (in m)	210 – 360	180 – 270

5.2.5. Seismicity

As per the seismic zonal map of India, all the ten project districts are located in the zone IV as shown in **Figure 5.11**. This zone is categorized as high damaged risk zone

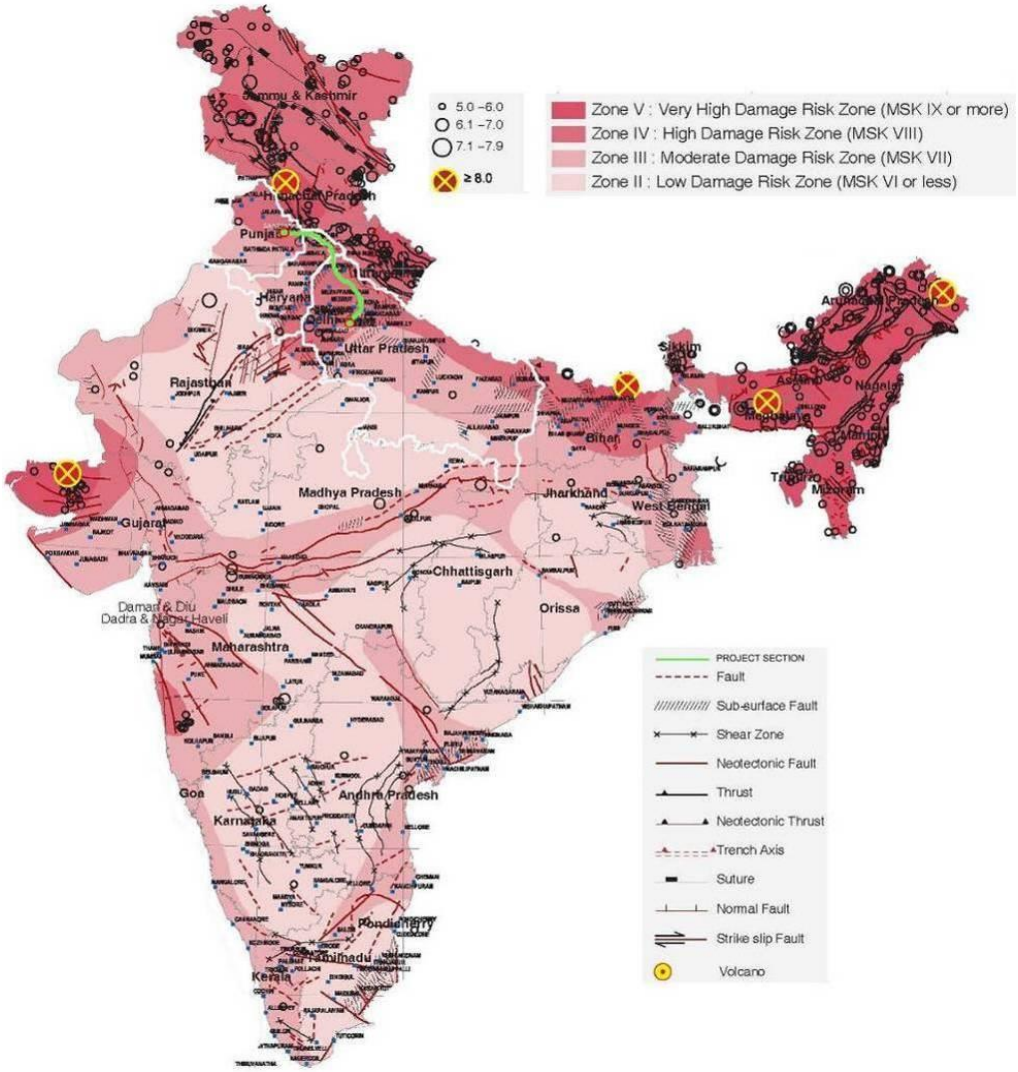


Figure 5.11 : Seismic Zoning Map of Indian Region

5.2.6. Water Hydrology and Drainage

5.2.6.1 Surface Water

The project area from Pilkhani to Sahnewal is a part of two different basins Ganga and Yamuna that contains the largest river system on the subcontinent comprising number of other rivers (**Figure 5.12**). The flow in the basin is largely contributed by the southwesterly 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 (Pilkhani) of the basin to more than 1200 mm at the western end (Ludhiana).

The proposed alignment crosses many surface water bodies of the Gang-Yamuna basin. Some of the important rivers and canals crossing the alignment are: Yamuna (at Kalahari in Yamunanagar), Tangri (Dukheri), Markanda (at Ambala), Chaudah Dhara and Ghaghhar. However, except Yamuna all other rivers are found to be non-perennial.

5.2.6.2 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 5.13, 5.14 and 5.15.**

The summary about the major drainage and its flow direction is given in **Table 5.8.**

Table 5.8 : Summary of Drainage along the Proposed Alignment

Parameters	Ch. 187+800 – 300 km	Ch. 301 – 360 km
Core Zone	NE – SW	NE – SW
	Major Drainage- Yamuna River, Markanda River, Tangri,	**Major Drainage-** Ghaghhar River
Buffer Zone	○ NE – SW	○ NE – SW, NW – SW, E – W, SSE- NNW
	Major Drainage- Markanda River, Tangri River	**Major Drainage-** Ghaghhar River

None of the above drainage system will be affected during construction or operation of Pilkhani-Sahnewal portion of EDFC. Only *Yamuna* river is perennial river in this section.

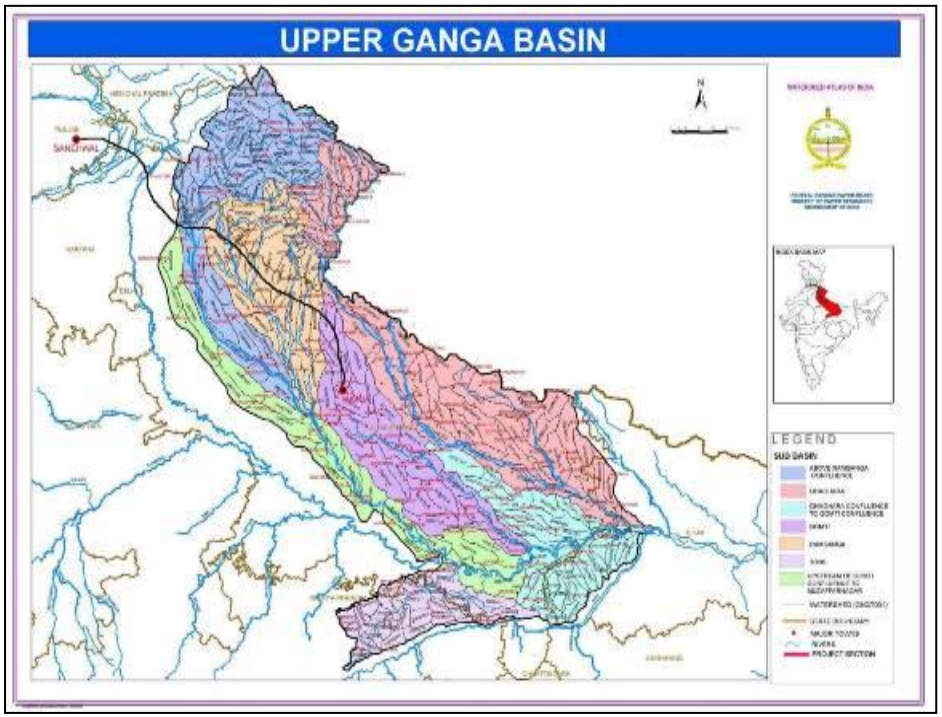
During construction as well as operational phases, it will be ensured that flow of water through existing watercourses is not restricted. This will be taken care at the design stage.

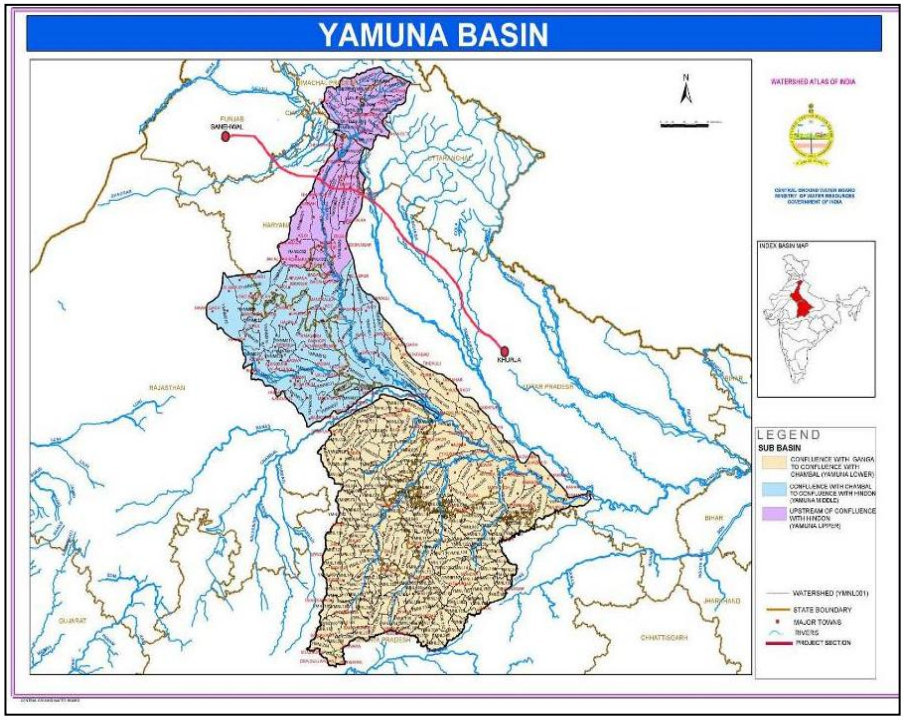
5.2.7. Water Quality

Surface Water Quality: The surface water samples are tested and analyzed as shown in **Table 5.9** 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.

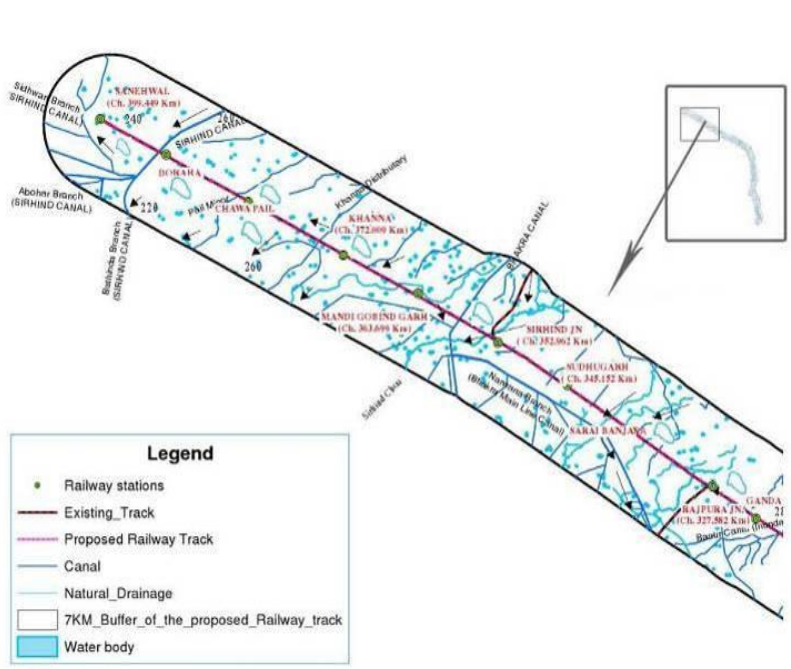
.

Figure 5.12 :Ganga-Yamuna Basin Map

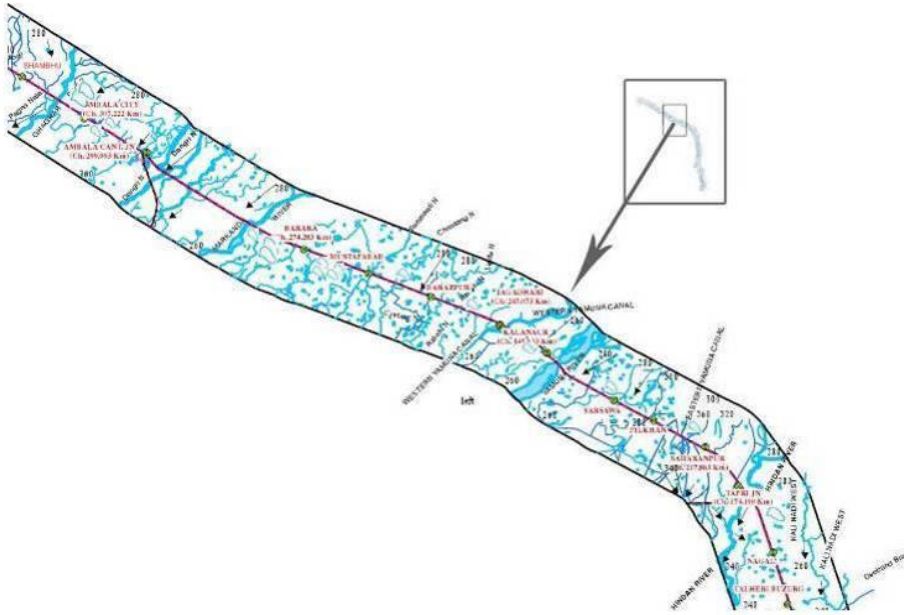




डेडीकेटेड फ्रेट कोरीडोर



Ch. 301 – 360 km



Ch. 187+800 – 300 km

Figure 5.13 : Drainage Map of the Proposed Alignment

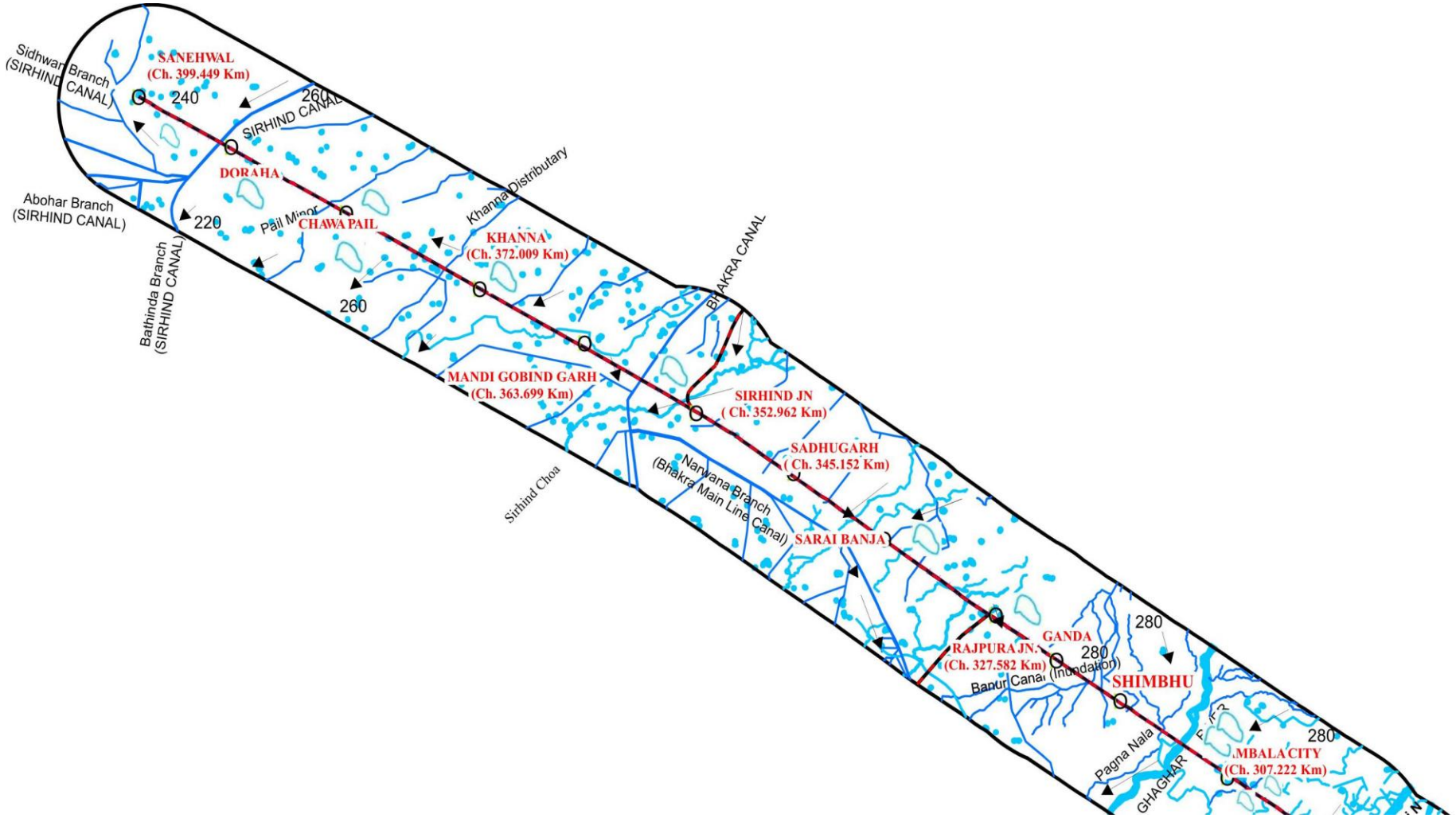


Figure 5.14 : Continued: Blow Up Drainage Map of Ch. 300 – 360 km

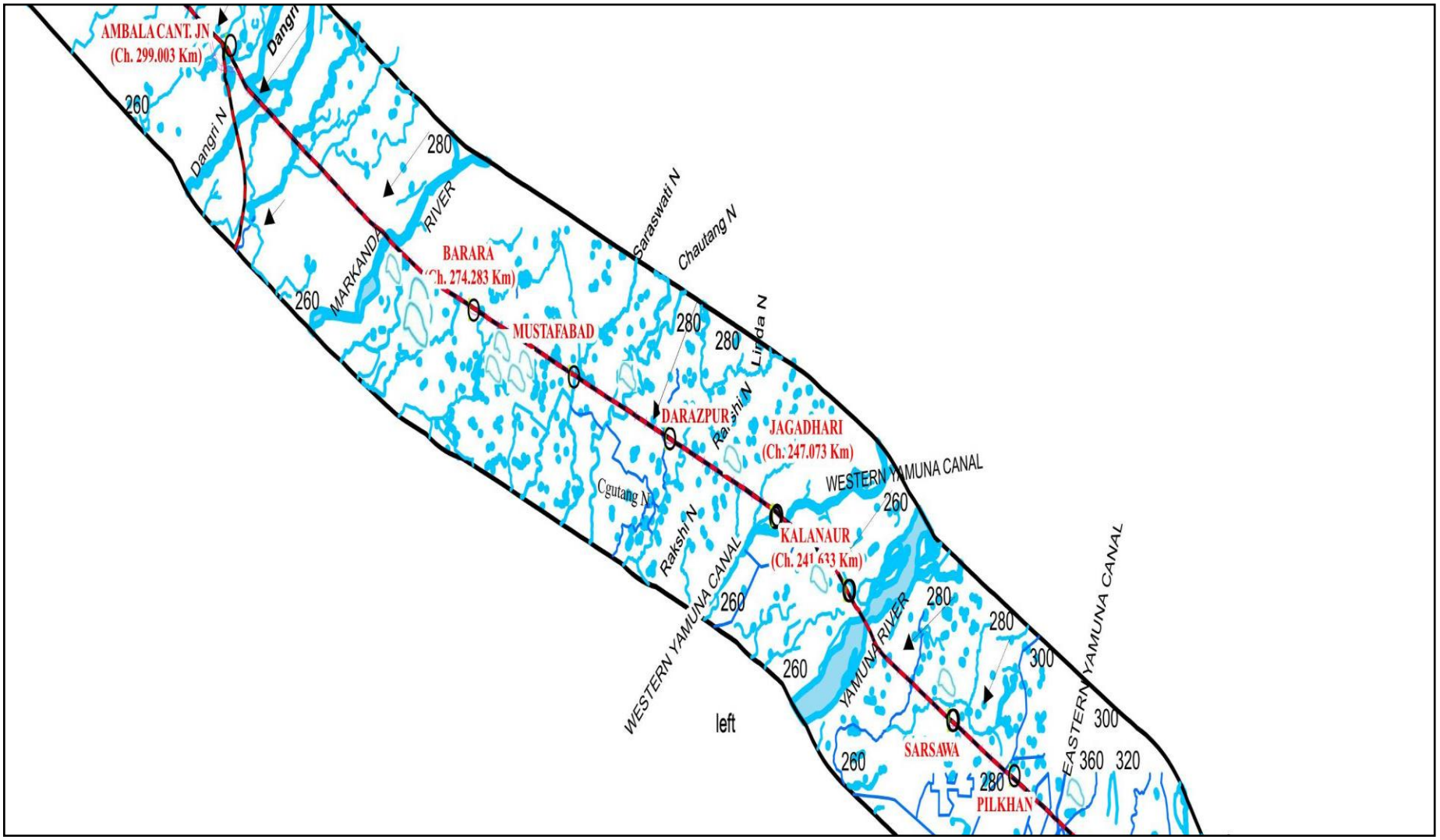


Figure 5.15 : continued: Blow Up Drainage Map of Ch. 300 – 187+800 km

Table 5.9 : Surface Water Quality along the Proposed Alignment

Parameters	Desirable Limit	Permissible Limit	Western Yamuna Canal	Yamuna River
Colour (Hazen Units)	5	25	>5	>5
Conductivity (µmhos/cm)	-	-	426	272
Turbidity (NTU)	5	10	3.1	16.3
pH value	6.5 to 8.5	6.5 to 8.5	8.2	7.4
Total Dissolved Solids (mg/litre)	500	2000	258	104
Total Suspended Solids	-	-	156	7900
Total Hardness (as $CaCO_3$) mg/litre	300	600	128	260
Chlorides (as Cl) mg/litre	250	1000	12	10
Sulphate (as SO_4) mg/litre	200	400	8	14
Nitrate (as NO_3) mg/litre	45	100	0.8	2
Phosphate (as PO_4) mg/litre	-	-	0.02	N.D
Fluoride (as F) mg/litre	1	1.5	N.D	0.5
Iron (as Fe) mg/litre	0.3	1	N.D	0.06
Lead (as Pb) mg/litre	0.05	0.05	N.D	N.D
Copper (as Cu) mg/litre	0.05	1.5	N.D	N.D
Nickel (as Ni) mg/litre	-	-	N.D	N.D
Zinc (as Zn) mg/litre	5	15	0.26	0.02
Total Chromium (as Cr) mg/litre	0.05	0.05	0.04	0.04
Manganese (as Mn) mg/litre	0.1	0.3	N.D	N.D
Oil & Grease (mg/litre)	-	-	N.D	8
alcium (as Ca) mg/liter	75	200	38	65.6
Magnesium (as Mg) (mg/litre)	30	100	8	23.32
Ammonical Nitrogern (mg/litre)	-	-	N.D	N.D
Total Alkalinity (mg/litre)	200	600	18	22
Chemical Oxygen Demand (mg/litre)	-	-	12	142
Bio-chemical Oxygen Demand (mg/litre)	-	-	N.D	18
Dissolved Oxygen (mg/litre)	-	-	6.4	4.6

Source: Onsite Field Monitoring N.D. – Not Detectable

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, YamunaNagar 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 5.10**.

Table 5.10 : 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	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: 10500-1993except total dissolved solids (874-564) & 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 5.11**.

Table 5.11 Groundwater Quality in the Project Area

Parameters	*Desirable Limit*	Saharanpur	Sarsawa	Jagadhari	Barara	Dukheri	Shambhu	Sarai Banjara	Mandi Gobind Garh	Sahnewal
Colour (Hazen Units)	*5*	>5	>5	>5	>5	>5	>5	>5	>5	>5
Conductivity (µmhos/cm)	-	1163	1167	1156	1245	1276	1166	1145	1231	1166
Turbidity (NTU)	*5*	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*	7.4	7.7	7.8	8.2	8.1	8.3	8.2	7.6	7.5
Total Dissolved Solids (mg/litre)	*500*	567	874	726	756	768	721	763	712	670
Total Hardness (as $CaCO_3$) mg/litre	*300*	231	245	255	266	255	278	244	255	240
Chlorides (as Cl) mg/litre	*250*	77	87	21	12	7.1	21	14.5	17.5	120
Sulphate (as SO_4) mg/litre	*200*	21	14	56	67	54	56	78	42	72
Nitrate (as NO_3) mg/litre	*45*	2.5	4.2	5.1	3.2	2.8	3.3	4.1	2.1	3.8
Fluoride (as F) mg/litre	*1*	0.5	0.2	0.4	0.5	0.6	0.2	0.3	0.5	0.4
Iron (as Fe) mg/litre	*0.3*	0.53	0.62	0.54	0.34	0.67	0.37	0.25	0.35	0.08
Lead (as Pb) mg/litre	*0.05*	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Copper (as Cu) mg/litter	*0.05*	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Zinc (as Zn) mg/litre	*5*	ND	ND	ND	ND	ND	ND	ND	ND	0.36
Total Chromium (as Cr) mg/litre	*0.05*	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Manganese (as Mn) mg/litre	*0.1*	ND	ND	ND	ND	ND	ND	ND	ND	N.D
Calcium (as Ca) mg/liter	*75*	62	45	25	65	56	45	28	35	83.2
Magnesium (as Mg) (mg/litre)	*30*	ND	ND	ND	ND	ND	ND	ND	ND	7.76
Total Alkalinity (mg/litre)	*200*	80	65	125	45	120	135	110	75	72

Source: Analysis of Field Samples

5.2.8. 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 are given in **Figure 5.16** and **Figure 5.17** respectively.

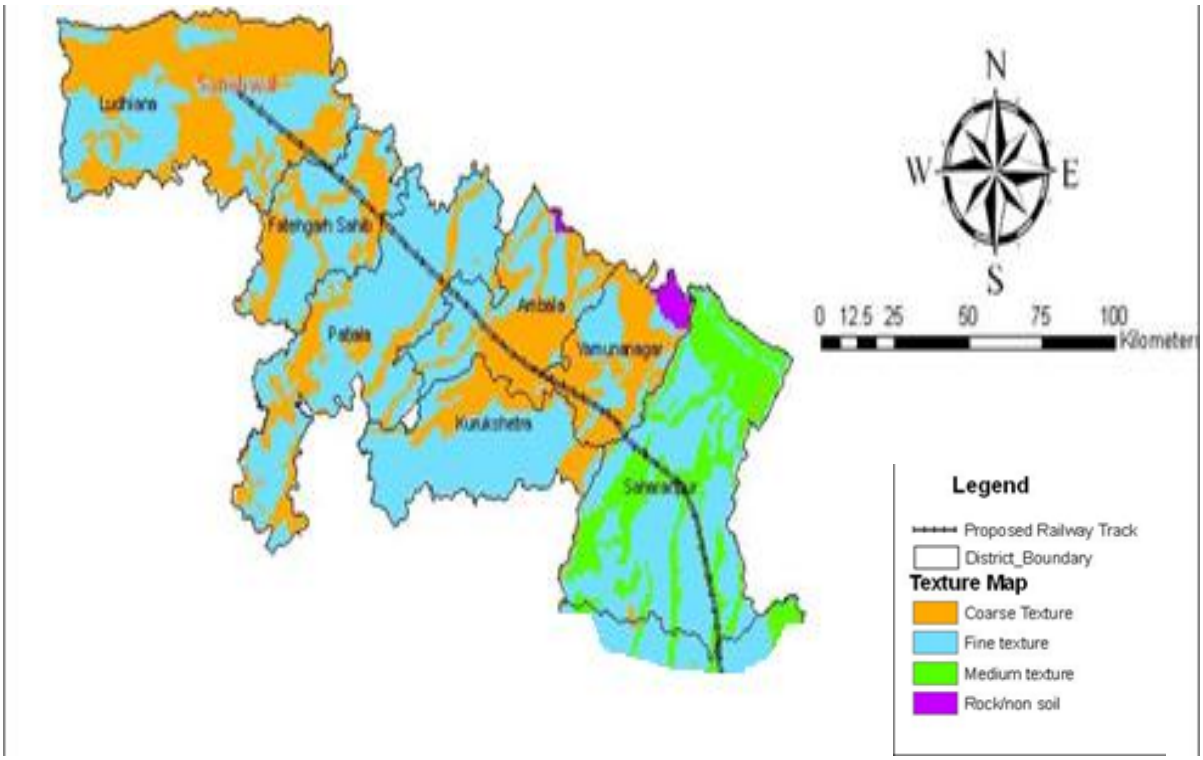


Figure 5.16 : Soil Texture Characteristic of the Proposed Alignment

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 5.12**. The table indicates that the soil in the project area is good for agricultural and plantation purposes

Table 5.12 : Physio-Chemical Characteristics of Soil

Location	Parameters								
	pH	Conductivity	Cat-ion Exchange Capacity	Sodium Absorption Ratio	Water Holding Capacity	Nitrogen as N	Phosphorus as P	Potassium as K	Sodium as Na
Saharanpur	7.8	333	26	0.27	24.0	0.68	0.39	41	150.1
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
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

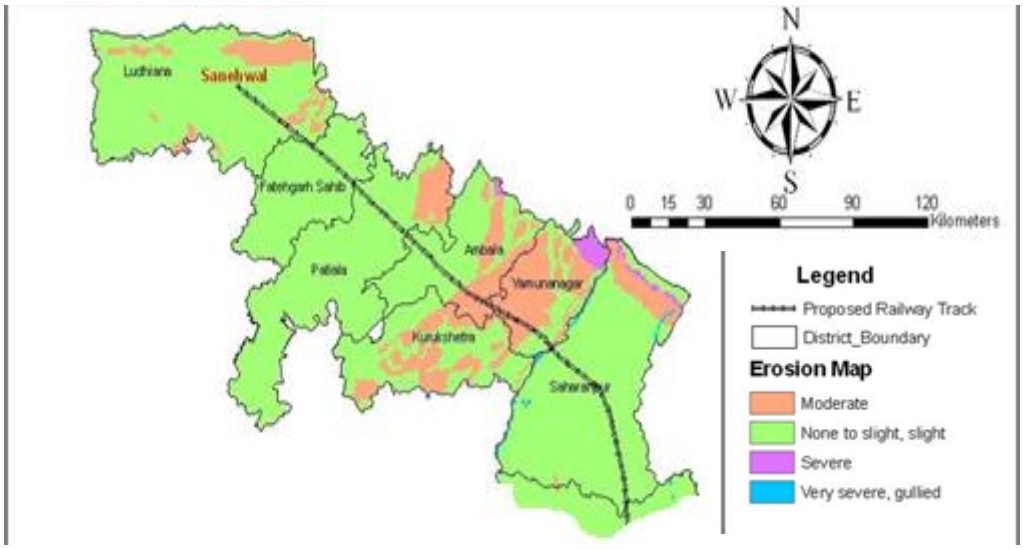


Figure 5.17 : Soil Erosion Map of the Proposed Alignment

Soil Sampling Along the Proposed Alignment

5.2.9. Land-Use

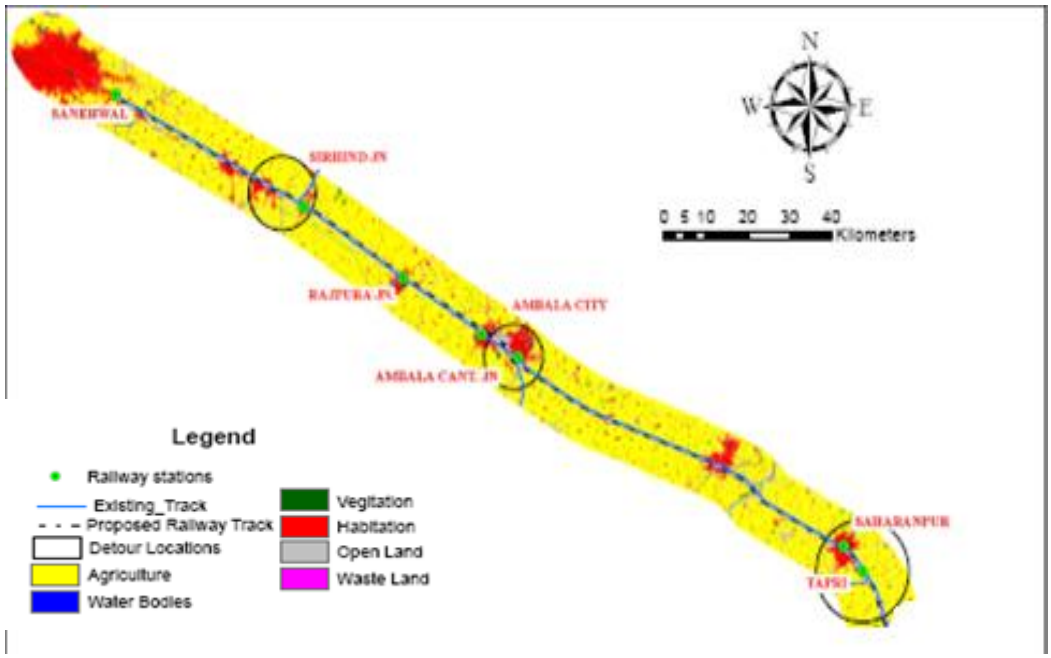
The land use study is of fundamental significance, as the land resources play a strategic role in the determination of economic, social and cultural progress of the region. Remote sensing data provides reliable accurate baseline information for carrying out the land use mapping. To delineate different 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 5.18**. It is observed to be predominantly agricultural (62 and 75%) in both the core and 7 km buffer zone as seen from **Table 5.13**. This is followed by open land (18 and 10%) and habitation or settlement area (17 and 11%) in both core and buffer zone.

Table 5.13 : 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
OpenLand	630.1	13.2
WasteLand	11.1	0.2

Figure 5.18 : Land-Use Mapping of the Proposed Alignment



5.3. 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.

5.3.1. 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

5.3.2. 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

5.3.3. Methods

5.3.3.1 Methods of Data Collection

To collect the baseline data from Pilkhani to Sahnewal EDFC Railway Corridor in the state of Uttar Pradesh, Haryana and Punjab tree species available on both sides up to the toe line 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 was made as per the available books and published materials. Analysis was done as per the standard methods**. Table 5.14** gives the survey points with chainages.

Table 5.14 : Data Collection from Important Locations with Chainage

Sl. No.	Survey Point	Chainage (Km.)	Sl. No.	Survey Point	Chainage (Km.)
1	Yamuna River	203	2	Yamuna Western Canal	210
3	Markhanda River	244	4	Bhakra Canal	319
5	Sirhind Canal	353+500			

5.3.4. Flora of the project Area

Field survey of flora has been carried out district wise where the project corridor Pilkhani to Sahnewal EDFC passes through. The analysis of the vegetation cover of the EDFC Pilkhani to Sahnewal 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.

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.

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.

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%).

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 5.15**.

Table 5.15 : 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 Pilkhani to Sahnewal 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.
- According the local people, both the sides of the proposed Pilkhani to Sahnewal 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 5.16**.

Table 5.16 : 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 globulus*)	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	√		□	√	√

Tree Species	Importance				Presence	
	Medicinal (M) /Economically Important (E)	Fuel wood	Fruit Bearing	Timber	Core Zone	Buffer Zone
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	√		√□	√	√

5.3.5. Tree Cutting

Number of trees to be felled to clear right of way along the track within 50 meters, from the edge of the existing track w.r.t proposed alignment has been estimated during the survey. The survey recorded altogether 28617 trees (**table 5.17**). In order to identify the trees to be cut the tree enumeration was done for the width of land to be acquired in each km and trees available in existing row towards the proposed EDFC line side.

Table 5.17 : Approximate No. of Trees Present in the RoW including the detour area

Section	No. of Trees
Ambala-Pilkhani Section	24868
Sahnewal- Ambala Section	3749
Total no. of trees required cutting (In both Pvt. and Govt. land)	28617

5.3.6. 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 azadirachta*, 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 pineraria,* Lasura or Lehswa-*Cordia dichotoma,* Shahtoot or Mulberry-*Morus albaatropurpurea ,Eucalyptus,* Kair or Teat - *Capparis decidua,*Amrood or Guava- *Psidium guajava* , Kanchan -*Bauhania purpurea.*

Some small tree species like Careya arborea, Holerrina 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.

5.3.7. Quantitative Analysis of Tree, Shrub and Herb by Quadrat Method

5.3.7.1 *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 globulus*, Shisham or Indian Rosewood- *Dalbergia sissoo*, Aam or Mango-*Mangifera indica* and Neem- *Azadirachta indica* etc. (**Table 5.18**)

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 (km187+800 -200 i.e. UP portion) stretch the top five dominant species found were – *Mangifera indica, Populus deltoids, Eucalyptus globulus, Dalbergia sissoo, Azadirachta indica.* In the second (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 301-360) project stretch the top five dominant species found were – *Populus deltoids, Eucalyptus globulus, 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 5.18 : 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
Eucalyptus-*Eucalyptus globulus*	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 azadirach*ta	3.29	0.41	0.53	4.23

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
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
Eucalyptus-*Eucalyptus- globulus*	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

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
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 the three stretches separately. Dominant tree species present in the the dominant tree species in first stretch of 187+800-200 km (UP portion) are Mangifera *indica, Dalbergia sissoo, Populus deltoids, Eucalyptus globulus, Syzygium sp.* (**Table 5.19**).

Table 5.19 Dominant Tree Species in the Second Stretch (km 187+800-200 km :UP portion) - 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 *globulus*	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 azadirach*ta	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
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 (**table 5.20**) in the in the second stretch of project length (km 201-300) are *Populus deltoids, Eucalyptus globulus, Dalbergia sissoo,* Neem- Azadirachta indica, *Mangifera indica*.

Table 5.20 : 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
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 (**Table 5.21**) in the last stretch (Km 301-360) are Populus deltoids, Eucalyptus globulus, Dalbergia sissoo, Neem- Azadirachta indica, Mangifera indica, Syzygium cumini

Table 5.21 : Dominant Tree Species in the Last Stretch (km 301-360) Based on IVI

Tree Species	Relative Density	Relative Dominance	Relative abundance	IVI
Poplar-*Populus deltoids*	33.33	17.54	27.19	78.06
Eucalyptus-*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
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 azadirachta	0.06	0.41	0.52	0.99
Deodaru-*Polialthia longifolia*,	0.04	0.39	0.52	0.95

5.3.8. 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-5.22**:

Table 5.22 : 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

Some small tree species:	Relative Density	Relative Abundance
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
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 sp.,	12.94	*20.54*
Oryopteris sp.	12.94	*19.18*

5.3.9. Fauna

The animals observed in the study area are mainly aves and mammals as listed in the **Annexures 5.4& 5.5**. 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.

5.3.10. Terrestrial and Aquatic Wildlife Fauna

5.3.10.1 Birds

Altogether 120 species of avian fauna were found in Pilkhani to Sahnewal 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.

5.3.10.2 Mammals

There were altogether 14 mammalian species recorded in Pilkhani to Sahnewal 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 etc.

5.3.10.3 Amphibian Fauna

There were altogether three amphibian species recorded in Pilkhani to Sahnewal EDFC corridor influence area, but no Schedule - I species under Indian Wildlife Protection Act, 1972 was found. (**Annexure 5.6**)

5.3.10.4 Reptiles

Altogether five reptilian species were recorded in Pilkhani to Sahnewal EDFC corridor reach during the survey. These were two snakes, two lizards, and one turtle. (**Annexure 5.7**)

5.3.10.5 Faunal Species Diversity(Diversity Index (H):

The species diversity index of the fauna in the study area is represented in **Table 5.23.**

Table 5.23 : Species Diversity Index of terrestrial fauna in different location of study area

Faunal Class	Shanon Wiener Diversity Index	Study Zones				
		Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal
Mammals	H	3.289	2.281	3.221	3.22	2.281
	Variance H	0.004966	0.004572	0.004702	0.006499	0.004572
Birds	H	3.472	3.434	3.366	3.301	3.221
	Variance H	0.004043	0.002347	0.002502	0.002592	0.004702
Amphibian Species	H	3.105	3.029	3.066	3.02	3.222
	Variance H	0.008135	0.006732	0.008482	0.008877	0.004043
Reptiles	H	3.562	3.308	3.438	3.519	3.127
	Variance H	0.00265	0.003309	0.003036	0.003323	0.004044

The species diversity of mammal, birds and reptiles was highest in the Yamuna River riparian zones, and amphibians in Sihind canal and nearby riparian zone.

5.3.10.6 Faunal Behaviour Pattern

The Nilgai and the Wild Boar were found to be free living in the forest patches near the Pilkhani to Sahnewal 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.

5.3.10.7 *Land River Interface*

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

5.3.10.8 *Migratory Route of Terrestrial Fauna*

There was **no migratory route** of terrestrial faunas reported so far throughout the Pilkhani to Sahnewal EDFC corridor, but the movements of amphibian and reptilian fauna from rivers to the land surface crossing the Pilkhani to Sahnewal 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.

5.3.10.9 *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 Pilkhani to Sahnewal EDFC corridor, however, these are not affected due to DFC.

5.3.10.10 *Endangered Avian Fauna In Pilkhani to Sahnewal EDFC Corridor*

There were one vulnerable specie (IUCN Red list) found in the area i.e. Sarus crane and one Schedule-I (IWPA 1972) species (*Gyps bengalensis*) in the area are listed in **Table 5.24.**

Table 5.24 : 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

5.3.10.11 *Wetland*

There is no notified wetland but prevalence of village ponds is seen near the corridor. There is no village pond in the RoW.

5.3.10.12 *Peoples Dependence on Flora And Fauna*

The people residing near Pilkhani to Sahnewal 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 Pilkhani to Sahnewal EDFC corridor.

5.3.10.13 *Areas of Eco-Important Zone / Protected Area*

No eco-important and protected areas were found in the Pilkhani to Sahnewal EDFC corridor and in the buffer zone of existing track. Also, no major wildlife habitat/ reserve forest areas/ sanctuaries were found in this reach.

5.3.11. Aquatic Ecology

In the whole stretch of Pilkhani to Sahnewal 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.

5.3.11.1 *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 Pilkhani to Sahnewal 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 Pilkhani to Sahnewal EDFC corridor (**Table 5.25**). This is because of rich aquatic environment of Yamuna River that 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 5.25 : Species Diversity of Aquatic Avian Fauna in the DFC Pilkhani to Sahnewal Project Stretch

Faunal Class	*Shanon Wiener Diversity Index*	*Study Zones*				
		Yamuna River	*Yamuna Western Canal*	*Markhanda River*	*Bhakra Canal*	*Sirhind Canal*
Fish	*H*	*3.306*	*2.105*	*3.219*	*3.014*	*2.341*
	Variance H	*0.004966*	*0.004572*	*0.004702*	*0.006499*	*0.004572*
Avian Fauna	*H*	*3.639*	*3.201*	*2.915*	*2.873*	*2.654*
	Variance H	*0.00265*	*0.003309*	*0.003036*	*0.003323*	*0.004044*

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

5.3.11.2 *Aquatic Avian Diversity:*

During the period of the study, there were 28 aquatic avifauna found in the study area. The aquatic avifauna found in the area are of migratory (M) and residential(R). Altogether 17 aquatic birds were found to be migratory and rest 11 were residential. (**Table 5.26**)

Table 5.26 : Aquatic avifauna in the DFC Pilkhani to Sahnewal 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

Sl. No.	Common Name	*Scientific Name*	Migration Status	Habitat
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 (Temminc)*	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

5.3.11.3

5.3.11.4 *Fish Species Diversity*

Altogether 67 species of fish have been identified in the study area (**Annexure 5.8**). 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.

5.3.11.5 *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. Therefore, 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.

5.3.11.6 *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.

5.3.11.7 *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 spawning and breeding ground. No specific area could be identified in the line of alignment.

5.3.11.8 *Area of Ecologically Important / Protected Area/ Restricted Area/ Legislative And Others Areas*

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

5.3.11.9 *Identification of Endemic/ Threatened and Endangered Species*

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

5.3.11.10 *Peoples Dependence on Aquatic Fauna*

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

5.3.11.11 *The Diversity of Plankton*

The phytoplankton, zooplankton population in the project area was much lower as compared to the normal. 48 phytoplanktons (Annexure 5.9) were found in Pilkhani-Sahnewal EDFC corridor. The total density of phytoplanktons ranged from 964 ind. M^{-2} to 1,832 ind. M^{-2} (07),

99 numbers of zooplanktons (**Annexure 5.10**) 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.

The species diversity of the plankton in seven major locations of the study area is represented in **Table 5.27**. The diversity both the phytoplanktons and the zooplanktons were found to be high in Yamuna River.

Table 5.27 : Species Diversity of Planktons in the Canals, Waterbodies and rivers in the EDFC Pilkhani to Sahnewal Project Stretch

Plankton	Diversity Index	Study Zones				
		Yamuna River	Yamuna Western Canal	Markhanda River	Bhakra Canal	Sirhind Canal
Phytoplankton	H	3.35	3.03	3.07	3.02	2.39
	Variance H	0.01	0.01	0.01	0.01	0
Zooplankton	H	3.46	3.12	3.3	3.37	3.26
	Variance H	0	0.01	0	0	0

5.3.11.12 *Ecological Important Areas -Aquatic*

There are ecologically important locations within the study area as represented in the following **Table 5.28**.

Table 5.28 : Ecologically important areas (aquatic) in the EDFC Pilkhani to Sahnewal Project Stretch

Sl. No.	Ecologically important location (Aquatic)	Chainage (Km.)	Ecological Importance(Habitat of F=Fish,P=Plankton,A= Aquatic Birds)
1	Markanda River	244	F,P
2	Eastern Yamuna Canal	184	F,P,A
3	Yamuna River	203	F,A,P
4	Yamuna Western Canal	210	F,P,A
5	Sirhind Canal	353	F,P,A
6	WB at Ambala	309	F,P
7	Bhakra Canal	319	F,P,A
8	Tangri river	257	F,P
9	Markhanda River	244	F,P,A
10	Waterbody	280	F,P,A

The main ecologically important (aquatic) locations are in the river Yamuna, Yamuna west canal, Bhakra canal, Markhanda river. These locations are important, as they are the habitat of fishes, planktons and aquatic avian fauna.

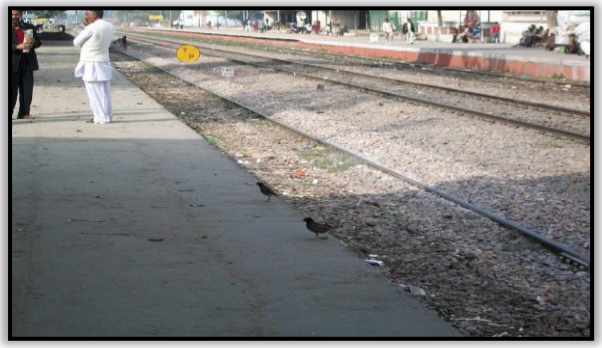
Sample of Fish Fauna

Vulnerable Sarus Crane Near Chainage 2 km

Black winged Stilt

Little Egret

Common Hoopoe



Common Myna

House crow

Fuel Wood Collection

Little egret

Kingfisher

Black Winged Stilt

Ficus tree

Segun or Teak in the Project area
(Buffer zone)

Poplar Plantation

5.4. Social and Cultural Resources

5.4.1. Population and Communities

The total population of Uttar Pradesh, Haryana and Punjab are- 199812341, 25351462 and 27743338 respectively as per census 2011. The decadal growth rates of population of UP, Haryana & Punjab are 20.09%, 19.90% & 13.90% respectively. The population density of the three project states are higher than the national average (411/km^2) viz. Uttar pradesh-828, Haryana-573 & Punjab-484.

5.4.2 The proposed DFC Corridor of Sahnewal-Pilkhani section passes through one district of Uttar Pradesh, two districts of Haryana and three districts of Punjab covering about 114 villages. This project falls in the basin of Ganga-Yamuna river in Uttar Pradesh, lower Yamuna plain in Haryana and part of Ghaghar-Satluj plain in Punjab. The average annual rainfall varies between 550 mm to 863 mm. The important crops of the project area are sugarcane, wheat, maize, rice, barley, gram, pigeon pea, moong, lentil, groundnut, rapeseed and mustard. Out of total 175.00 km of project length, about 162.21 km is in parallel and about 12.79 km is in bypass stretch. (**Table 5.29**)

Table 5.29: Project Area: Salient Features

Sections	Chainage (km)		Distribution of length (km)		Total			
	From	To	Parallel	Bypass	Length	Districts	Villages	LA (Ha)
CPM Ambala	187.5	360.20	162.21	12.79	175.00	6	138	355.34

5.4.3 Findings of the Census and Baseline Survey

The census and socio-economic surveys have been carried out in 26 affected villages. These surveys were carried out from November 2011 to December 2011. The census identified a total of 3051 project affected families comprising of 3051 persons. During the census survey, the data gathered from the census survey reveals that amongst the affected 3051 PAFs, the majority 77% will incur impact on agricultural land and 23% families incurring impact on their residential or commercial structures/land.

The following section will analyze the key data findings of the census survey and impacts on the people along the project area.

5.4.4 Project Impacts

The proposed project stretch will involve acquisition of about 355.34 ha of land of which approximately 330.91 (93.12%) is private land (**Table 5.30**). However, the project will require very less (approximately 2.10 ha) built-up area which includes residential and commercial or residence-cum commercial and community properties (0.59%). At many built-up locations land width has been reduced to as less as 17 meters which has resulted in reducing impact on residential as well as commercial structures.

Table 5.30: Project Area: Loss of Land

Section	Private Land(in ha)			Government	Total (In Ha.)
	Agri.	Resi. /Com.	Community		
Sahnewal-Pilkhani	328.51 (92.45%)	2.10 (0.59%)	0.30 (0.08%)	24.43 (6.88%)	355.34 (100%)

5.4.5 Agricultural land

Table 5.31 presents extent of loss in terms of loss of area of agricultural land of each PAF. Explorative techniques have been used to extrapolate the data of 26 villages for entire project length. Analysis of the data indicate that out of the total 3051 PAPs losing their agricultural land, about 82.23% PAPs will lose less than 0.15 Ha. of land, about 12.39% will lose between 0.15 Ha. to 0.50 Ha., 4.23% will lose between 0.50 Ha. to 1 ha of land and 1.15% above 1 ha. As per the provisions of NRRP, all Khatedars would receive the same (Rs. 20,000) ex-gratia irrespective of their extent of loss. The ex-gratia of Rs 20,000 will help land losers to find replacement value of land losing about 0.15 ha of land. Severity of Impact is adequately addressed by providing additional INR 15 per sq meter for additional land beyond 0.15 Ha.

Table 5.31: Parcel of Plot Affected of each PAFs

Section	Category of Affected Area of Agriculture Land in Ha.				Total
	0 - 0.15	0.15 - 0.5	0.5 - 1.0	More than - 1.0	
Sahnewal-Pilkhani	1925 (82.23%)	290 (12.39%)	99 (4.23%)	27 (1.15%)	**2341 (100%)**

5.4.6 Structures

Table 5.32 indicates the physical impact on the structures being acquired. As can be seen from the Table all structures are losing more than 75% of its part and will require to be relocated. During census survey and consultations, it was established that losing more than 25% of structures may cause displacement of the people. Hence, social assessment has categorized families losing more than 25% of area as displaced families. However, actual displacement categories will be verified at the time of R&R implementation.

Table 5.32 Assessment of Impact on Structures

Section	0-25%	25-50%	50-75%	75-100%	Total
Sahnewal-Pilkhani	0 (0.00%)	0 (0.00%)	66 (20.4%)	258 (79.6%)	**324**

5.4.7 Identification of Small, Marginal and Landless farmers

Census and baseline survey has ascertained that about 1484 landowners are landless, marginal or small. Out of 2341 agricultural PAPs, about 1.06% are landless, 52.58% Marginal and 9.74% are small (Table 5.33). The landowners, who have been reduced to the status of small /marginal or landless because of DFCC land acquisitions, will be assisted as described in the Entitlement Matrix (based on the relevant provision of NRRP 2007). However, these numbers will be verified by the concern Revenue Department during implementation.

Table 5.33: Identification of Small and marginal farmers

Section	Landless	Small	Marginal	Total (S+M+L)	General	Total
Sahnewal-Pilkhani	25 **(1.06%)**	228 **(9.74%)**	1231 **(52.58%)**	1484 **(63.38%)**	857 **(36.62%)**	**2341 (100%)**

5.4.8 Impact on PAFs losing structure due to the Project

Information given in **Table 5.34** indicates the families that will be affected because of loss of structure (residential or commercial) in the project. It can be seen from the Table 5.34 that out of 324 affected families about 57% are titleholders and 43% are non titleholders. As mentioned in Table 5.34 all these families are losing more than 25% of their properties hence all of these families will be considered as displaced. However, nature and extent of displacement of PAFs will be determined during implementation stage.

Table 5.34: Project Affected Families (PAFs) losing Structures

Section	Titleholders		Non Titleholders (Squatters, Tenant & Kiosks)				Total
	Resi	Comm	Resi	Comm	Tenants	Kiosks	
Sahnewal-Pilkhani	134	51	83	56	0	0	324

5.4.9 Impact on Community structures

Apart from individual assets, SIA study had identified eight CPRs within the proposed ROW. Efforts were made to minimize the impact on these CPRs by reducing Corridor of impact (COI) to minimum (about 17 m). As a result, number of CPRs need relocation will be reduced (**Table 5.35**). Consultation with the community suggests that people use these facilities very often. Therefore, these facilities will be replaced in consultation with the communities who are using it, irrespective of ownership of these, CPRs. Enhancement of the CPRs along with environmental measures such as plantation of trees is being planned under EA/EMP. Wherever required suitable boundary wall will be constructed to mitigate noise and vibration impact. All these community properties will be enhanced in consultation with community.

Table 5.35: Affected Community Properties Resources (CPRs)

Section	Temple/ Mosque	Gurdawara	Hospital	School	Others/Burial ground/Samadhi	Total
Sahnewal-Pilkhani	2	2	-	0	4	**8**

5.4.10 Socio-Economic Analysis of the PAF_s and PAP_s

5.4.10.1 Age-Sex Composition

Amongst PAPs (3392) under the project, there are 1796 males (52.95%) and 1596 females (47.05%). Average family size is about 5.32. It is noticed from **Table 5.36** that the sex ratio for this stretch is 775.

Table 5.36: 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	72	61	247	211	214	201	670	589	222	194	191	179	**1616**	**1435**

Source: Census Survey, 2012

5.4.10.2 Annual Income Patterns of the PAPs

Information collected during Census survey on income level of each PAP indicates that PAPs are economically weak. It can be seen from **Table 5.37** that out of total 3051 PAPs, about 16.03% of total PAPs 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 3.11% of total PAFs.

Table 5.37: Total Annual Income

Section	Income Group (Rs.)				Total
	0 - 25000	25000 – 50000	50000 - 1 Lakh	above 1 Lakh	
Sanehwal-Pilkhani	146 (4.78%)	335 (10.99%)	588 (19.29%)	1982 (64.94%)	3051 (100%)

5.4.10.3 Social Status of the Project Affected Families

Table 5.38 presents information about social status of PAPs. Out of total 3051 PAPs, about 42.45% are general and 39.82% are OBC. About 17.73% are schedule caste. As mentioned in **Table 5.38**. Schedule tribes are not found in the project.

Table 5.38: Social Status of the PAFs

Section	General	Schedule caste	Schedule Tribe	Other backward caste	Total
Sahnewal-Pilkhani	1295 (42.45%)	541 (17.73%)	0 (0%)	1215 (39.82%)	**3051 (100%)**

Furthermore, the SIA established the proposed project would not affect 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).**

5.4.10.4 Vulnerability

Table 5.39 presents number of PAPs under vulnerable categories as per NRRP 2007. Among the PAPs, there are 149 vulnerable persons Out of these, 6.04% are people above the age of 50 years. Other significant categories are widows (18.79%) and unmarried girls above the age of 18 years (1.51%). 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 5.39**, it is ascertained that about 95 PAPs are below the poverty line. Under the project (as per EM), BPL families are also considered as vulnerable. Table 5.39 present vulnerability status of the PAPs. These families will be assisted to regain their living standard

Table 5.39 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	
Sahnewal-Pilkhani	5 (3.35%)	28 (18.79%)	12 (8.05%)	95 (63.76%)	9 (6.05%)	**149 (100%)**

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.

5.4.10.5 Education Status

Amongst the PAPs, there is a high degree of illiteracy in the project area. About one-sixth (15.56 %) PAPs are uneducated. Another 17.75 % of the PAPs are basic literates. About 16.57% of the total PAPs have studied up to the 8th standard school level (**Table 5.40**). Amongst PAPs, there are 556 (18.22%) graduates in the area. Since about 16% 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 5.40: Education Status of PAPs

Section	Education level						Total
	Un Educated	Educated	8th	10th	Inter mediate	Graduate	
Sahnewal-Pilkhani	474 (15.56%)	542 (17.75%)	505 (16.57%)	488 (15.98%)	486 (15.92%)	556 (18.22%)	**3051 (100%)**

5.4.10.6 Occupational Background

In the families loosing agricultural land, about 13.1% PAPs are housewives who are engaged in daily household work. Another, 13.2% are students, 10.4% PAPs are labourers in the agricultural sector or otherwise. About 7.7% 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 5.41: Occupation Profile of PAPs

Section	Occupation profile(PAPs)								Total PAPs
	Service	Business	Cultivator	Students	House Wife	Labour	Un-Employed	Workers	
PAPs	**405 (13.3%)**	**213 (7.7%)**	**476 (15.6%)**	**402 (13.2%)**	**400 (13.1%)**	**317 (10.4 %)**	**253 (8.3%)**	**585 (18.4%)**	**3051 (100%)**

5.4.11 Important Findings and conclusions of the project are:

- Census survey identifies approximately 3051 PAPs. Out of 2341 agricultural PAPs about 1.06% are landless, 52.58% Marginal and 9.74% are small. About 330.91 (93.12% private land) is required for the construction of the project.
- Number of displaced families is approximately 324. Approximately 1.85 family per kilometer is getting displaced for this project, which is fairly low.
- DFCCIL has further reduced land width from 40 meter to 20 meter in some built-up stretches resulting in minimizing displacement.

The following are some of the key baseline socio-economic standard of the affected, which will become basis for measuring the changes in the living standards during the impact assessment studies.

Table 5.42 Socio-economic data on affected people

Status on Indebtedness

Amount of debt	0 - 10000	10000-25000	25000-50000	50000-above	reported cases
Percentage of cases	To be determined at the time of RAP implementation				

Status on Income Level

Income per year in Rs.	0-25000	25000-50000	50000-100000	above 100000	Nos. of families
Percentage	153 (5.04%)	335 (10.99%)	589 (19.29%)	1974 (64.68%)	3051 (100%)

Education Status

Education level	Un Educated	Educated	8th	10th	Intermediate	Graduate	Total PAPs
Percentage	474 (15.56%)	542 (17.75%)	505 (16.57%)	488 (15.98%)	486 (15.92%)	556 (18.22%)	**3051 (100%)**

Occupation Profile

Occupation	Service	Business	cultivator	Students	House Wife	Labour	Un-Employed	Workers	Total PAPs
Percentage	**405 (13.3%)**	**213 (7.7%)**	**476 (15.6%)**	**402 (13.2%)**	**400 (13.1%)**	**317 (10.4 %)**	**253 (8.3%)**	**585 (18.4%)**	3051 (100%)

Project Affected People: Based on an analysis of impacts, the affected people are categorized into various impact categories with applicable entitlements, which are given in the table below:

Table 5.43 Summary

Sl. No	Impact Category	No. of PAFs	Entitlements	Remarks
(a) Title Holders: Loss of Land				
1	Land owners loosing less than 1500 Sq.mts and becoming Land less/Marginal/Small land owners	1484	• Compensation as replacement value as per EM • Ex-gratia of Rs. 20,000 Reimbursement of stamp duty charges	Reimbursement should be claimed within one year of receipt of compensation
(b) Title Holders: Loss of Structures				
1	Those losing less than 25% of structures	0	• Replacement cost of affected structure evaluated by Independent Valuer	
2	Those losing more than 25% of structures	324	• Replacement cost of affected structures evaluated by Independent Valuer • Reimbursement of stamp duty charges • Transition allowance Rs. 4,000 • Shifting allowance of Rs. 10,000 • House construction assistance in case of BPL • Rs 25,000 in case of business/ artisan/ self employed	
3	Affected Tenants/Lease holders	0	• 3 months written notice • Shifting allowance of Rs. 10,000	Rental allowance as per EM in case of advance t notice cannot be served
4	Kiosks	0	• 3 months written notice • Shifting allowance of Rs. 10,000	
(c) Non Title holders				
1	Those loosing residential /commercial structures	139	• Compensation for structure loss based on Independent	

Sl. No	Impact Category	No. of PAFs	Entitlements	Remarks
			valuer's assessment • Transitional allowance Rs. 4,000 • Shifting allowance of Rs. 10,000 • House construction assistance in case of BPL • Rs 25,000 for business, self employed, artisans	
(d) Additional /Other Assistance				
1	Loss of livelihood (Agricultural Labourers/Employees)	107	• Rehabilitation Grant of 750 days agricultural wages • Training assistance of Rs. 4,000 • Employment with contractors to BPL persons as per EM	
2	Vulnerable People	149	• Assistance of 300 days minimum wages	
3	Tribal Households	0	• Additional one time assistance of 500 days minimum wages.	If lost customary rights/ access to forest produce

5.4.11 Archaeological Monuments/Protected Areas

There are no protected monuments/sites/structures in the core zone of the alignment and within 300 m from the proposed alignment/detours. However, few protected monument are present in the buffer zone as shown in **Table 5.44**. All the ASI monuments are more than 1 Km away from the track.

Table 5.44: Archaeologically Important Sites along the Proposed Alignment

S. No.	State	District	Locality	Name	Distance of structure from centre of DFC alignment
1.	Uttar Pradesh	Saharanpur	Badshahi Mahal	Badshahi Bagh locally known as Badshahi Mahal	>300 m
2.	Uttar Pradesh	Saharanpur	Lodhipur	Khera ki Bandi, Old Cemetery	>300 m
3.	Uttar Pradesh	Saharanpur	Saharanpur	Old British Cemetery, Khata Khedi	>300 m
4.	Uttar Pradesh	Saharanpur	Saharanpur	Old British Cemetery, Saharanpur City	>300 m
5.	Haryana	Ambala	Ambala	Kos Minar	>300 m
6.	Punjab	Ludhiana	Dhandari Kalan	Kos Minar	>300 m
7.	Punjab	Ludhiana	Sunet	Ancient Site	>300 m
8.	Punjab	Ludhiana	Sahnewal	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 central line. Therefore, no NOC is required as per the Act.

Annexure- 5.1: Ambient Air Quality Sampling Methodology

I. Sampling Methodology for $PM_{2.5}$

Instrument Used

The Envirotech APM 550 instrument was used for sampling fine particles ($PM_{2.5}$ 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 $PM_{2.5}$ impactor is passed through a 47mm diameter Teflon filter membrane that retains the FPM. The instrument allows removal of the $PM_{2.5}$ impactor from the sample stream so that the same system may be optionally used as a PM_{10} 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, $PM_{2.5}$, 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 than 10 micron size and allow only fines (less than 10 micron particles) to reach the glass microfiber 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 settle able 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- 5.2: Ambient Air Quality Data

S. No	Location	Chainage	Zone	Date	Category	SPM µg/m^3	PM2.5 µg/m^3	RSPM µg/m^3	SO_2 µg/m^3	NO_X µg/m^3
1	Saharanpur Railway Station (km 180+790)	Ch. 201 km – 300 km	Buffer	**09/01/10**	Rural	354	36	170	18	15
			Buffer	**10/01/10**	Commercial	436	37	209	14	12
2	Jagadhari Railway Station, Yamuna Nagar(km210+930)		Core	**11/01/10**	Commercial	442	38	212	18	15
3	Mustafabad (km 228+410)		Buffer	**12/01/10**	Commercial	415	31	199	16	14
4	Asian Group of Colleges (Chainage-220+570)		Core	**13/01/10**	Rural	368	27	177	17	13
5	Kalanaur(km 204+560)		Core	**14/01/10**	Rural	386	24	185	16	14
6	Yamuna Nagar (km 210+930)		Buffer	**15/01/10**	Commercial	456	31	219	15	12
7	Sarsawa(km 194+080)	Ch. 301 km – 360 km	Buffer	**16/01/10**	Commerical	431	29	207	16	13
8	Near Modern Senior Secondary School (Chainage-353.4km)		Core	**17/01/10**	Residential	200	21	134	12	10
9	Near Sanjivani Group of Institutes (Chainage-339.4km)		Core	**19/01/10**	Residential	234	21	112	15	12
10	Mandi Gobindgarh (km 324+790)		Buffer	**20/01/10**	Industrial	521	45	250	23	18
11	Sirhind(km 315+220)		Core	**21/01/10**	Commercial	345	44	166	18	15
12	Sahnewal(km 360+000)		Buffer	**22/02/10**	Rural	289	32	139	17	13
13	Robin Model School, Khanna (Chainage- 334km)		Core	**23/01/10**	Commercial	456	31	219	21	16
14	Om Prakash Bansal School, (Chainage- 322.1km)		Core	**24/01/10**	Rural	225	26	108	13	10
15	Pashupati Kusht Ashram Society, Ambala, (Chainage- 268km)		Core	**25/01/10**	Commercial	286	31	137	12	9
16	Rajpura (km 289+500)		Buffer	**26/01/10**	Commercial	235	24	113	11	9
17	Chawla Pail(km 344+000)		Buffer	**27/01/10**	Rural	245	27	118	13	11
18	Doraha (km 352+000)		Buffer	**28/01/10**	Rural	227	24	109	14	10
19	Sahnewal (km 360+000)		Core	**29/01/10**	Rural	267	21	128	15	12

Annexure-5.3: 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 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 two 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.

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

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
- Land use (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	Land use	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 two vibration levels.

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

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-5.4: List of Avian Fauna recorded in Pilkhani-Sahnewal 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 shrike	*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	√	√
Rose ringed Parakeet	*Psittacula krameri (Scopoli)*	R	T	√	√

Name		Habitat & Migration Status		Presence	
English Name	Family/Scientific Name	Status (Migratory /Residential)	Habitat	Core Zone	Buffer Zone
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- 5.5: List of Mammalian Fauna recorded in Pilkhani-Sahnewal Reach

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 Jackal	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- 5.6:List of Amphibian Fauna in Pilkhani-Sahnewal DFC Reach

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

Annexure- 5.7: List of Reptilian Fauna in Pilkhani-Sahnewal DFC Corridor

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

Annexure- 5.8: 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	-	-	+	+	+	-	-	√	√
Nangra nangra	-	-	-	-	-	+	-	√	√
Naziritor chelynoides	-	-	-	-	-	-	-	√	√

SPECIES NAME	Study Points							Presence	
	1	2	3	4	5	6	7	Core Zone	Buffer Zone
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- 5.9: List of Planktons in the DFC Pilkhani-Sahnewal 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
21	*Gomphonema*	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1432
22	*Melosira*	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	1142
23	*Navicula*	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	+	+	+	+	+	1562
24	*Nitzschia*	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1121
25	*Stephanodiscus*	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	1131

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	
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 gracile*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1432
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- 5.10: List of Zooplanktons in the DFC Pilkhani-Sahnewal 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
18	*Soirostomum ambiguum*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	22
19	*Brachon spiralis*	-	-	+	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	+	+	+	23
20	*Uroleptus mobilis*	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+	25
21	*Euglena acus*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24

Sl. No.	Name	Sites																					ity L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
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
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

Sl. No.	Name	Sites																					ity L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	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
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

Sl. No.	Name	Sites																					ity L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
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
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

Sl. No.	Name	Sites																					ity L1-)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
94	*Neodiaptomus strigilipes*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23
95	*Phyllodiaptomus annae*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
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 6. Analysis of Alternatives

6.1. Introduction

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.

6.2. 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.

6.2.1. '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 withdrawal (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.

6.2.2. 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.

6.3. Alternative Analysis of proposed Detour

Three detours are proposed at Ambala, Rajpura & Sirhind in Pilkhani-Sahnewal section of EDFC. The detours have been proposed due to non-availability of space in the built up portions.

Ambala Detour
The change in alignment at Saharanpur area is analysed from alternatives, 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 in **Table 6.1.**

Table 6.1 : Route and Length of Ambala Detour Alternatives

Option	Starting IR Chainage	End IR Chainage	Route	Length (km)
Ambala Detour				
DFCCIL Preferred alignment	259+500	263+890	Bypassing the Ambala Cant	**4.39**
Alternative-I	259+500	264+000	Bypassing the Ambala Cant	4.50

There are only three options in this section as shown at ***Figure 6.1.*** (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 6.1 : A view of Ambala Cantt Detour

Rajpura Detour

The alignment has been shifted towards eastern side between Shambu- Rajpura because of

i Existence of Esulti Dhuri line on eastern side would otherwise needed cut cross connection between IR and DFCC, resulting detention of trains and reducing overall capacity of IR as well as DFCC.

ii To avoid heavy dismantling of railway buildings and reduction in circulating area of Rajpua stn.

iii Existence of Rajpura-Patiala highway about 500m away from Rajpura stn towards land side would otherwise needed complete elevated DFCC line in about 1000m length and might have increased overall project cost as well as time overrun.

Sirhind Detour

Facts regarding fixing of Alignment of EDFC between Sirhind and Sahnewal are given below:

i Alignment has been switched over from down main line side to up main line side between Sirhind and Mandi Gobindgarh by providing Railway Flyovers over Sirhind – Nangal Dam line and Delhi – Ludhiana Main line due to

- Non-availability/very poor availability of existing Railway Land on down line side i.e. Eastern Side as at some locations only 4-5 mtrs land was available beyond Railway Land, whereas surplus land to the tune of 10 - 15mtrs is available on up-line side (western side) in almost whole of the stretch.
- To avoid dismantling of existing large number of houses, shops and other structures on eastern side at the following locations which would otherwise have resulted in heavy displacement of general public and attracted agitations:

SN	Village	Km	Length of habited area
1	Mandi Gobindgarh	Ch.135100 to 136200	1100m
2	Rattan Heri	Ch.141150 to 141450	300m
3	Khanna (i)	Ch.141900 to 142100	200m
4	Khanna (ii)	Ch.142400 to 144500	2100m
5	Rahoon	Ch.144500 to 145000	500m
6	Kauri	Ch.147290 to 147600	310m

SN	Village	Km	Length of habited area
7	Daheru	Ch.151400 to 151900	500m
8	Chawa	Ch.154100 to 154600	500m
9	Rupalon	Ch.156600 to 156700	100m
10	Jaspalon	Ch.159500 to 160000	500m
11	Mallipur	Ch.161400 to 161850	450m
12	Doraha	Ch.163300 to 164300	1000m
13	Kanech	Ch.168350 to 168400	50m
Total			7610m

ii Chandigarh – Ludhiana Railway line is taking off on eastern side of Sahnewal Station. Surface crossing would have resulted if alignment of EDFC was kept on eastern side and operation of IR and DFCC trains would have become difficult job due to this surface crossing (copy of yard plan of Sahnewal station showing Chandigarh-Ludhiana line is attached for ready reference.

iii Availability of lesser land due to existence of circulating area of Sirhind Station and thick populated area of Sirhind town on western side.

iv Few goods sidings were under planning by Northern Railway on eastern side i.e. (B2B) sidings at Sahnewal Station and Priston Goods Sidings at Chawa Pail station.

v Feeder route of WDFC has been planned on Ludhiana-Hisar section and terminal depot planned at Ahmedgarh station on this line. There was a planning to connect both the corridors i.e. EDFC & WDFC at Ahmedgarh station. This was also one of the main reasons of keeping alignment of EDFC on Western side.

vi In fact, there was a proposal of keeping the alignment of EDFC on Eastern side between Sirhind-Sahnewal. Presentations of proposed alignment were made to Ambala Division as well as N.Rly./HQ. Final consensus of keeping alignment on western side was evolved between DFCC and IR.

6.3.1 Summary of detours lengths after alternative analysis:

Detour	**Length (km)**
Ambala	4.39
Rajpura	4.00
Sirhind	4.40
Total	**12.79**

Chapter 7. Environmental Impact Assessment

7.1. Introduction

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.

7.2. 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 7.1.**

Table 7.1 : 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.

7.3. Impact on Physical Environment

7.3.1. 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 28617 trees in the corridor of impact.

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 CO_2 emission to the tune of 6.72 tonnes/day. The detailed calculation is given in **Annexure-7.1**. 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.

7.3.2. Natural Hazard

Design and Construction Phase

Impact: The Pilkhani – Sahnewal EDFC is located in seismic zone IV that 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.

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.

7.3.3. Air Quality

Design and Construction Phase

Impact: The ambient air quality of area is good except between Rajpura to Khanna section. The particulate matter concentrations except of size 2.5 microns ($PM_{2.5}$) exceeds at all the locations along the alignment (**Table 7.2**). 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 Rajpura to Khanna section where concentration level is higher than other places.

Table 7.2 : The Ambient Air Quality Exceedance Level along the Alignment

Chainage	Pollutants	Exceedance at Chainage/Location	Maximum Level µg/m^3	Standards (µg/m^3)
Ch. 187+800 - 200 km	SPM	All	376	NA
	RSPM	All	257	100
	$PM_{2.5}$	None; High at industrial areas	37	60
	SO2	None; High at industrial areas	37	80
	NOX	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
	SO2	None	28	80
	NOX	None	25	80
Ch. 301 - 360 km	SPM	All	421	NA
	RSPM	All	250	100
	$PM_{2.5}$	None; >40 at Sirhind and Mandi Gobindgarh	45	60
	SO2	None; High at industrial areas	53	80
	NOX	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 (NOx) 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, NOx and SO_2. The level of emissions from stationary and mobile diesel engines is indicated in **Table7.3**. 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 7.3 : 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 complied by the quarry owner. The aggregate shall be transported in the covered Lorries through existing national and state highways.

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.

7.3.4. 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 dBA is likely to be of the order of only 3 - 5 dBA.

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.

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

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

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.

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 7.4**. 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.

(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, labour 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

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

Table 7.4 : Prediction of Noise from the Proposed DFC

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)*
1.	Temple	Mustafabad	228+410	70	72.1	25	Noise Barrier wall	81.1	
2.	Temple	Near Markanda River (km	244	80	58.1	35	Noise Barrier wall	67.1	
3.	Angel's Public School	Ambala	267	70	53.5	25	Noise Barrier wall	62.3	10000 of 120 dB(A) noise peak
4.	Pashupati Kusth Ashram	Ambala	268	82	54	28	Noise Barrier wall	60	
5.	Residential area	Sirhind station	315.220	75	58	20	Noise Barrier wall	71	
6.	Robin Model School	Khanna	332.300	60	75	6	Relocation	88	
7.	Gurdwara	Between Chawa Pail & Khanna	333	70	74.2	25	Noise Barrier wall	83.2	
8.	High School	Between Chawa Pail & Khanna	348	60	64.3	15	Noise Barrier wall	73.3	
9.	Sanjivani College of Nurshing	Chawra Palli	343.900	79	56	24	Noise Barrier wall	62	
10.	Primary School	Between Doraha & Chawa Pail	348.800	80	70.2	35	Noise Barrier wall	79.2	
11.	Modern Sr. Sec. School	Doraha	351.800	70	54.3	25	Noise Barrier wall	63.3	
12.	Temple	Doraha	352	70	57.6	25	Noise Barrier wall	66.6	
13.	Gurdwara	Doraha	352	70	52.1	25	Noise Barrier wall	61.1	

**Source: Delhi Factories Rule, 1950*

As number 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 channelled 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

Identification and predicting the impact

Identification of Impacts:

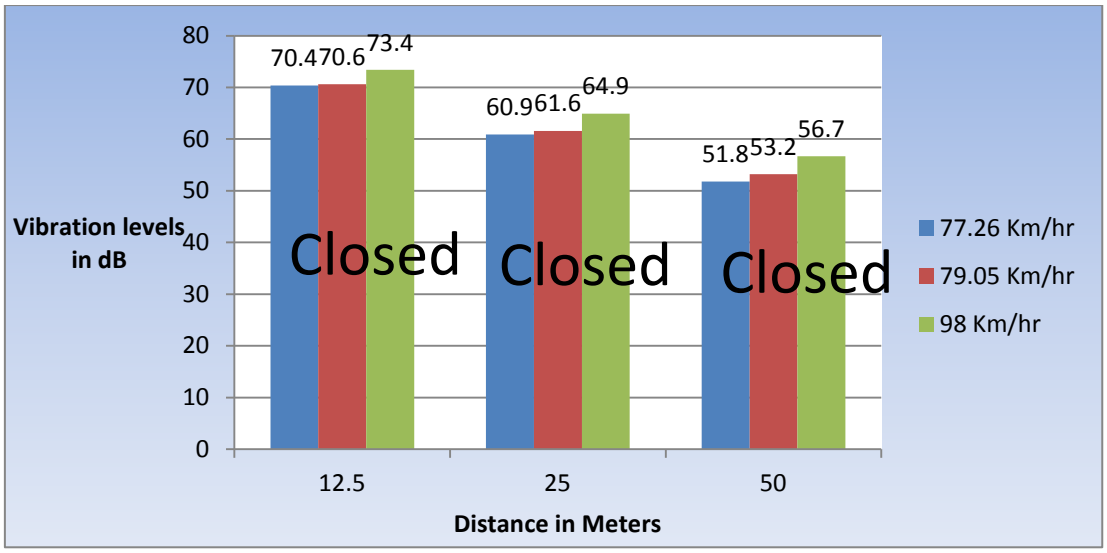
We have identified several kinds of impacts from the data collated in previous chapters. Typically, these impacts could be of following types

1) **Impacts in Plane areas i.e.**travel of Vibration; reverberations at 90 degree to the track will affect all the buildings, archaeological 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 i.e.** trains while crossing each other or while running parallel to each other in two or more numbers cause increase or reduction in overall vibrations. This aspect is to be taken into consideration for estimating maximum impacts in each of the above two situations
3) **Impacts in Populated Areas i.e.** travel of vibrations, reverberations through the variety of ground conditions existing between the track and point of measurement / impact assessment. Variety of conditions existing included mix of plain, embankment, hard standing platform of building floors, and roads. .

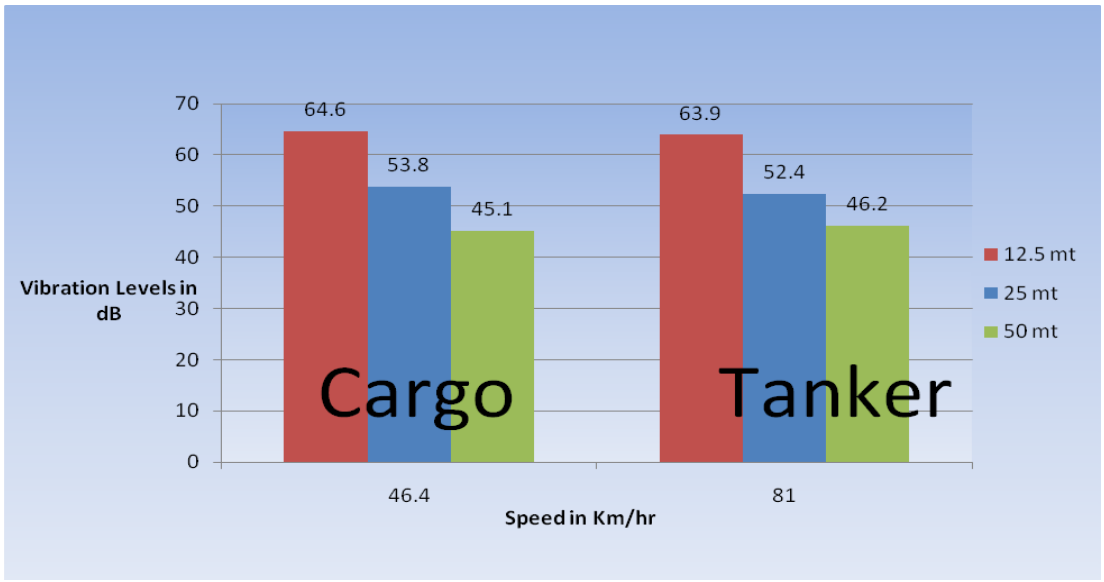
Impacts in Plain areas vis-a-vis distances from the track

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

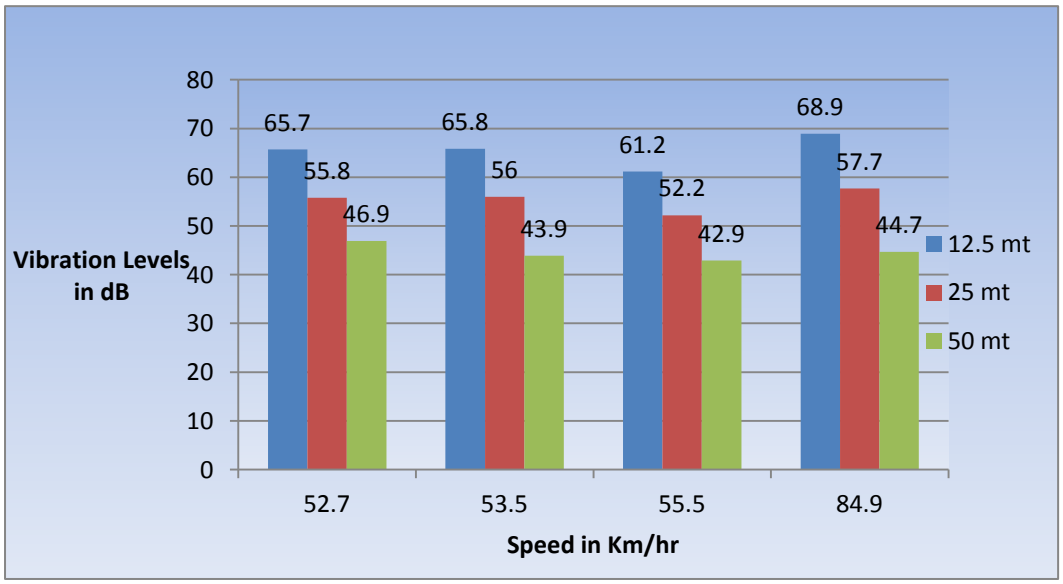
Closed Wagon



Tanker and Cargo



Open Wagon

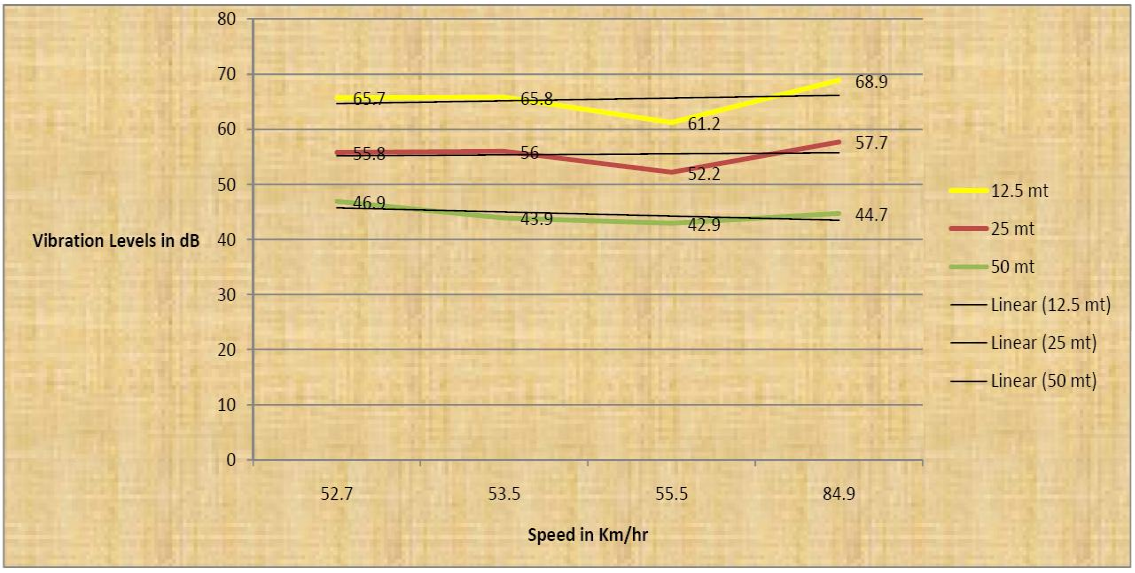


From the graphs above, we can select the highest vibration levels of all the categories of train for one distance (say 12.5, 25, or 50 meters) as the upper limit for that distance, for estimating the impact at 90^0 to the track. This is tabulated at **Table 7.5**.

Table 7.5 : Highest Vibration Levels for All Category of Trains

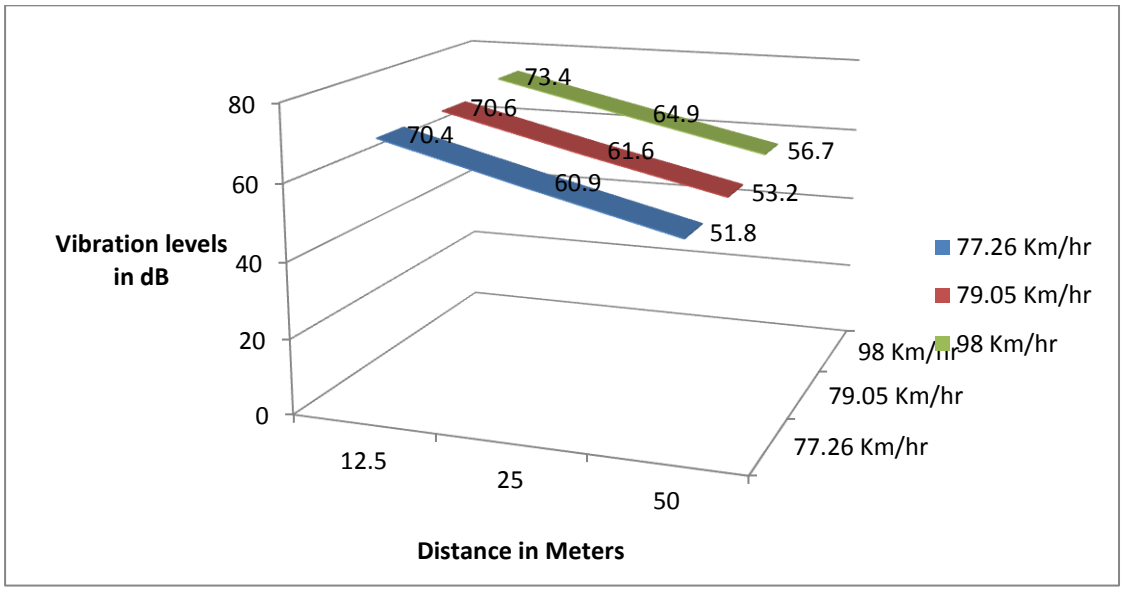
Distance (m)	Maximum dB
12.5	73.4
25	70.6
50	70.4

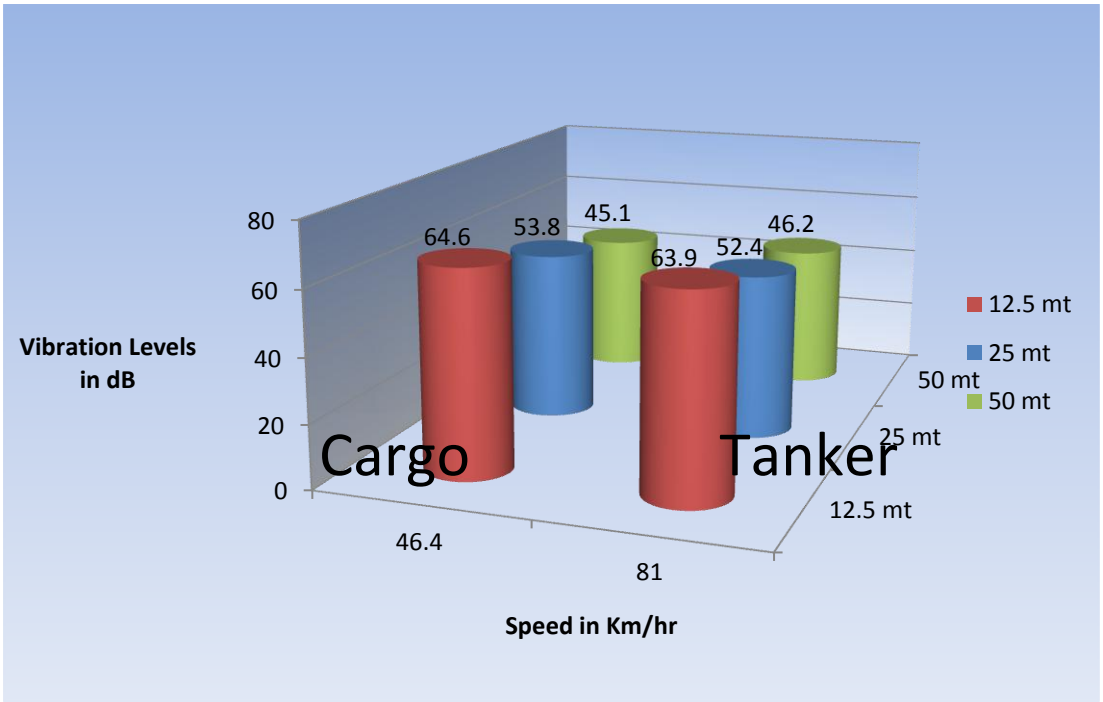
These values for all the three distances coincidentally correspond to only one categories of freight train that is **Closed Wagon**; Graph for this is as below:



Impacts with speed and axle load were similarly evaluated and identified for

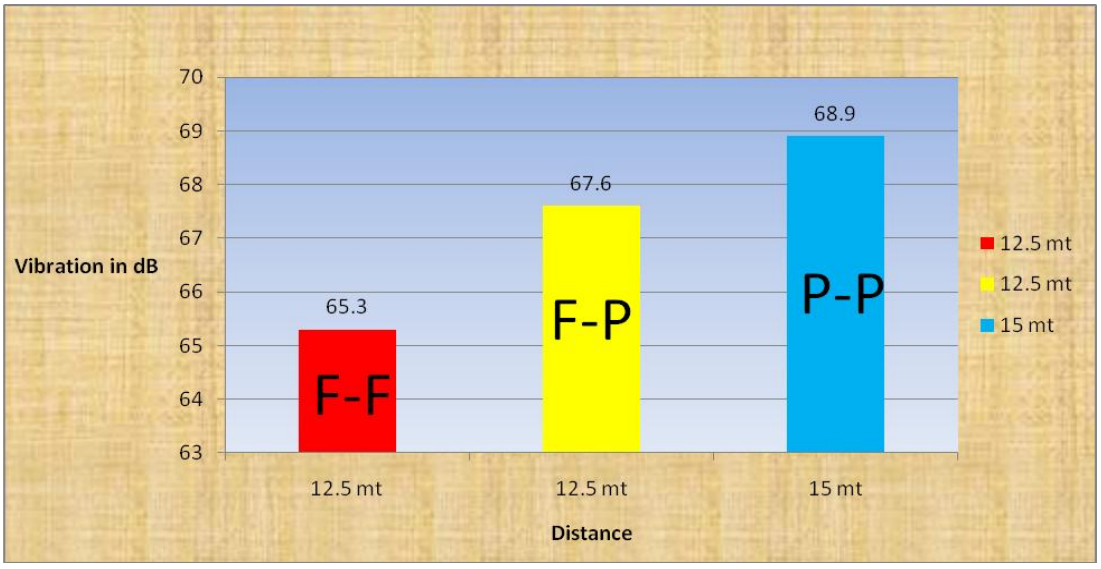
- maximum speeds of trains in each category as well as for
- maximum vibration in these categories and are as placed below:





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 can be inferred that in parallel 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 two 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-7.6**:

Table 7.6 : Sensitive Receptors along the Alignment of DFC- vibration

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)
1.	Temple	Mustafabad	228+410	70	72.1	25
2.	Temple	Near Markanda River	244	80	58.1	35
3.	Mosque	Between Sambhu and Rajpura station	284	90	78.2	45
4.	Gurdwara	Between Chawa Pail & Khanna	333	70	74.2	25
5.	High School	Between Chawa Pail & Khanna	348	60	64.3	15
6.	Temple	Between Doraha & Chawa Pail	349	100	68.8	55
7.	Primary School	Between Doraha & Chawa Pail	348.800	80	70.2	35
8.	Modern Sr. Sec. School	Doraha	351.800	70	54.3	25
9.	Temple	Doraha	352	70	57.6	25
10.	Gurdwara	Doraha	352	70	52.1	25

Source: Consultants' Field Survey

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.

Of all possibilities, the various combinations of trains running on two closest tracks as these trains have maximum influence of individual vibrations on each other will

generate maximum vibrations. 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 dBA 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 cancelling 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 dBA**. 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 dBA**

The Mathematically Attenuated value calculated for vibration at 35 meters in reference to the train running on the 2nd track = **72.8 dBA** (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.

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

In the light of this discussion for predictions, **75.3 dBA** 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 dBA**
   - This level attenuated to 17.5 mts for second freight train = **71.5 dBA**.

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

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

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 dBA**
   - Highest value of Vibration level of passenger train attenuated to 35mtrs = **72.9 dB**

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

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

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 35mtrs = **72.9 dBA**
- Highest value of vibration level by one freight train attenuated to 20mtrs = **71.5 dBA**

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

Lp $_{F-P}$ = 10*LOG (10^ (72.9/10)-10^ (71.5/10)) = 67.3 dBA

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

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

Lp $_{F-F-P}$ = 10*LOG(10^(71.5/10)+10^(77.2/10)) = 78.2 dBA

On Passenger Track Side

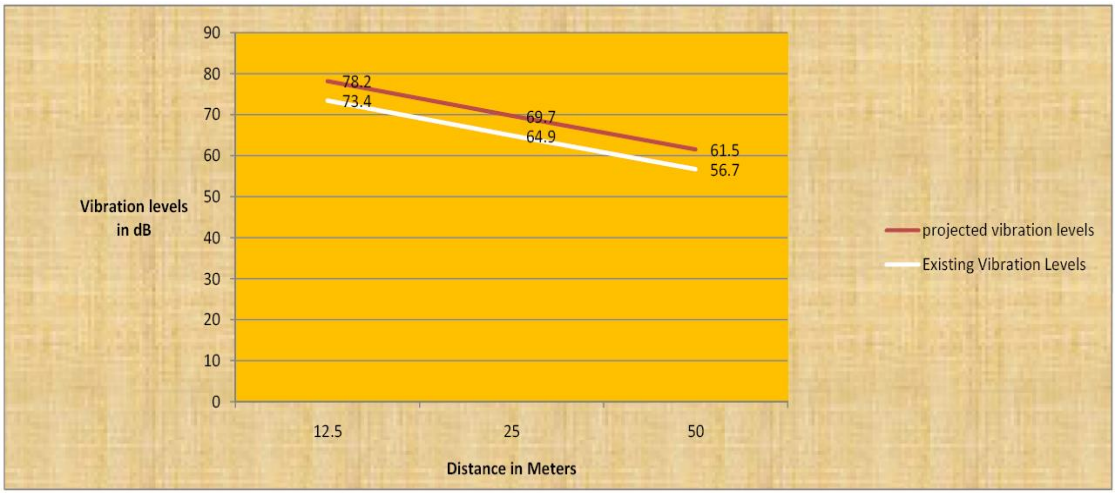
4. On the other side of two tracks, the situation will be driven by passenger train in similar four possibilities. The evaluated highest Lmax for these four possibilities are:

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

(ii) 1 Passenger on track 3 and one freight on track 2 both in opp. direction- **66.5 dBA**

5. 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 along with 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 dBA** at 12.5 meters measurement point, when the interfacing ground is plain ground. This will be at crossing stations

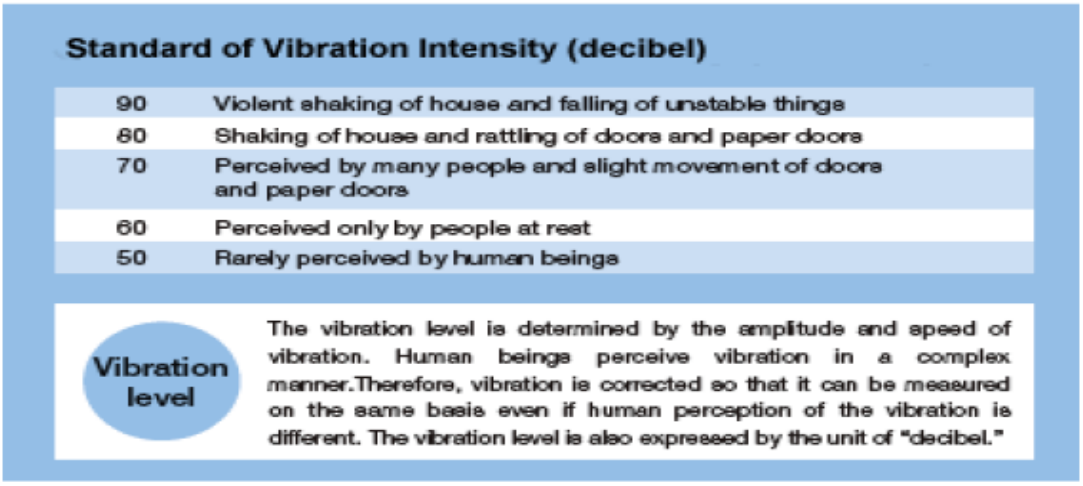
However, this value is lower than the highest Vibration Levels generated by running of Single Freight train.

Therefore predicted highest vibration levels for the detour portions = **75.3 dBA** 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:

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;



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 the 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 EDFC are as below:

Plain route: 78.2 dBA as against permissible levels of 70 dBA

Populated areas 78.2 dBA as against permissible levels of 65 dBA

Therefore vibration levels have to reduced by

8.2 dBAs - for Plain areas

13.2 dBAs - Populated areas

8.2 to 13.2 dBAs - 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 below in **Table-7.7.** It is clear that vibrations these are exceeding at all sensitive receptors.

Table 7.7 : Prediction of Vibration Impact from the Proposed DFC

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)	Predicted Vibration Level with DFC L'max dB(A)
1	Temple	Mustafabad	228+410	70	72.1	25	79
2	Temple	Near Markanda River	244	80	58.1	35	78
3	Mosque	Between Sambhu and Rajpura station	284	90	78.2	45	74
4	Gurdwara	Between Chawa Pail & Khanna	333	70	74.2	25	79
5	High School	Between Chawa Pail & Khanna	348	60	64.3	15	83
6	Temple	Between Doraha & Chawa Pail	349	100	68.8	55	69
7	Primary School	Between Doraha & Chawa Pail	348.800	80	70.2	35	78
8	Modern Sr. Sec. School	Doraha	351.800	70	54.3	25	79
9	Temple	Doraha	352	70	57.6	25	79
10	Gurdwara	Doraha	352	70	52.1	25	79

Mitigation Measures

Mitigation measures for each of the above sensitive receptor location have been detailed out in section 8.1.8 However, mitigation in the form of 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. 5. This school 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. Hence, it is felt that no additional mitigation measure is required to be considered.

7.3.5. 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.

7.3.5.1 Change in Landuse and Landscape

Design and Construction Phase

Impact: The project will require acquisition of 355 Ha land. About 90% of this land comprises of agriculture land. Most of the remaining land parallel to the existing railway track is in the possession of Indian Railways, which is unproductive or under tree cover. The agricultural land likely to be acquired is negligible compared to the net sown area of the districts. This means that project would cause negligible impact in terms of loss of agricultural produce.

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.

7.3.5.2 Loss of Productive Soil and Soil Erosion

Design and Construction Phase

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

The project areas vulnerable to soil erosion are proposed earth stockpile locations, high embankment areas of the detour, Riverbanks, 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 waterlogged 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.

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. .

7.3.5.3 Borrow Areas And Quarries

Design and Construction Phase

Impact: The project area topography is characterised as flat. GIS based assessment is carried out in 15 km radius along the entire 175 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 their 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 mainly from existing and approved quarries since many approved quarries are located in the area. No direct impact is envisaged from sourcing of this material.

A view of embankment filled with earth blended with fly ash and GGBS is shown in **Figure 7.1.**

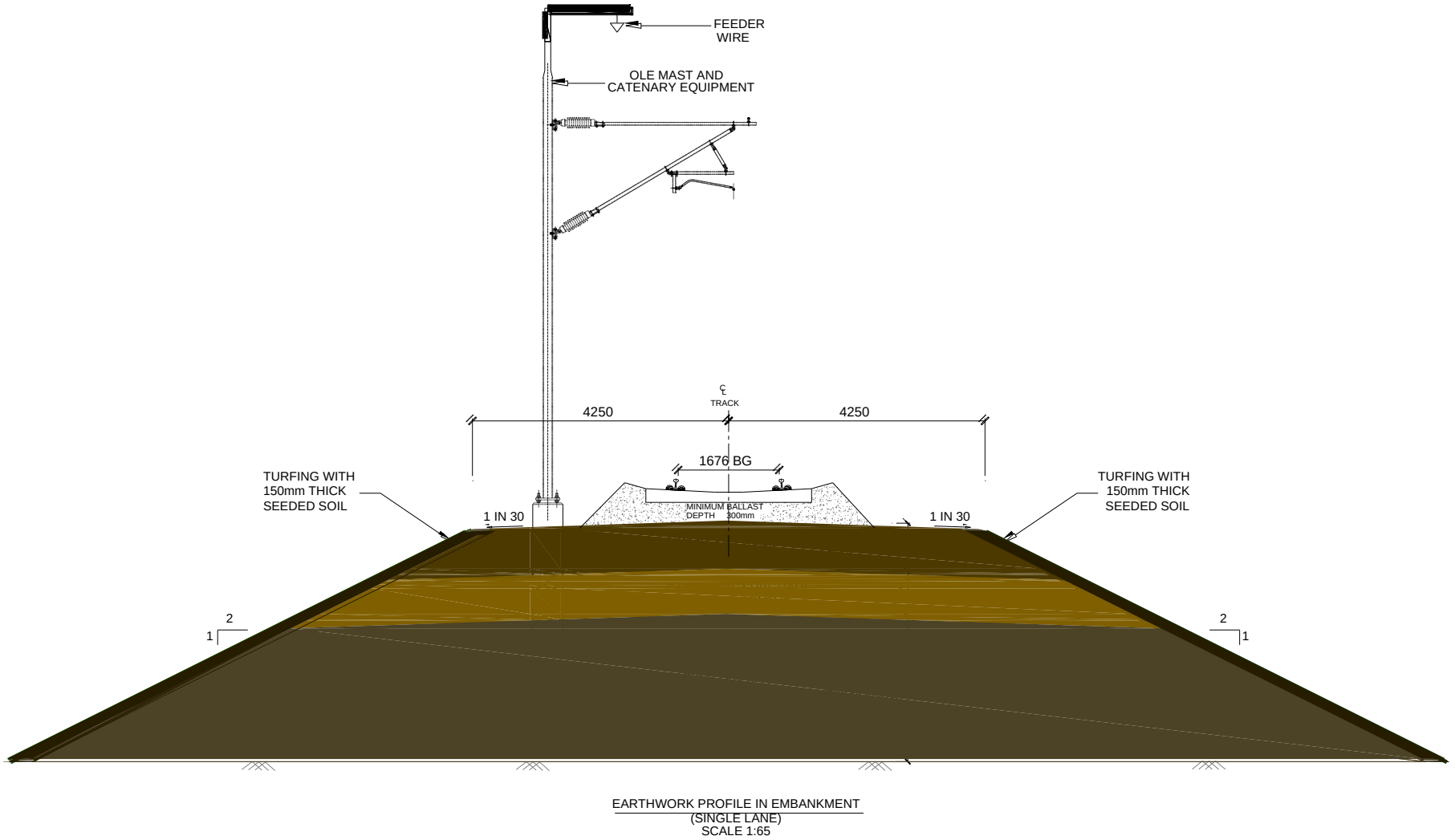


Figure 7.1 : A View of Embankment filled with Earth Blended with Fly Ash / GGBS

7.3.5.4 Compaction And Contamination Of Soil

Design and Construction Phase

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.

Operation Stage

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

7.3.6. Water Resources

7.3.6.1 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 Yamuna Nagar district of Haryana, Sirhind, Khanna, Rajpura in district Fetehgarh Sahib, Ludhiana and Patiala of Punjab respectively) (ii) Critical (Barara, Doraha in district Ambala of Haryana, and Ludhiana in Punjab respectively) and (iii) Semi-critical (Saharanpur in Uttar Pradesh) areas from ground water availability perspective. As per an estimate about 0.62 million cubic meter of water shall be required for the construction of 175 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 m^3. This much quantity of water can be extracted only with prior permission from CGWA and with the adequate provision of rain water harvesting.

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.

7.3.6.2 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 7.8**. 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 7.8 : Summary of Major Canals and River Crossing the DFC alignment

Chainage	Water Body	Water Availability	Water Quality
201 – 250 Km	*Yamuna* River	Perennial	Irrigation Quality
251 – 300 Km	Western Yamuna Canal Rakshi River Saraswati River Markanda River Tangri 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 – 360 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.

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.

7.3.6.3 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 7.9.** 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 7.9 : Water Accumulation Locations Along the track

Section	Chainage	Nearest Drain Present	Slope
Ch. 201 - 300 km	184	Eastern Yamuna Canal	NE-SW
	196	Kala Nala	NE-SW
	204	Branch of Western Yamuna Canal	NE-SW
	214	Nearby natural drainage	NE-SW
	229.500	None	
	229.800	Nearby natural drainage	NE-SW
	236.600	Chainage of Bentan nadi	NE-SW
	241.600	Chainage of Bentan nadi	NE-SW
	244+000	Markanda River	NE-SW

Section	Chainage	Nearest Drain Present	Slope
Ch. 301 -360 km	301	Nearby natural drainage	NE-SW
	325	Nearby natural drainage	NE-SW
	319	Bhakra canal	NE-SW

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.

7.4. Impact on Biological Environment

7.4.1. Terrestrial Ecology

7.4.1.1 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 Pilkhani to Sahnewal Stretch. Except 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 under the private ownership.

A total tree cutting in the corridor of impact has been estimated as 28617. 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 Pilkhani to Sahnewal stretch were mostly of *Populous deltoids*, Eucalyptus-*Eucalyptus globulus*, 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.

Operation Phase

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

7.4.1.2 Forest Fragmentation And Destruction

Design and Construction Phase

Impact: 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).

Operation Phase

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

7.4.2. Migratory Route of Terrestrial Fauna

Design and Construction Phase

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

Operation Phase

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

7.4.2.1 Endangered Species

Design and Construction Phase

Impacts: No impact is anticipated on any endangered, vulnerable, schedule species in EDFC Pilkhani to Sahnewal 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*.

Operation Phase

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

7.4.3. Aquatic Ecology

7.4.3.1 Effect on Fish Diversity

Design and Construction Phase

Impacts: In the stretch of Pilkhani to Sahnewal 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 affect the fish diversity and abundance in the Rivers, canal and water body areas.

Operation Phase

Impacts: No impact is anticipated during operation stage concerning fish activities.

7.4.3.2 Effect on Plankton Diversity

Design and Construction Phase

Impacts: The Rivers, canals present in the stretch of Pilkhani to Sahnewal EDFC proposed project have considerable diversity of phytoplankton and zooplankton population in the project area. A total of 48 phytoplanktons were found in Pilkhani to Sahnewal 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.

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.

Operation Phase

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

7.4.3.3 Effect on Aquatic Avian Diversity

Design and Construction Phase

Impacts: Aquatic avian diversity present in the Rivers and canals of the stretch of Pilkhani to Sahnewal 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.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to aquatic avifauna.

7.4.3.4 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. Therefore, their movement will get impacted if the flow of the water through the Yamuna River is disrupted.

Operation Phase

Impacts: No impact is anticipated during operation stage with regards to *Tor tor* activities.

7.4.3.5 Effect on Spawning and Breeding Grounds

Design and Construction Phase

Impacts: Along the whole stretch of EDFC Pilkhani to Sahnewal 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 spawning and breeding ground along the line of the alignment.

Operation Phase

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

7.5. 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, 34 community structures are likely to get affected. Other structures have already been saved by suitable modifications in the alignment design/finalisation.

7.6. Environmental Matrix

Based on the potential impacts on natural resources in planning construction and operation phase an impact matrix has been prepared. The Environmental Impact Matrix for pre-construction and construction stages are provided in **Tables 7.10** and **7.11** respectively. The scale of impact under individual parameter is discussed with mitigation measures in **Table 7.12.**

Most of the impacts are localized, insignificant and temporary in nature, except those related to noise and vibration during the operation phase.

Table 7.10 : 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 7.11 : 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

Note: A- significant, B- relatively significant, C- insignificant, D- negligible, E- no impact

Table 7.12 : Scaling of Impacts on Natural environment due to DFC Section from Pilkhani to Sahnewal

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

7.7. 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.

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

7.8. Impacts due to Construction Camp

Poor siting and improper management of construction camp may lead to several adverse impacts on environment land and water bodies.

7.9. Right-of -Way Maintenance

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.

7.10. 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 largely along the existing electrified rail and majority of the stretches passes through agriculture field/open field. Some occupational health effect may occur which is defined under subsequent sections .

7.11. Occupational Health and safety

7.11.1. Rail Operation

7.11.2. Train/Worker Accident

Railway workers near 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.

7.11.3. 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.

7.11.4. 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.

7.11.5. Electric and Magnetic Fields

Railway workers 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

7.11.6. 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.

7.11.7. 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.

7.12. 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.

7.13. 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.

7.14. 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 danger of 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.

7.15. Chance Find

Any archaeological article or structure found during construction shall be as per the provision of the Act/ Rules.

7.16. 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 7.13.**

Table 7.13 : 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	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 of ROBs/RUBs to prevent vehicular pollution	Moderate
Noise and Vibration	Increase in ambient noise levels	Moderate	▪ Timely serviced and properly maintained equipments 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 and Soil Erosion	Loss of productive soil due to Borrow areas and erosion at River banks, embankment areas of detours, bridge	Moderate	▪ Top soil preserved and reused for plantations ▪ Repairing of River banks after construction ▪ Cross drainage structures to prevent water logging and thus soil erosion ▪ Turfing of embankment slopes	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
	approaches		▪ Surface slope stabilization prior to seeding	
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				

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
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 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.	Insignificant
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 28617 trees in core zone during project intervention	Significant	▪ Minimization of tree cutting 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	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
			during afforestation programme	
Forest fragmentation and destruction	There is diversion of protected forest land Protected Forest to the extent of 175 Ha.	Moderate	▪ Afforestation as per provisions of sanction ▪ Monitoring of survival rates of trees planted during afforestation programme ▪ Forest Land diversion proposal submission and necessary cost provision for compensatory afforestation and NPV.	Insignificant
Endangered species	Only one vulnerable species of Sarus crane	Insignificant	▪ Arboreal species so no remedial measures suggested	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 at least through one channel to be maintained to allow migration of fishes	Insignificant
Spawning and Breeding Grounds	Disturbance on breeding and spawning grounds	Moderate	Restriction of construction activities near the identified breeding and spawning grounds during the breeding period of April to August	Insignificant
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	Significant	▪ Adopt safe working practices ▪ Trainings to workers	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
	and at crossings		▪ 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	
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
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	Moderate	▪ Guidelines shall be formulated for material handling practices (particularly for loading	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
	unloading of cargo		and unloading) ▪ Covered areas used for loading and unloading ▪ Covered vehicles for transportation ▪ PPEs to Workers	
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				
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 ▪ Carrying out periodic check to assess 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
Drainage 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 survival of the tree plantation ▪ Selection of healthy sapling; selection of fertile land for plantation; provision of fertilizers (Bio-fertilizer or artificial-NPK);	Insignificant

Activity	Environmental Issue/ Component	Nature of Impact	Remedial Measures	Residual Impacts Level after Mitigation Measures
			provisioning of fencing in the plantation area; arrangement of watering facility after plantation ▪ Tree survival audit	
Disturbance to fauna	Collision between the animals and rail cars	Moderate	▪ Cross structures should be designed to allow safe passage for animals, promote habitat connectivity, be accessible, and encourage natural movements.	Insignificant
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

Chapter 8. Measures for the Mitigation of Environmental Impacts

8.1. Description of Mitigation Measures

The mitigation measures to mitigate the negative impacts due to the development of proposed Pilkhani-Sahnewal DFC on various parameters of the environment during various phases of the project are described hereunder.

8.1.1. Mitigation Measures of Land Environment

Land acquisition, soil erosion and contamination of soil have emerged as major sources of land impact especially in urban areas and nearby watercourses. Due to the proposed project aimed at enhancing the efficiency of rail transport system, which will result in economic growth in the region over time.

Table-8.1

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1	Change in topography	Marginal impact	• Due to embankment raising	• Balancing culverts will be provided
2	Change in geology	Direct, long term, negative impact	• Extraction of materials (borrow earth, coarse & fine aggregates)	• No blasting is envisaged • Quarry redevelopment plan need to be enforced
3	Change in seismology	No negative impact	• Natural process	• Cross drainage structures are checked and complied with the seismological settings of the region
4	Change in land environment	Direct negative impact	• May be due to construction activities	• Preventive measures against pollution of land/ soil to be taken
a	Loss of land	Direct, long term negative impact	• Land acquisition change in land use pattern	• Land acquisition to be minimized with provision of retaining walls
b	Generation of debris	Negative impact	• May contaminate air, water and land, if not disposed properly	• Disposed properly to avoid contamination
c	Soil erosion	Moderate, direct, long term negative impact	• Slopes and spoils near the bridges • Construction of new bridges and culverts • quarry and borrow areas	• Embankment protection • For Emb, ht.>3 m stone pitching, • Emb ht. < 3m. turfing • Residual spoil need to be disposed properly • silt fencing need to be provided, • quarries need to be reclaimed
5	Contamination of soil	Direct, long term negative impact	• Scarified bitumen wastes • Oil & diesel spills • Emulsion sprayer and laying of hot mix • Production of hot mix and rejected materials • Residential facilities for the labor and officers • Routine and periodical maintenance	• Hazardous Waste (Management and Handling Rules, 1989) to be enforced. • Oil interceptor will be provided for accidental spill of oil and diesel • Rejected material will be layed in village roads or as directed by engineer • Septic tank will be constructed for waste disposal
6	Soil quality monitoring		• Effectiveness / shortfall (if any) • Any unforeseen impact	• Measures will be revised & improved to mitigate / enhance environment due to any unforeseen impacts

Plantation programme will be carried out to improve the aesthetic look of the construction area. The plantation all along the railway line will be carried out to improve aesthetic along the existing as well as detour locations.

8.1.2. Mitigation Measure for Borrow Area Management

Borrow areas will be finalized either form the list of locations identified by contractor. The finalization of locations by contractor depends upon the formal agreement between landowners and contractor and its suitability from civil engineering as well as environmental consideration. Meeting the guidelines/notifications as stipulated from time to time by the Ministry of Environment and Forests, Government of India, and local bodies, as applicable shall be the sole responsibility of the contractor.

Besides this certain precautions have to be taken to restrict unauthorized borrowing by the contractor. No borrow area shall be opened without permission of the Engineer/EO. The engineer in addition to the established practices, rules and regulation will also consider following criteria before approving the Borrow areas.

To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Engineer. Redevelopment of the borrow areas to mitigate the impacts will be the responsibility of the contractor. The contractor shall evolve site-specific redevelopment plans for each borrow area location, which shall be implemented after the approval of the Engineer-in-Charge.

To ensure that the spills, which might result from the transport of borrow and quarry materials do not impact the settlements, it will be ensured that the excavation and carrying of earth will be done during day-time only. The unpaved surfaces used for the haulage of borrow materials will be maintained properly. Borrowing of earth shall be carried out at locations recommended as follows:

Non-Cultivable Lands: Borrowing of earth will be carried out upto a depth of 2.0 m from the existing ground level.

Borrowing of earth shall not be done continuously. Ridges of not less than 8m width shall be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges, if necessary, to facilitate drainage.

Productive Lands: Borrowing of earth shall be avoided on productive lands. However, in the event of borrowing from productive lands, under circumstances as described above, topsoil shall be preserved in stockpiles. The conservation of topsoil shall be carried out as described in section of this chapter. At such locations, the depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside.

Elevated Lands: At locations where private owners desire their fields to be levelled, the borrowing shall be done to a depth of not more than 2 m or up to the level of surrounding fields.

Borrow pits along Roadside: Borrow pits shall be located 50m away from the toe of the embankment. Depth of the pit should be such that the bottom of the pit shall not fall within an imaginary line of slope 1 vertical to 4 horizontal projected from the edge of the final section of the bank. Borrow pits should not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains should be cut through the ridges to facilitate drainage.

Borrow pits on the riverside: The borrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood.

Community / Private Ponds: Borrowing can be carried out at locations, where the private owners (or in some cases, the community) desire to develop lands (mostly low-lying areas) for pisciculture purposes and for use as fishponds.

Borrow Areas near Settlements: Borrow pit location shall be located at least 1.0 km from villages and settlements. If unavoidable, they should not be dug for more than 30 cm and should be drained.

After identification of borrow areas based on guidelines. Contractor will fill reporting format as under and submit the same for approval to the "Engineer" Once approved the contractor will adhere to the recommendation for borrow area to the satisfaction of Engineer.

1) In no case the depth of borrow area should exceed 2m from the existing ground level.
2) Borrow pits slope should be maintained, no steeper than 1 Vertical: 2 Horizontal.
3) Water pooling to be avoided/managed so that NO disease spread due to water stagnation.
4) Precautionary measures as the covering of vehicles will be taken to avoid spillage during transportation of borrow area.
5) The unpaved surfaces used for the haulage of borrow materials should be maintained properly for dust suppression.
6) Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction facility is operating at the place of deposition, to minimize dust pollution.
7) During rains appropriate measures to be taken to minimize soil erosion, silt fencing to be provided as directed by Engineer/EO.

The Contractor will keep record of photographs of various stages i.e., before using materials from the location (pre-project), for the period borrowing activities construction Phase) and after rehabilitation (post development), to ascertain the pre and post borrowing status of the area

8.1.3. Mitigation Measures to Minimize Soil Erosion

1) Construction Phase
   - Suitable protection measures consisting of bio-engineering techniques such as plantation of grass and shrubs, may be provided to control erosion. The measures shall be applied along the slopes at high embankment where bridges will be constructed.
   - Borrow areas may be finalized in concern with ecological sensitivity of the area. Agriculture land may not be used as borrow areas. Priority may be given to degraded area for excavation of borrows 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 stored separately in bunded areas and utilized during plantation or refilling of excavated area.
   - Selection of borrow areas may be done considering the waste land available in the district. Agricultural areas may be not used as borrow areas.
   - A separate borrow area management plan may be made providing location, ownership details, timing of borrowing and rehabilitation measures.

2) Post-Construction Phase
   - No impact is envisaged on soil during post implementation phase.

8.1.4. Mitigation Measures to Improve the Ambient Air Quality

1) Pre Construction Phase

- The dust generation due to pre-construction activities will be temporary in nature and localized and will be effectively countered by sprinkling of water.

2) Construction Phase

During the construction stage, there are two major sources: the first one is construction activities at working zones, which cause primarily dust emission and second are from operation of the construction plant, equipments and machinery, which causes gaseous pollutants. The specific measures include:

- Locating Plant at a significant distance from nearest human settlement in the predominant down wind direction.
- Vehicles delivering fine materials like soil and fine aggregates shall be covered to reduce spills on existing roads.
- Water will be sprayed on earthworks, temporary haulage and diversions on a regular basis.
- Batch type hot mix plants fitted with the bag filter / cyclone and scrubber will be installed for the reduction of the air pollution.
- Pollution control systems like water sprinkling and dust extractors and cover on conveyors will be installed for the crushers.
- All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the emission levels conform to the SPCB/CPCB norms.
- Air pollution monitoring plan has been delineated for construction phase separately for checking the effectiveness of the mitigation measures adopted during the construction phase of the Contract
- Air quality monitoring shall be conducted during construction period as per CPCB norms. The location and frequency of air monitoring is covered in Chapter-9.
- Impact on air quality is likely to be temporary and reversible.

3) Operation Phase

- Air quality of the area is likely to be improved as reduction in emissions due to shifting of freight from road transportation to railway transportation.
- Plantation along the DFC is likely to improve the air quality of the area.

8.1.5. Mitigation Measures on Water Quality

Due to the proposed project there will be some direct and indirect long term impacts on the water resources. Table below presents the major adverse impacts on the water resources and the mitigation measures taken.

Table- 8.2

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1	Loss of water bodies	Not significant as no major water bodies is fully affected	• Part or acquisition of source of water	• Land acquisition to be minimized with provision of retaining walls • Relocation of ground / surface water sources
2	Alternation of cross drainage	Very low impact	• One major bridge over existing causeway • Widening of minor bridges and culverts	• Construction of new bridges and bridging of existing causeways, there will be an improvement in the drainage characteristics of the project area
3	Runoff and drainage	Direct impact	• Siltation of water bodies • Reduction in ground recharge • Increased drainage discharge	• Silt fencing to be provided • Recharge well to be provided to compensate the loss of previous surface • Continuous drain is provided, unlined in rural area and lined in urban areas.
4	Water requirement for project	Direct impact	• Water requirement for construction activity. • Water requirement of	• Contractor needs to obtain approvals for taking adequate quantities of water from surface and ground water sources. This

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
			labour	is required to avoid depletion of water resources.
5	Water Quality			
a	Increased sedimentation	Direct impact	• Increased sediment laden run-off alter the nature & capacity of the watercourse	• Guidelines for sediment control to be enforced
b	Contamination of water	Direct adverse impact	• Scarified bitumen wastes • Oil & diesel spills • Emulsion sprayer and laying of hot mix • Production of hot mix and rejected materials • Residential facilities for the labour and officers • Routine and periodical maintenance	• Hazardous Wastes (Management & Handling) Rules, 1989 to be enforced • Oil interceptor will be provided for accidental spill of oil and diesel • Rejected material will be layed in village roads or as directed by engineer • Septic tank will be construction for waste disposal
6	Water quality monitoring		• Effectiveness / shortfall (if any) • Any unforeseen impact	• Measures will be received & improved to mitigate / enhance environment due to any unforeseen impact

8.1.6. Water Quality

a. Contamination of water

- Oil interceptor will be provided at plant site and material trucks lay byes.
- Construction work close to the streams or water bodies will be avoided during monsoon.
- The discharge standards promulgated under the Environmental Protection Act, 1986 will be strictly adhered to. All wastes arising from the project will be disposed off in a manner that is acceptable to the State Pollution Control Board (SPCB).
- All relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996 will be adhered to.
- Construction labourers' camps will be located at least 1000m away from the nearest habitation.
- Unless otherwise authorised by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the workplace suitably approved by the local medical health or municipal authorities will be made.
- All approach roads to rivers and other surface water bodies need to be closed permanently to avoid vehicle washing and to avoid major pollution sources. This applicable to all areas including the secondary construction sites.
- Automotive service centres will be discouraged from establishing along the corridors without installing preventive measures against petroleum and oil contamination.
- Water quality shall be monitored regularly near the construction site.

8.1.7. Noise Environment – Mitigation Measures

Environmental noise particularly railway noise, is a complex phenomenon because its intensity and characteristics vary with time depending upon the frequency and speed of the trains.

Table- 8.3

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1	Sensitive receptors	Direct impact	• Increase in noise pollution	• Noise barrier to be provided
2	Noise pollution(preconstruction)	Direct impact,short duration	• Man, material and machinery movements • Establishment of labor camps onsite offices, stock yards and construction plants	• Area specific and for short duration • Machinery to be checked & complied with noise pollution regulations. • Camps to be setup away from the settlements, in the down wind direction.
3	Noise Pollution(Construction Stage)	Marginal impact	• stone crushing, asphalt production plant and batching plants, diesel generators etc • Community residing near to the work zones • Temporary as the work zones will be changing with completion of construction	• Camps to be setup away from the settlements, in the down wind direction. • Noise pollution regulation to be monitored and enforced.
4	Noise Pollution (Operation Stage)	Marginal impact	• due to increase in traffic (due to improved facility	• will be compensated with the uninterrupted movement of heavy and light vehicles till the facility reaches the level of service C.
5	Noise Pollution Monitoring		Effectiveness / shortfall (if any) Any unforeseen impact	• Measures will be revised & improved to mitigate/ enhance environment due to any unforeseen impact.

8.1.8. Sensitive Receptors – Mitigation Measures

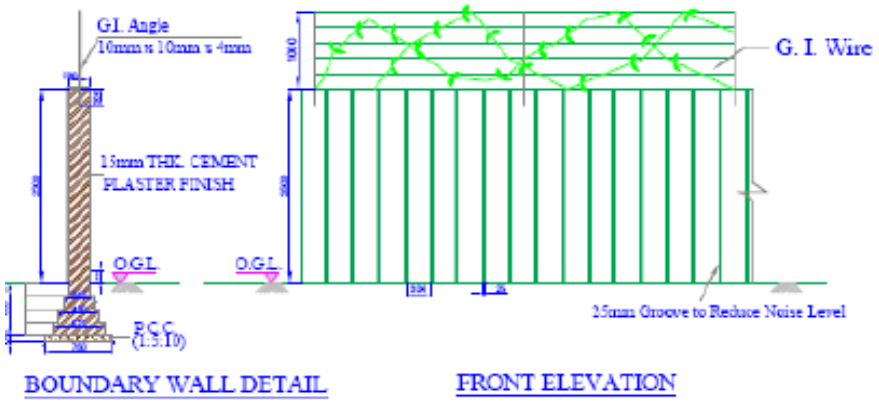
List of sensitive receptors along the proposed DFC Corridor and proposed mitigation/ enhancement measures is presented below:

Table- 8.4

S.N	Type of Receptors	Location	Chainage	Predicted Vibration Level with DFC L'max dB(A)	Mitigation/ Enhancement
1	Saraswati Gyanvarti School	Near Nagal Station	203.1	78	Vibration control measures to be considered during design & construction stage
2	Temple	Mustafabad	269.2	79	-do-
3	Temple	Near Markanda River	286.5	78	-do-
4	Mosque	Between Sambhu and Rajpura station	317.4	74	-do-
5	Gurdwara	Between Chawa Pail & Khanna	377.4	79	-do-
6	High School	Between Chawa Pail & Khanna	383	83	-do-
7	Temple	Between Doraha & Chawa Pail	389.1	69	-do-
8	Primary School	Between Doraha & Chawa Pail	391.5	78	-do-
9	Modern Sr. Sec. School	Doraha	393.4	79	-do-

S.N	Type of Receptors	Location	Chainage	Predicted Vibration Level with DFC L'max dB(A)	Mitigation/ Enhancement
10	Temple	Doraha	394	79	-do-
11	Gurdwara	Doraha	394	79	-do-

Figure: 8.1: Typical Design of Noise Barrier



8.1.9. Mitigation Measures for Noise during Construction Phases

- Noise standards will be strictly enforced for all vehicles, plants, equipment, and construction machinery. All construction equipment used for an 8-hour shift will conform to a standard of less than 90dB(A). If required, high noise producing generators such as concrete mixers, generators, graders, etc. must be provided with noise shields.
- Machinery and vehicles will be maintained regularly, with particular attention to silencers and mufflers, to keep construction noise levels to minimum.
- Workers in the vicinity of high noise levels will be provided earplugs/ earmuff, helmets and will be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90dB(A) per 8 hour shift.
- During construction vibratory compactors will be used sparingly within the urban areas. In case of complaints from roadside residents, the engineer will ask the site engineer to take suitable steps of restricting the work hours even further or use an alternative roller.
- Proposed tree and shrub plantations planned for avenue plantation especially close to settlements, may form an effective sound buffer during the operation stage.
- People will be convinced / educated to prevent sensitive land uses from developing up adjacent to the project corridors.

Chapter 9. Public Consultation & Disclosures

9.1. Introduction

The Public Consultation meetings for the Pilkhani to Sahnewal Section of Eastern Dedicated Freight Corridor were conducted in the affected villages from June 2009 to February 2010 by the previous Consultants. In addition to these consultations, the present consultants 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.

9.2. 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

9.3. Methodology of Organising Public Consultations Meetings

These meetings were organized at village level through DFCC project offices at 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.

9.4. 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.

9.4.1. 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 safeguard policy in the years 2009 and 2010. After appointment 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.

9.5. 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-9.1-9.3.**

Table 9.1 : 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 Ludhiana and Delhi	Dedicated Freight Corridor Corporation of India Ltd	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 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 Ludhiana, Yamuna Nagar	Mr. V.Chauhan (D.F.O. Ludhiana), Deputy Superintendent, Mrs. Saroj Bala Forest Department Yamuna Nagar)	• 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

Date and Venue	Institution	Participants	Issues Discussed	Outcome
				pass through PF. 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. 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 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

Table 9.2 : Village Level Consultations and Concerned Raised (2009-2010)

Date	Location	Participants	Issues	Outcomes
12-09-2009	Near Khanna Station and nearby areas	Kulvindar Singh,Ramsarup, Raghuveer Singh, Rajesh Kumar, Pitam Singh,Panjab	• Problem of access through the existing level crossing. • Problem of traffic	Since the proposed track is parallel to the existing one, at most of the locations, the residents staying close to

Date	Location	Participants	Issues	Outcomes
	along the track	Singh, Avatar Singh, Om Prakash Verma Hansraj, Rajesh Kumar, 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	congestion. • No sewerage facility. • Since the habitation is very close to the track, accidents are frequent. • Problem of noise and vibration that affects studies of children.	it were concerned about safety of their 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 nearby 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 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	• Problem of access through the existing level crossing. • Problem of traffic congestion. • No sewerage facility. • Since the habitation is very close to the track, accidents are frequent. • Problem of noise and vibration, which affects studies of children.	• Welcomed the project but want these issues to be addressed before planning its construction. • 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 children.
22-12-2009	Yamuna Nagar and nearby	D.B. Batra, Satish Kumar, A.N.Singh, Jaipal	Environmental problem due to nearby industries	People were highly concerned about existing environmental problems due to

Date	Location	Participants	Issues	Outcomes
	area along the track		Impact on living standards	heavy industries. People were hopeful that the proposed project of DFC would decrease the vehicular pollution due to road traffic. People are also expecting increasing employment opportunity of the local people.

Table 9.3 : 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 people	All the NGOS' consulted had welcomed the project and views given by a prominent local NGO (Janhit Foundations) revealed that the proposed project is long due and would not have any 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.
30-01-2010	Target Invention	Mr. Jasbir Singh, (Project Coordinator) Mrs. Suman Sharma (Project Manager)		
12-02-2010	Bharat Jan Gyan Vigyan Jatha	Dr. Arun Mitra (Director)		

9.5.1. Consultations During December 2011 and January 2012

The summary of consultations carried out during December 2011 and January 2012 is given below in **Table-9.4**.

Table 9.4 : 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 especially near habitations.	• Provision of job has not been decided upon yet. • Compensation at replacement value under revised EM. • Since Land Acquisition for DFC project is a linear acquisition. No surplus land is 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 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	• Lost pipeline will be replaced, • Width of Land is reduced to 17 meters at many locations to minimize the impact, • 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.

9.5.2. 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.

9.5.3. 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, hand pumps, mosque, etc. The water stagnation and wastewater problems will be solved through provision of drains and channelizing the water. The wastewater treatment issue will be taken up in consultation with local civic authorities.

9.5.4. Government Regulators' Comments and Consideration in Project Design

Discussions with concerned forest officials, including Divisional Forest Officer of Ludhiana, Divisional Forest Officer of Yamuna Nagar 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 Saharanpur, Yamuna Nagar. The construction camps will not be established in these areas.

9.5.5. 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 them 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.

9.6. 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 with NGO at Khanna

Consultation with inhabitants near MandiGobindgarh Railway Station

Consultation near Sahnewal Station with Passengers

Consultation with inhabitants near Khanna

Consultation with inhabitants near Chandsara Halt

Consultation with Pollution Board Official at YamunaNagar

Consultation with villagers at Barara in Saharanpur district on 16-01-2012

Chapter 10. Environmental Management Plan

10.1. Introduction

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 cannot 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.

10.2. 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

10.3. 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.

10.3.1. 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 planned in consultation with the PAFs and local authorities 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 175 ha of protected forestland 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 175 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, pipelines etc that 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 / labour 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 least 15 m away from the toilets or drains.
- Adequate and clean washing and bathing facilities must be provided. The camp will also have adequate drainage facilities.
- Adequate sanitary facilities will be provided within every camp. The place will be cleaned daily and maintain strict sanitary conditions. Separate toilets 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 checkups 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

No borrow pit can be opened by the contractor without prior Environmental Clearance from State Environment Impact Assessment Authority. 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 may 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 Environment Impact Assessment Authority.
- 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 shall be reclaimed to the satisfaction of the landowner and use may be as per local requirement. Public lands may be developed as parks 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 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 *Reduction Strategy*

Silicosis reduction strategy shall be adopted during construction. Details are given at **Annexure 10.1**.

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:

1. Mitigation of air pollution problems
2. Attenuation of noise level
3. 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-10.2** below:

Table 10.1 : 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
1	**Shrubs & Grasses**	Akand
2	*Calotropis gigantea*	Harsighar
3	*Nyctanthus arboriristis*	Kaner
	Nerium indicum	

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).

10.3.2. 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.

10.4. Environmental Management Plan & Responsibilities

Table 10.2 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.

The mitigation measures during the operation phase will be implemented by Social and Environmental Management Unit (SEMU) of DFCCIL. The SEMU is headed by General Manager. Overall responsibility of the implementation of mitigation measures during construction stage will be with the Contractor and with the DFFCIL –SEMU unit during operation phase. The details of Environmental Management Programme are discussed in the subsequent paragraphs.

Table 10.2 : Environmental Management Plan

S. No.	Environmental Issue	Action to be Taken	Implementation By	Supervision By
Pre-construction phase				
1.	Permission for Removal of Trees	28617 Trees are likely to be felled in the existing and acquired area for the proposed corridor The forestland in 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 built in project cost.	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	DFCCIL	State Revenue Dept / DFCCIL-SEMU

S. No.	Environmental Issue	Action to be Taken	Implementation By	Supervision By
		prepared for the PAPS and provide compensation in compliance with National Resettlement and Rehabilitation (R&R) policy Information dissemination and community consultation		
3.	Relocation of Cultural and Religious Properties	34 CPRs shall be shifted only after public consensus. Relocation shall be completed before construction work is taken up.	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 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 stored separately in bunded areas and utilized during plantation or refilling of excavated area.	Construction Contractor	DFCCIL through Engineer
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	-do-
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. Compensatory planting as per statute for other than forest area needs to be done. Trees falling outside the RoW should not be felled. Compensation must be provided	Construction Contractor	-do-

S. No.	Environmental Issue	Action to be Taken	Implementation By	Supervision By
		before initiating construction activity. Fruit bearing trees may be compensated including 5 years fruit yield. 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 aesthetic and ecological value. Social forestry may be practiced for success of the plantation. Local people can be involved in plantation and maintenance of plantation as part of the project in 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. It may be ensured by the Contractor that no hunting or fishing is practiced at the site by any of the 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.	Construction Contractor	-do-
5.	Archaeological structure/ article	There is no archaeological structure affected, directly or indirectly, on the alignment. However, such structures/ articles found i.e., 'chance find' if any, during construction stage along the alignment, shall be dealt with as per the Act and procedure detailed in Environmental Management Framework.	Arch.Dept./ Construction Contractor /DFCCIL	-do-

S. No.	Environmental Issue	Action to be Taken	Implementation By	Supervision By
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 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 to minimize generation of dust. All crusher used in construction should conform to relative dust emission devises Air quality monitoring maybe conducted at construction sites as per monitoring plan.	Construction Contractor	-do-
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	-do-
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	-do-
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	Construction Contractor	-do-

S. No.	Environmental Issue	Action to be Taken	Implementation By	Supervision By
		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 framed for camp areas. Dustbins may be provided in the Camps. The Contractor must provide proper sanitation facilities in Camp.		
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/ relocation shall be provided at 13 noise sensitive locations mentioned at Table 7.4. This is because noise levels are exceeding the limits at these noise sensitive receptors. Plantation may be carried at the work site. Headphones, ear-plugs 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	-do-
6.	Land Subsidence	Plantation must be carried to control erosion	Construction Contractor	-do-
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	-do-
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-7.4.	DFCCIL	SPCB / DFCCIL

10.5. Environmental Monitoring

The environmental monitoring shall be undertaken during construction and operation phases as per the details in **Table 10.3**. The purpose of environmental monitoring is to check the efficacy of mitigation measures.

10.6. 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 in **Table 10.4**.

Table 10.3 : Proposed Monitoring Programme

Construction 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 (6) proposed at Sahnewal, Rajpura, Khanna, Yamuna Nagar, Kalanaur, Asian Group of colleges (km 220+570)	3 times in a year (once in every season except monsoon) during construction period	Construction contractor	DFCCIL through Engineer
2	Water Quality	As per IS:10500 standards	CPCB standards	Surface water sources- western *Yamuna* Canal, *Yamuna* River Ground water-Saharanpur, Sarsawa, Jagadhari, Barara, Shambhu, Ambala, Rajpura, Sirhind and Doraha	Once in a season During construction period (Excluding Monsoon Season)	-do-	-do-
3	Noise	Noise level on dB (A) scale	CPCB standards	At construction camps (60) and at noise sensitive receptors (13).	3 times in a year (once in every non monsoon season during construction period)	-do-	-do-
4	Soil Quality	Parameters are NPK, Sodium Absorption Ratio, Oil & Grease	CPCB Standards	Locations where baseline monitoring done i.e. Kalanaur, Jagadhari, Ambala cant, Sirhind Detour, Doraha	Once in a year during construction period	-do-	-do-
5	Vibration Measurements	Vibration Levels in dB(A)	70 dB(A)	Locations of sensitive receptors (13)	Once in year during construction phase	-do-	-do-

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 220+570),	3 times in a year (once in every season except monsoon) for 3 years	Office of CPM Ambala through Accreditted Laboratory	SEMU
2	Noise	Noise level on dB(A) scale	CPCB standards	At SRs (13 locations)	3 times in a year (once in every non monsoon season) for 3 years	Office of CPM at Ambala through Accreditted Laboratory	SEMU
3	Vibration level	Vibration on dB scale respectively	70 dBA	Locations of sensitive receptors (13)	Once a year for 3 years	Office of CPM at Ambala 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	Annually for 3 years	Respective offices of CPMs at Ambala	SEMU
5	Water Quality	As per IS:10500 standards	CPCB standards	Surface water sources- Western Yamuna Canal, Yamuna River Ground water- Saharanpur, Sarsawa, Jagadhari, Barara, Shambhu, Ambala, Rajpura, Sirhind and Doraha	Once in a season for 3 years (Excluding Monsoon Season)	Office of CPMat Ambala through Accreditted Laboratory	SEMU
6	Soil Quality	Parameters are NPK, Sodium Absorption Ratio, Oil & Grease	CPCB Standards	Locations where baseline monitoring done i.e. Kalanaur, Jagadhari, Ambala cant, Sirhind Detour, Doraha	Once in a year for first 3 years	Office of CPM at Ambala through Accreditted Laboratory	SEMU

Table 10.4 : 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 Manager at Ambala (DFCC)	• Overall responsible for EMP implementation • Coordination with PIU Staff . • Assisting GM (SEMU) to reporting various stakeholders (World Bank, Regulatory bodies) on status of EMP implementation • 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..
Dy.CPM	• Assisting CPM in overall implementation of EMP • Review of periodic reports on EMP implementation and advising CPM in taking corrective measure. • Preparing environmental training program and conducting the same for field officers and engineers of contractor. • Conducting need-based site inspection and preparing compliance reports and forwarding the same to the Environmental Management Unit (DFCCIL)
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.
Asst. Project Manager (Env)-designated	• Working as site-representative of APM(Env) • 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 CPM
Environment & Safety Manager of Contractor	• As detailed below

For ensuring that EMP is implemented as per provision in the document, Contractor shall nominate along with all necessary staff a qualified and experienced Manager 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 EMF/EMP 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:

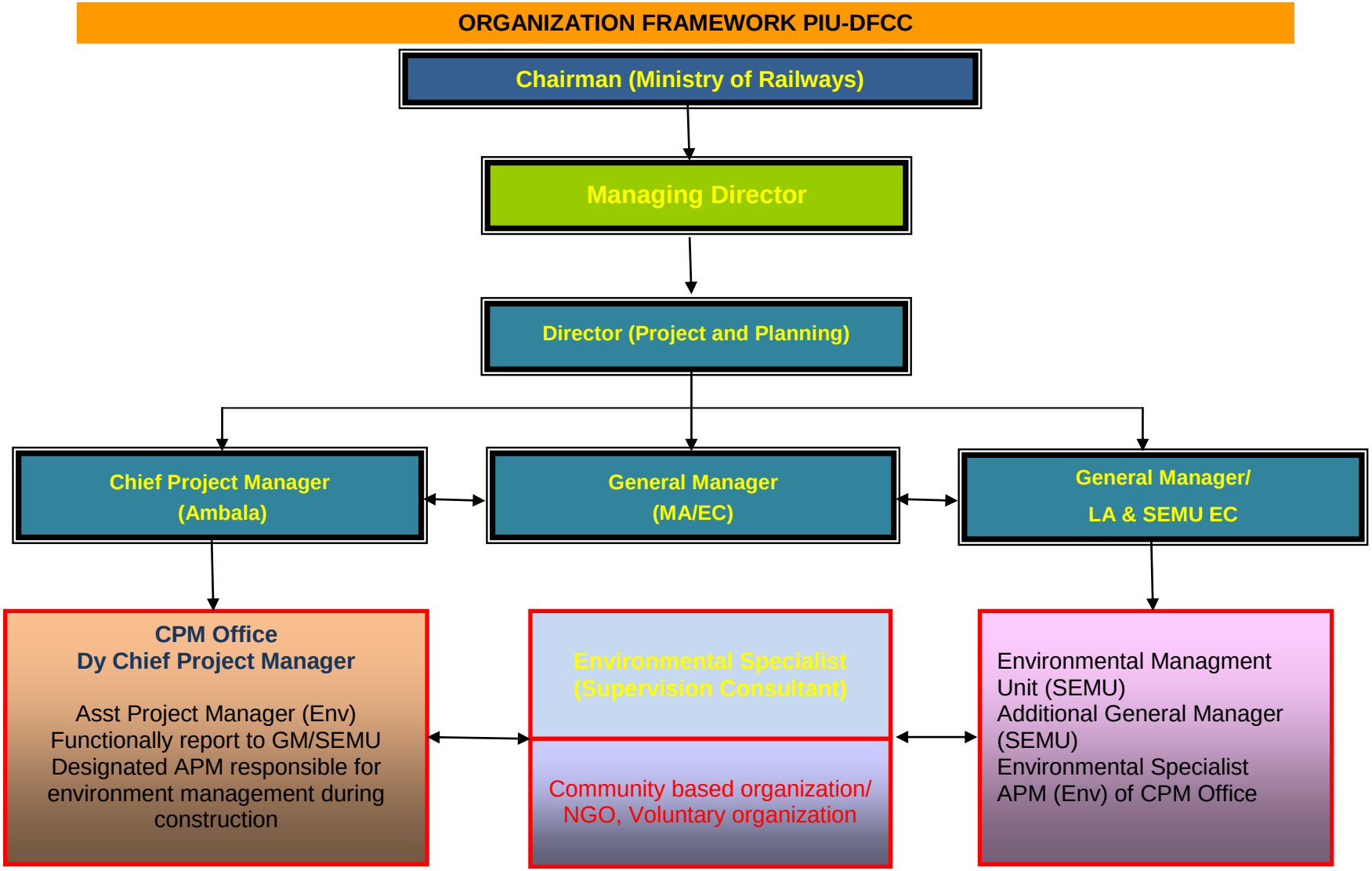

ORGANIZATION FRAMEWORK PIU-DFCC
Chairman (Ministry of Railways)
Managing Director
Director (Project and Planning)
Chief Project Manager (Ambala)
General Manager (MA/EC)
General Manager/ LA & SEMU EC
CPM Office
Dy Chief Project Manager
Asst Project Manager (Env)
Functionally report to GM/SEMU
Designated APM responsible for environment management during construction
Environmental Specialist (Supervision Consultant)
Community based organization/ NGO, Voluntary organization
Environmental Managment Unit (SEMU)
Additional General Manager (SEMU)
Environmental Specialist
APM (Env) of CPM Office

Fig- 10.1

10.7. 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 10.5**

Table 10.5 : 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	100	28617	28,61,700	Covered under regulatory clearances
2.	Forest Clearance and land diversion cost	ha	500000	175	8,75,00,000	Covered under forest clearances
3.	Acquisition of land required for acquisition	Ha	-	355.34	900,00,00,000	Covered under project cost
4.	Utility Shifting	-	-	LS	5,00,00,000	Covered under regulatory clearances, engineering cost
Sub-total for A					**914,03,61,700**	
1.	**Mitigation Measures other than Good Engineering practices**					
1.1	Oil interceptors at camps (Minimum 5 camps, per camp 2 oil interceptors at vehicle parking and washing areas)	Number	20,000	10	2,00,000	Will be provided near storage, vehicle repair section in construction camp
1.2	Soak pits for construction camp @ 2 soak pits at each camp	Number	20,000	10	2,00,000	
	Sub-total				***4,00,000***	
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 either side) and compensatory plantation of 80,000	Number	1,000	1750 (Avenue Plantation)+ 80,000 (Compensatory Plantation)=81750	8,17,50,000	

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
	trees for 28617 trees to be cut					
2.1.2	Half brick circular tree guard	Number	1750	21161	3,70,31,750	
	Sub-total				***11,87,81,750***	
3.	**Monitoring of Environmental Attributes during Construction Phase**					
3.1	Monitoring of Air Quality	Per sample	10,000	140	14,00,000	
3.2	Monitoring of Water Quality	Per sample	6,000	140	8,40,000	
3.3	Monitoring of Noise Level	Per sample	3,000	60	1,80,000	
3.4	Monitoring of Soil Quality	Per sample	6,000	30	1,80,000	
3.5	Vibrations	Per Sample	30,000	20	6,00,000	
	Sub-total				***32,00,000***	
Sub-total for B					**12,23,81,750**	
C. ITEMS COVERED UNDER THE RAP BUDGET						
1.	Relocation of private properties			LS	80,00,000	Covered under RAP Budget
2.	Relocation of private water points (wells, tanks, water taps and hand pumps)			LS	35,00,000	
3.	Relocation of graveyards, statues, motor sheds			LS	75,00,000	
4.	Relocation of other community assets including temples, major, mosque, school etc.			LS	90,00,000	
Sub-total for C					**2,80,00,000**	
D. OPERATION PHASE						

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
1.	Monitoring of Noise Level	Per sample	5,000	40	2,00,000	Initial Three years Monitoring
2.	Monitoring of vibration Level	Per sample	30,000	10	3,00,000	Initial 3 years Monitoring
3	Monitoring Water Quality	Per Sample	8000	80	6,40,000	
4	Monitoring of Air quality	Per sample	12000	20	2,40,000	
5	Monitoring of Soil Quality	Per Sample	8000	20	1,60,000	
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 12 Receptors) and one relocation.	m relocation	10,000 10,00,000	1200 1	22,00,000	Initial 3 Years maintenance
Sub-total for D					**37,40,000**	
E. GOOD ENGINEERING PRACTICES						
1.	Dust suppression			LS	14,60,000	Covered under contractors quoted rate under construction cost
2.	Erosion control measures (Turfing / Pitching / Seeding & Mulching)			LS	15,00,000	
3.	Provision of cross drainage & side drainage structures			LS	15,50,000	
4.	General borrow area management and maintenance of haul road related to borrow areas			LS	58,00,000	

Sl. No.	Item	Unit	Rate (in INR)	Quantity	Cost (in INR)	Remarks
5.	Air / noise pollution control measures in construction equipments			LS	85,000	
6.	Management and disposal of scarified waste bituminous material			LS	80,000	
7.	Provision of informatory signs			LS	5,50,000	
8.	Cattle crossings			LS	7,20,000	
9.	Management of quarries			LS	2,00,00,000	
10.	Redevelopment of borrow area			LS	15,00,000	
11.	Construction camp management cost			LS	65,00,000	
12.	Safety measures for workers			LS	10,00,000	
Sub-total for E					**4,07,45,000**	
F. TRAINING & MANPOWER						
1.	Training	Number	5,00,000	4	20,00,000	Twice in a year during construction period
2.	Provision of environmental expert	Number	1,00,000	12	12,00,000	
Sub-total for F					**32,00,000**	
G. Total EMP Budget					**INR 933,84,28,450, Say, Rupees 9338 Million**	

Annexure- 10.1

Specification Addendum

Silica Exposure Reduction Strategies for Dedicated Freight Corridor – EDFC Project

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 litres 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 sulphate 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 bare soil surfaces with vegetation or pavement to reduce exposure to residual silica dust.