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# Draft (Final) Environmental Assessment Report

**for**

# PILKHANI- SAHNEWAL SECTION

**of**

**Eastern Dedicated Freight Corridor**

## Dedicated Freight Corridor Corporation of India Ltd.

**May, 2015**

**Prepared By**

**Engineering and Technological Services, Delhi**

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## Abbreviations

| | |
|---|---|
| ACF | Assistant Conservator of Forest |
| ADB | Asian Development Bank |
| AIDS | Acquired Immune Deficiency Syndrome |
| BOXN | Air braked box wagons |
| Ch | Chainage |
| CPCB | Central Pollution Control Board |
| CPM | Chief Project manager |
| CPR | Community Property Resources |
| 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 |
| FFP | Food, Feed and Product |
| GDP | Gross Domestic Product |
| 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 |
| 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) |
| kV | Kilo Volt |
| LC | Level Crossing |
| LTL | Low Tension Line |
| 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 |
| 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 |
| PPE | Personal Protective Equipment |
| PPTA | Project Preparation Technical Assistance |
| PUC | Pollution Under Control Certificate |
| 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 |
| SPCB | State Pollution Control Board |
| SPM | Suspended particulate Matter |
| SPV | Special Purpose Vehicle |
| T & C | Transport and Communication |
| TVU | Traffic Vehicle Units |
| VOC | Volatile Organic Compound |

# Executive Summary

## 1. Introduction

Ministry of Railways established "Dedicated Freight Corridor Corporation of India Limited (DFCCIL)" as a Special Purpose Vehicle (SPV) for construction, operation and maintenance of the dedicated freight corridors. DFCCIL 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 Delhi-Howrah routes 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 of the DFC is identified as the Eastern Corridor with a total length of 1839 km, while the section from Jawaharlal Nehru Port Trust (JNPT) to Dadri via Vadodara- Ahmadabad - Palanpur-Phulera - Rewari is identified as the Western Corridor having total length of 1483 km.

Present EA study pertains to development of single-track **Pilkhani to Sahnewal** (Ludhiana) section of the Eastern Dedicated Freight Corridor (EDFC) covering about **175 km** in length.

## 2. Objective of the Assignment

The prime objective of the Environment Assessment (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 Pilkhani-Sahnewal section based on Environmental Management Framework (EMF) of DFCCIL for EDFC prepared earlier shall prevail. EMF is available on DFCCIL website.

## 4. Project Description

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

The DFC rail lines have been generally 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 projects to seek for Environmental Clearance from the Ministry of Environment and Forests (MoEF) under the Notification of 14.9.2006 of the Environment (Protection) Act, 1986 and thus mandate undertaking of an Environmental Impact Assessment (EIA) study for undertaking the project. However, considering the magnitude of activity that is envisaged as part of EDFC, DFCCIL has undertaken the present 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 Pilkhani-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 Pilkhani-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. Gol; 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 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 Indian Forest Act, 1927<br>The Forest (Conservation) Act, 1980<br>The Forest (Conservation) Rules, 1981 | To check tree felling 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 and railside 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.<br>No ASI monument is located within 300m from proposed DFC track on either side.<br>But 'chance find', if any, shall be governed by the Act & to be surrendered to 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 CCoE | Chief Controller of Explosives (CCoE) |
| 12 | Minor Mineral and Concession Rules, The Mining Act | For opening new borrow pits & quarry. | Quarry Licenses shall be obtained by Contractors. | District Collector/Mining authority of the area |
| 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 of the state |
| 14 | The Mining Act | For safe & sound mining activity | Quarry licence to be obtained by the Contractor | State Govt. Dept. Of Mines |
| 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 |
| 17 | The Petroleum (Amendment) Rules, 2011 | Use and storage of petroleum products | Applicable | CCOE /District Collector of the area |
| 18 | Municipal Solid Wastes (Management and Handling) Rules, 2000. Municipal Solid Wastes (Management and Handling) Rules, 2000. | Management & disposal of Construction & Demolition debris | Applicable | SPCB |

Besides the above, any other Act or Rule of Govt. of India or State Govt. directly relevant to the project shall be followed during implementation.

**5.2** *The World Bank Operational Policies*

The project is proposed to be funded by the World Bank. This will require project to comply with World Bank Operational Policies. The operational policies of the Bank that are triggered 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 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 | EA and EMP prepared |

| Sl. No. | Safeguard Policy | Subject Category | Triggered | Triggered By | Mitigation Measures | Documentation |
|---|---|---|---|---|---|---|
| 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 | As applicable under the Act. |
| 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 adequately covered in Contract document & reference document of SHE manual. |

Physical work proposed under this project is expected to cause significant Environmental & Social impacts involving large scale land acquisition (325 Ha.), significant earth work ((7.3 million $m^3$) & construction materials (0.1 $m^3$ ballast) and expected to have impact on environment (felling of 42400 trees & diversion of 175 Ha. Protective Forest land), relocation of 8 CPRs as well as construction work on 175 km linear work front involving construction equipment etc. Therefore, the Project is considered as Category **'A'** as per the World Bank safeguard policy. This will help in making the construction stage more environment compliant and also setting up a system for better and more environment friendly construction in the project area. DFCCIL is committed to establish the most efficient and eco-friendly systems.

## 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. Based on the guidelines of Ministry of Environment, Forest and Climate Change ( MoEF&CC), Government of India for the environmental impact assessment of road/rail projects the impact study 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 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.

The primary data was 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 area 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. |

| S. No. | Components | Environmental Features | Remarks |
|---|---|---|---|
| | Tree cover | Poplar, Eucalyptus, Mango, Neem and Shisam are the most dominant species observed.<br>Approx. **42400** trees need to be cut. Out of this, 20526 trees are in private land, 21875 trees are under Protective Forest. | All along the alignment |
| 2. | Archaeological Monuments | No ASI monument / structure is affected. | - |
| 3. | National Park, Wildlife Sanctuary, Wetland | None | - |
| 4. | Water Bodies | Surface water quality largely conforms to the CPCB prescribed standards while the groundwater quality conforms to the drinking water standards (BIS: 10500).<br>The alignment passes through over exploited blocks of Jagadhari, Mustafabad, Rajpura, Sirhind and Khanna, critical blocks of Barara and Doraha and semi-critical blocks of Saharanpur district | Crossing Rivers – Yamuna, Markanda, Tangri and Ghaghhar<br><br>Crossing Canals – Western Yamuna Canal, Bhakra Canal |
| 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%). | - |

## 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 consultation meetings (PCM)were organised in 2009-10, 2011-12 and again in 2013. 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
- Land compensation, jobs in lieu of land.

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 (RAP) and Environmental Management Plan. Further, stake-holders' discussions were

conducted in 2013 & 2014 as well. DFC alignment has not undergone any change since 2012 when most of the PCMs were conducted.

## 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 seperately.

The alignment of Pilkhani- Sahnewal section of EDFC has been planned in most portion (162.21 km out of 175 km) on the available Indian Railway land. This has minimised the impacts on agriculture land, local community, trees, natural resources and ecology. The bridges have been planned parallel to existing bridges and in close proximity, which will avoid impacts on aquatic environment of water bodies.

## 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 account of linear plantation on railway land and along highways in UP, Haryana & Punjab; Trees are local species.
b) Cutting of about 42400 trees which include the trees on the forest land and other govt and private lands;
c) Earth work of 7.3 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 barriers with one requiring 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) 8 common property resources (CPR) 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 30,000 trees; compensatory plantation will be carried out as described in the chapter.
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; 13 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.
l) Seismic zone-IV in Punjab will be considered during detailed design as per relevant Railway codes/ standards.
m) Water requirement plan will be drawn by the Contractor for meeting water demand during construction. Effort will be to use surface water to maximum extent and dependence on ground water will be kept minimum keeping in view of scarcity & Authority's decision to allow 25% of the yield for industrial purpose, subject to the permission granted.
n) Resilient fastners or its improved version will be provided for suppression of vibration. This is in practice in Indian Railways already.
o) Tree plantation plan has been drawn in this report.
p) Water requirement management during construction, Construction wastes & debris management plan, Siting management plan of construction camp & facilities and Silicosis exposure reduction plan are annexed as broad guidelines for the contractor to develop own plans & implement during construction.

## 11. Environmental Management Plan

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

i. About 42400 trees along the alignment will be felled. Plantation plan is drawn and would be taken up;
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. Silt fencing at major bridge work to prevent construction debris, mud etc. going into the river to protect movement of fish fauna;
x. Permission will be obtained for tree cutting with suitable compensation;
xi. Crossing passage for wildlife near forest area, ponds will be provided for wildlife in forest area, if required;
xii. Measures to be taken for archaeologically important chance finds, if any, as per ASI Act.
xiii. Estimated cost for Environmental Management is Rs. 9554 million including land acquisition cost**.**
xiv. Silicosis Exposure Reduction Strategy will be adopted during construction;
xv. Waste & debris management guideline has been drawn for the Contractor to adopt & prepare its own plan according to the same;
xvi. Guideline for siting, & cons management & construction camp is prepared for reference to the Contractor during construction..

DFCCIL has a Social and Environmental Management Unit (SEMU) headed by General Manager (SEMU) for EDFC, along with GM/Environment & Consultant (Environment). Implementation of the project & Supervision of Construction activities will be by Chief Project Manager (CPM), supported by Deputy CPM, PM and designated APM/Env. SEMU together with the field unit will ensure implementation of EMP during pre-construction, operation phases and during construction through Contractor.

# 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 rail 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 to obtain financial assistance from the World Bank for the implementation of EDFC. The project area is part of the EDFC and 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. under ageis of Asian Development Bank. The EA findings were reviewed & updated after repeat field survey & PCMs for the 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 requirements of the World Bank safeguard policy. The location of EDFC on 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.

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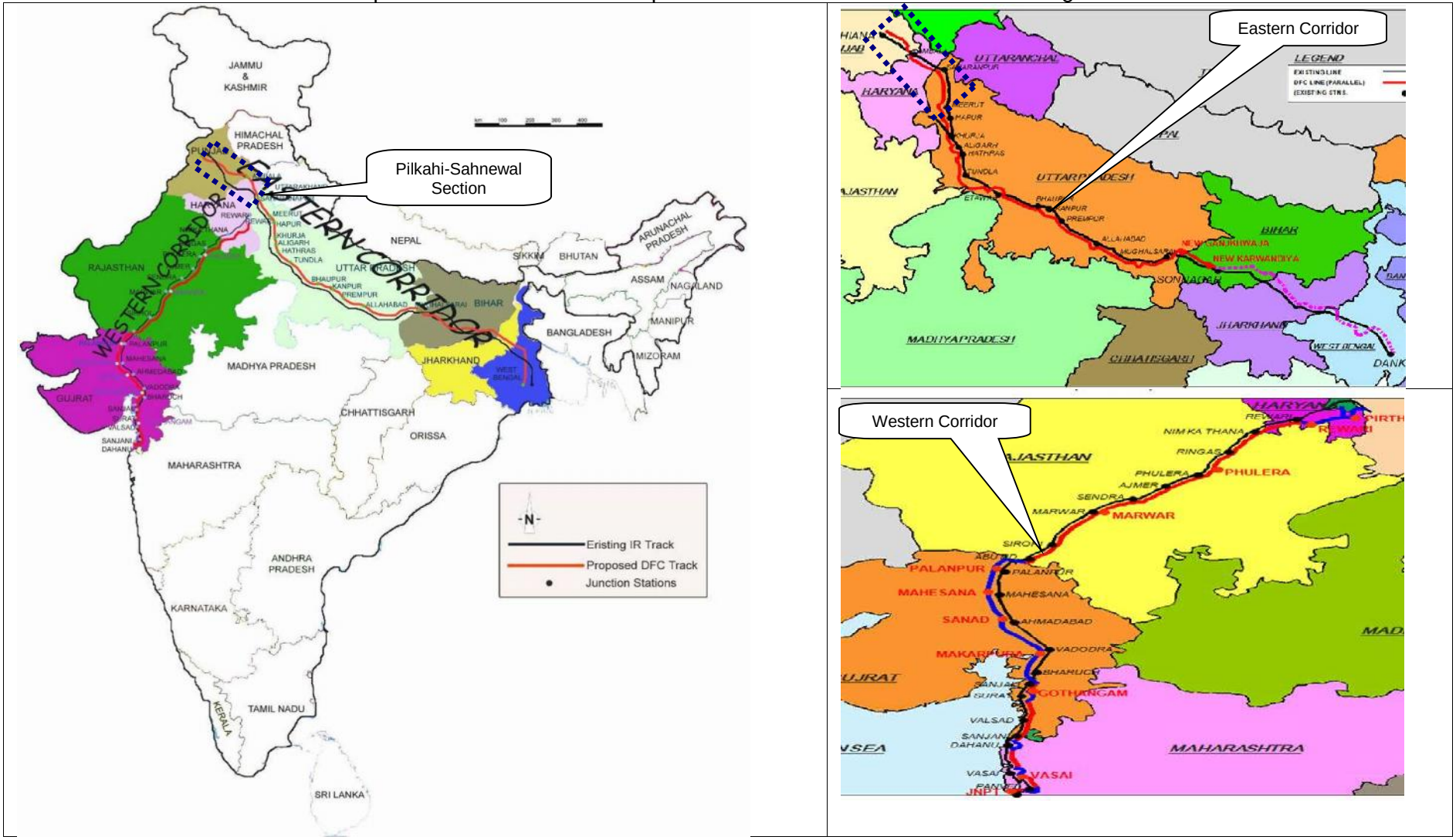
Map 1: Location and Route Map of Eastern and Western Dedicated Freight Corridors



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## 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 study 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 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 based on recent satellite data of the project area were used 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 considerationsto 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 the 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 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, once again in December 2011-January 2012 and 2013. It is noted that the Project alignment has not undergone any change since PCMs held last in 2012. Further, stake-holders' discussions were conducted in 2013 & 2014 as well.

# 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 commences. The Pilkahi-Sahnewal section ends at Sahnewal, as it is not possible to connect it with Ludhiana railway station because of challenges to be faced due to the 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 (188.50Km) to Sahnewal (360.54 Km) | Northern | Ambala, Firozpur | 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 188.50 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 360.54 | Parallel to Existing Track | Left |

The length 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

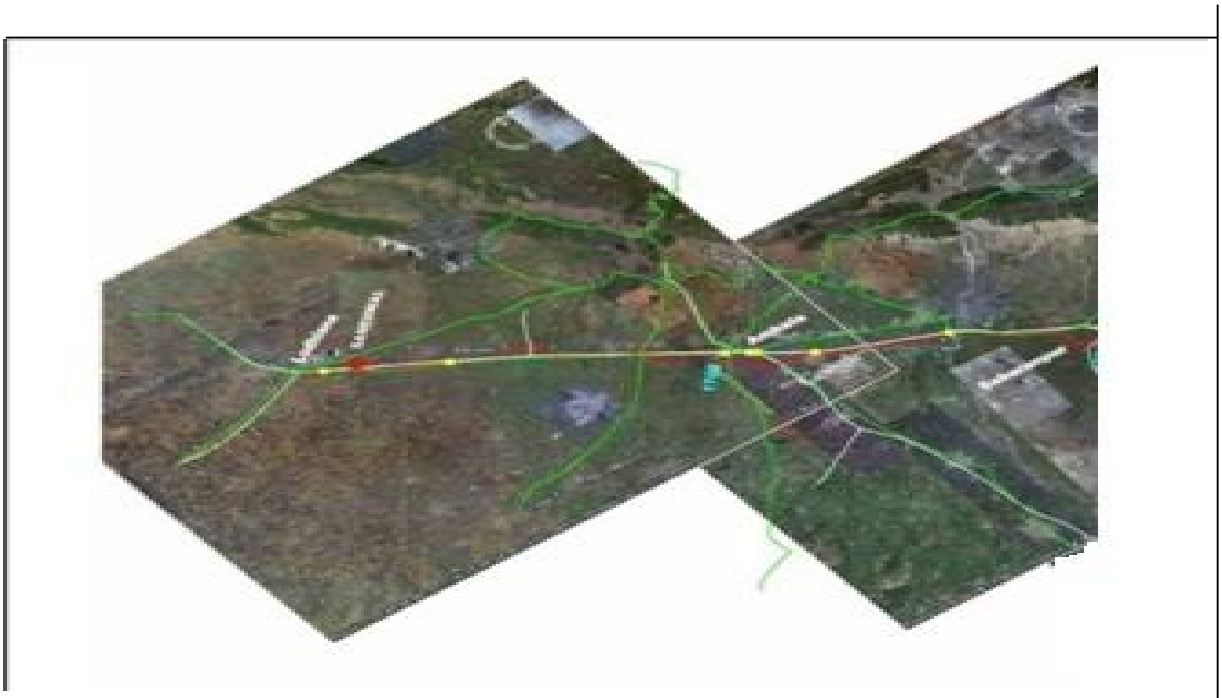


Figure 2.2 **:** Location and Route Map of Pilkhani – Sahnewal DFC


## 2.2. Need of the Project

India's transport sector is large and diverse; it caters to the need of 1.25 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 more 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 (**Table 2.3**). 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 forecast: 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 **Table 2.4**.

**Table 2.4 : Traffic Projection for 22.9 t and 25 t Axle load of 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 (**Table 2.5**). If transport of food grains is taken as an example from the table below, the introduction of 25 tonne axle wagons would optimally require only 55% of the movements with 22.9 tonne axle loading. This makes a considerable difference in the projection of train movements as shown in Table 2.44.

**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 **Table 2.6.**

**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, 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 |
| **Curves** | |
| Maximum degree of curvature | 2.5 degree |

| Description | Details |
|---|---|
| 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 | 3 (Ambala, Rajpura, Sirhind) |
| **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 | 50 Nos. |
| RUB | 27 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.<br>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 **Table 2.7.** 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 |
| 23 | **Sahnewal** | 360.540 |
| 24 | Dahandari Kalan | 368.360 |
| 25 | Ludhiana Jn. | 375.650 |

Source: PPTA Feasibility Study, 2009

**Table 2.8 :** District-wise length of Pilkhani – Sahnewal section

| S. No. | District | State | Length (KM) |
|---|---|---|---|
| 1 | Sahranpur | U.P. | 14.872 |
| 2 | Yamuna nagar | Haryana | 29.280 |
| 3 | Ambala | | 42.439 |

| S. No. | District | State | Length (KM) |
|---|---|---|---|
| 4 | Patiala | Punjab | 27.480 |
| 5 | Fatehgarh Saheb | | 27.100 |
| 6 | Ludhiana | | 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**). Total Ballast requirement is estimated 0.1 Million $m^3$.

### 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 10,45,795$m^3$. The earthwork formation may be independent or integrated with existing IR. The cross section profile of both type of earthwork is shown in **Figure 2.3** 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**: The land acquisition has been planned chainage-wise to fit the cross section. Suitable land will be identified for tree plantation during project implementation. The number of trees to be felled and planned for compensatory afforestation as given below:

Table 2.9 : Trees to be cut and Compensatory Plantation

| **State** | **Trees to be Cut** | | | **Total** | **Compensatory Plantation** | |
|---|---|---|---|---|---|---|
| | Declared Protected Forest | Railway Land | Private Land | | Forest Department | BY DFCC |
| UP | - | 4414 | 4470 | 8884 | 8438<br><br>(Saharanpur District) | 9330<br>(Junction station, Yard and space in RoW and community land in consultation with district authorities & community ) |
| Haryana | 19889 | 8523 | 682 | 29094 | 103540<br><br>(at Muzadwala PF, Sugh PF, Kalanaur RF, Deogarh PF, Dadupur canal side, along Khera railway line, along Chetan drain) | 20600<br><br>(Junction station, Yard and space in RoW and community land in consultation with district authorities & community) |
| Punjab | 1986 | 1763 | 674 | 4423 | 50337<br><br>(at Bir Kheri Gujjaran, Bir Mazal, Bir Sanaur, Bir Miranpur Ghoghpur) | |
| Total | 21875 | 14700 | 5826 | 42401 | | |

**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:

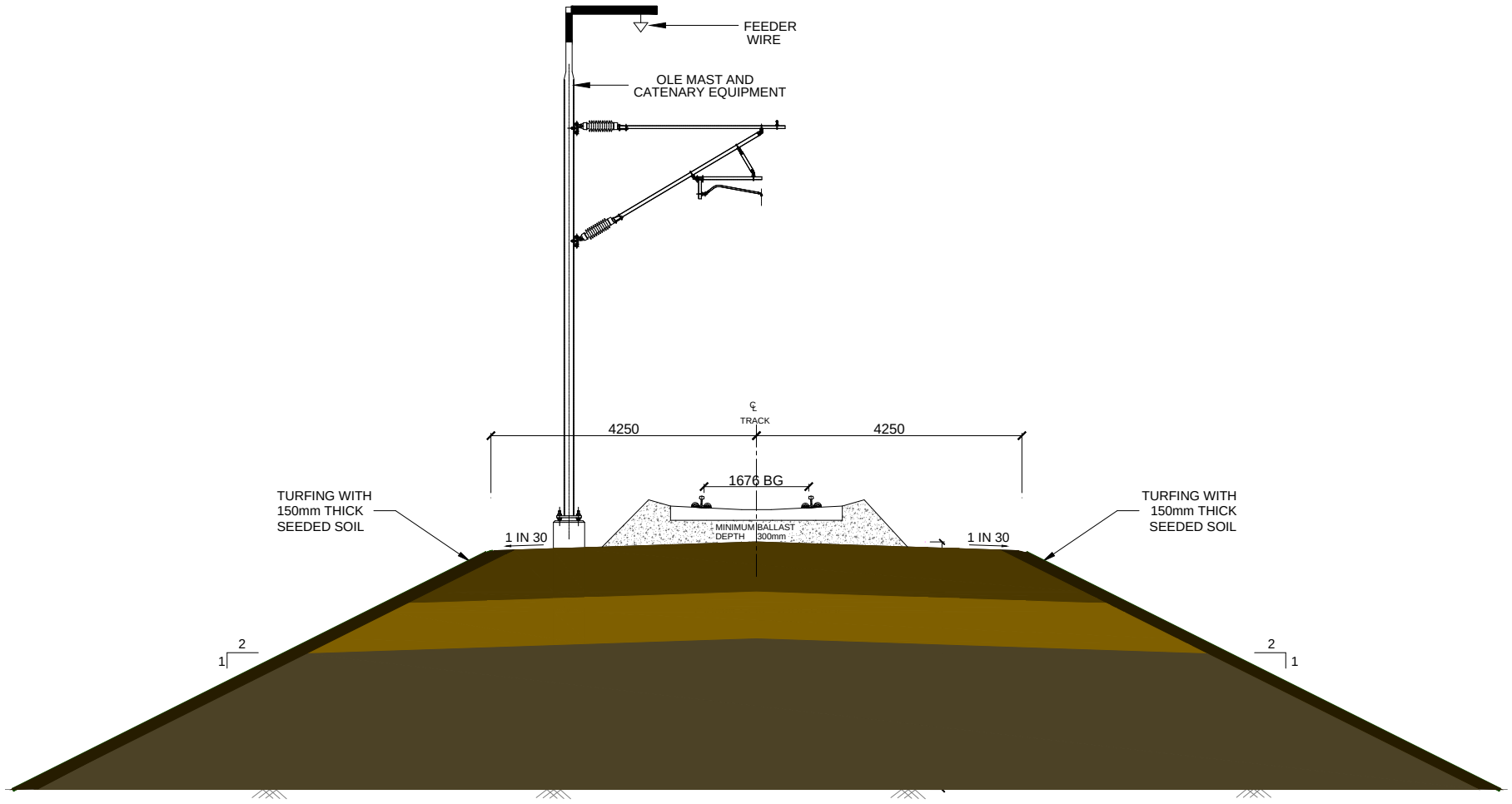
*Khanna station**:*** DFCCIL runs south side of Khanna Station requiring existing goods sidings removal and platform reconstruction.

*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.

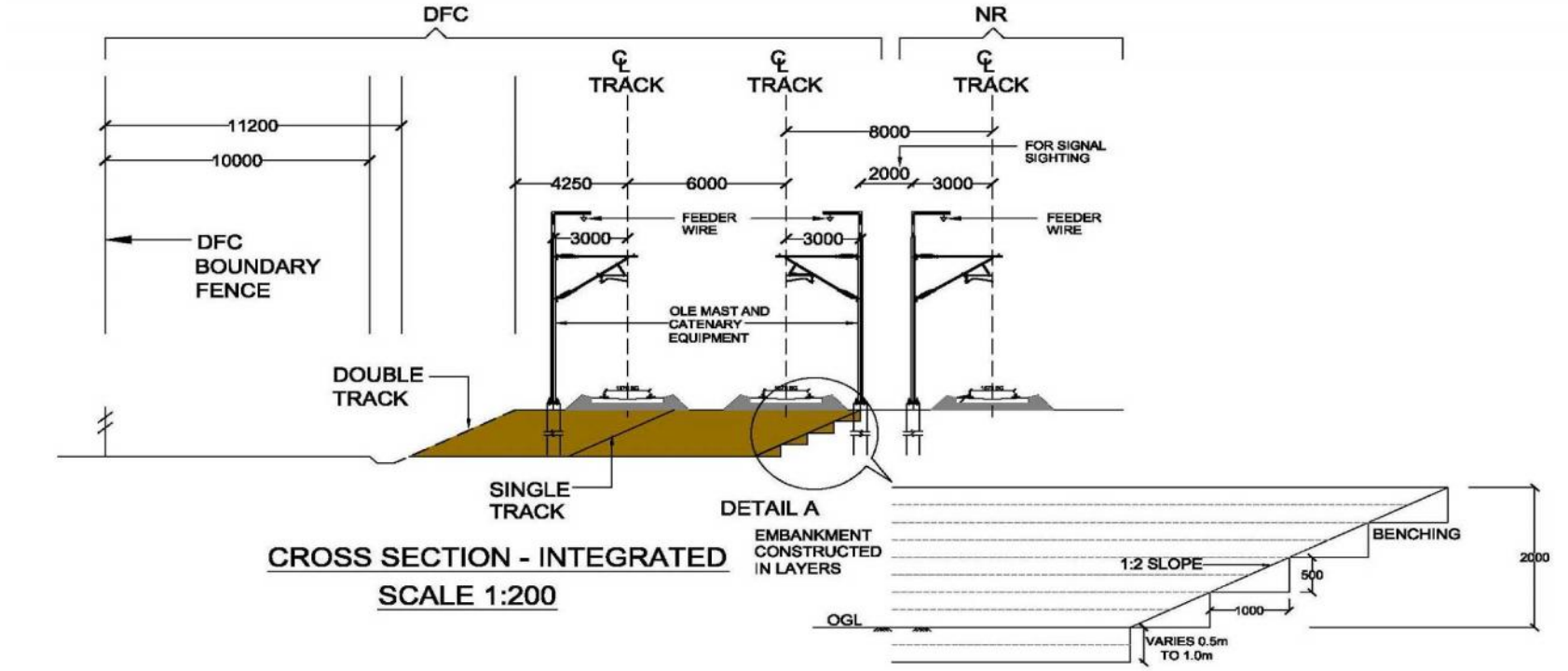
**Physical cultural resources***:* About 8 such structures are likely to be shifted due to the construction of Pilkhani-Sanhewal section of EDFC. Details of the same are given in further sections.

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 the project has been estimated as 3600 kl/day per km. This water requirement will be met from the combination of ground and surface water sources. In order to minimise fresh water consumption and impact on ground water table water conservation measures will be adopted during the construction and operation phases. The water requirement in Uttar Pradesh and Haryana ( km 188.000 to km 270.000). For this portion surface water sources available are Yamuna river, Tangari River, Markanda River and Tangari River. The contractor will obtain NOC from the concerned authorities if it is used as a source of water.

In Punjab portion surface water sources available are Ghaggar River, Bhakara Main Line canal, and Sirhind canal.

A Water Management Plan will be prepared by the contractor and this will be approved by the DFCCIL or its representative. The guidelines for water management plan based on guidelines prepared by the Central Ground Water Authority. Water management plan at Annexure 10.4 is to be referred.

### 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 2.10: 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<br>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 2.11: 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. The junction station has been planned to provide connection with Indian railway for transfer of goods between DFCC and railway. All the features of Junction station will be within the existing yard ( Boundary limits of Indian railway station) only. |
| 2. | Kalanaur | The traffic that has to be transferred from the corridor at Kalanaur is |

| S. No. | Junction Station | Interconnections |
|---|---|---|
| | | Coal for Reliance powerhouse and other comodities to be handled by DFCC. Number of trains to be transferred is about 3.5 trains per day. Surface crossing has been planned at this station. The junction station has been planned to provide connection with Indian railway for transfer of goods between DFCC and railway. All the features of Junction station will be within the existing yard ( Boundary limits of Indian railway station) only. |
| 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.<br><br>The Rajpura-Bhatinda section is a single line section and takes off from the existing lines on the same side as that of corridor. Hence, the single line corridor will be connected to the Rajpura-Bathinda line directly.<br><br>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.<br>All features of this junction station will be within the boundary limits of existing station. Additional area acqusition for this station is nil. |
| 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<br>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.<br>All the features of Junction station will be within the existing yard ( Boundary limits of Indian railway station) only. Additional area acqusition for this station is nil. |
| 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.<br>All the features of Junction station will be within the existing yard ( Boundary limits of Indian railway station) only. Additional area acqusition for this station is nil. |

### 2.3.11. *Crossing Sations*

Crossing stations are provided to facilitate safe and smooth movement of DFCC trains from both the directions. The planned crossing stations in Pilkhani- Sahnewal section have been given in Table 2.12.

**Table 2.12 : Features of Crossing Stations Along Pilkhani- Sahnewal Section of EDFC**

| S.No. | Name of Station | Railway Area ( m2) | Area Acquired (m2) | Total Area (m2) | Use of Area Acquired | Remarks |
|---|---|---|---|---|---|---|
| 1 | New Pilkhani | 38488 | 123936 | 162424 | Agriculture | This station requires about 76 % area of current landuse of agriculture. This sation is planned to be located at km |
| 2 | New Kalanour | 88000 | 6656 | 94656 | Agriculture | The area required for this station is totally agriculture. This station is planned to be located at km |
| 3 | New Jagadhari | 55500 | 41000 | 96500 | MC Land + Agriculture | The part of area required for this station is municipal area and part agricuture area. This station is planned to be located at km |
| 4 | New Darajpur | 78000 | 15000 | 93000 | Agriculture + Residential | This station is planned to be located mainly on agriculture area and its location is at km |
| 5 | New Barara | 37500 | 54000 | 91500 | Agriculture | The total area required for this station is agriculture and it is planned to be located at km |

| S.No. | Name of Station | Railway Area ( m2) | Area Acquired (m2) | Total Area (m2) | Use of Area Acquired | Remarks |
|---|---|---|---|---|---|---|
| 6 | New Keseri | 53500 | 39500 | 93000 | Agriculture | This station is also planned to be located on agricuture land and its location is at km |
| 7 | New Dukheri | 59600 | 53000 | 112600 | Agriculture | The New Dukheri station is planned to be located on agriculture land at km |
| 8 | Ambala City | 50500 | 17100 | 67600 | Huda Land Part. Residential | This station falls within the jurisdiction of Ambala city and land to be acquired from Haryana Urban Development Authority ( HUDA). The station will be located at km |
| 9 | New Shambhu | 20000 | 145000 | 165000 | Agriculture | The total area required for this sation is under agriculture. The location of this station is at KM279/21-282/5 CH 88650-91150 |
| 10 | New Sarai Banzara | 0 | 37000 | 37000 | Agriculture | This station is also planned to be located on agriculture land at km298-300 (CH 107100 - 109100) |
| 11 | New Gobindgarh | 124000 | 310000 | 434000 | Agriculture | This station is planned to be located on partly Railway land and partly |

| S.No. | Name of Station | Railway Area ( m2) | Area Acquired (m2) | Total Area (m2) | Use of Area Acquired | Remarks |
|---|---|---|---|---|---|---|
| | | | | | | private land at km 321/19-324/1 (CH 131150-134610) |
| 12 | New Khanna | 25000 | 300000 | 325000 | Agriculture | The predominant landuse of this station is also agriculture and planned to be located at km 336/23-339/27 (CH 147310-150400) |
| 13 | New Chawa Payal | 40300 | 395000 | 435300 | Agriculture | This station is planned to be located on agriculture land and located at km344/15-(348/15 CH155050-159080) |
| 14 | New Sirhind | 0 | 86490 | 86490 | Agriculture | This sation is also planned to be located on agriculutre land at km 311/17-314/5 CH 120591-122250 |

Source : Land Acqusition Plan Drawings
The photographs of some crossing stations have been given in the end of chapter in Figures **2.6 - 2.16**.

### 2.3.12. *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

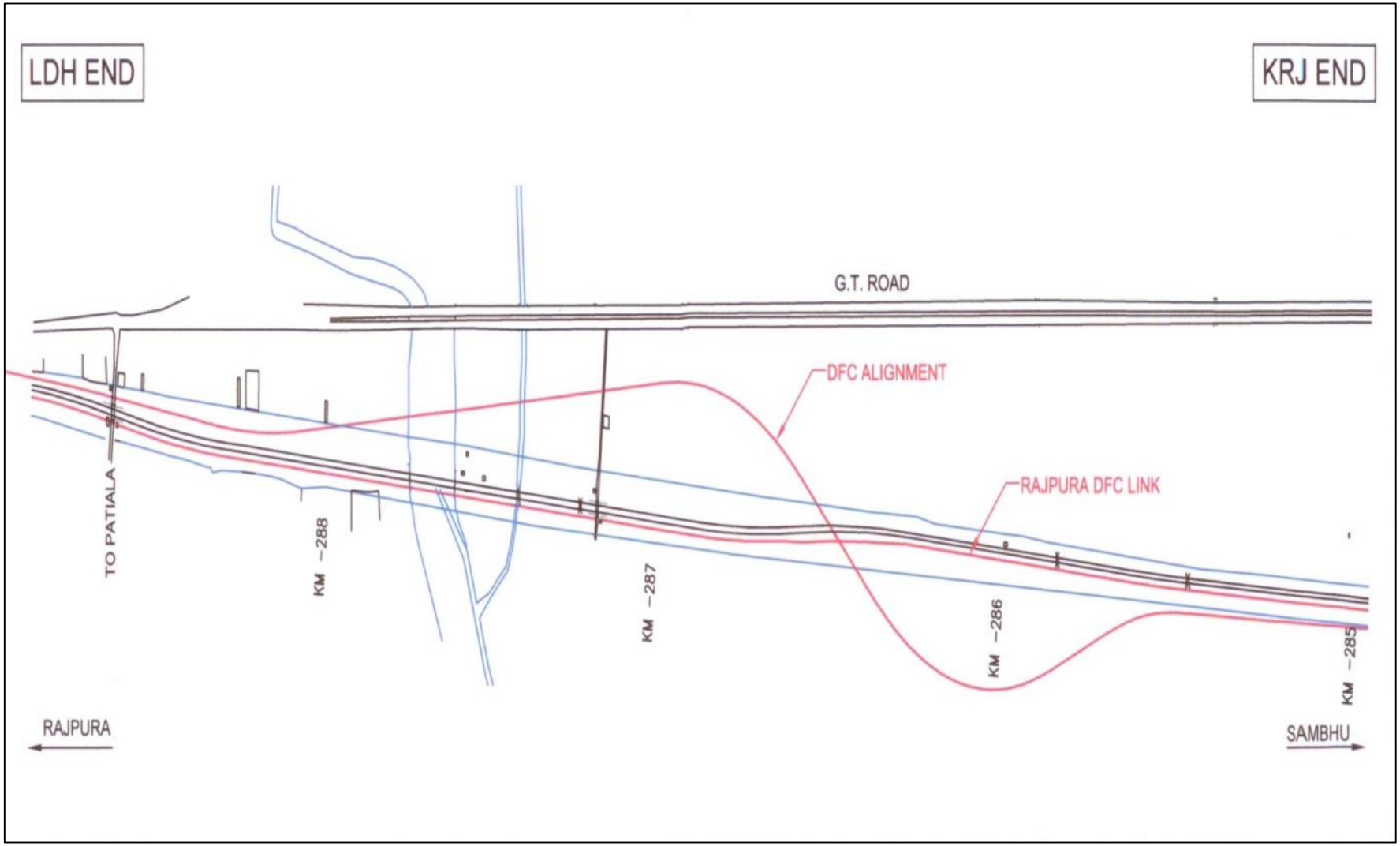
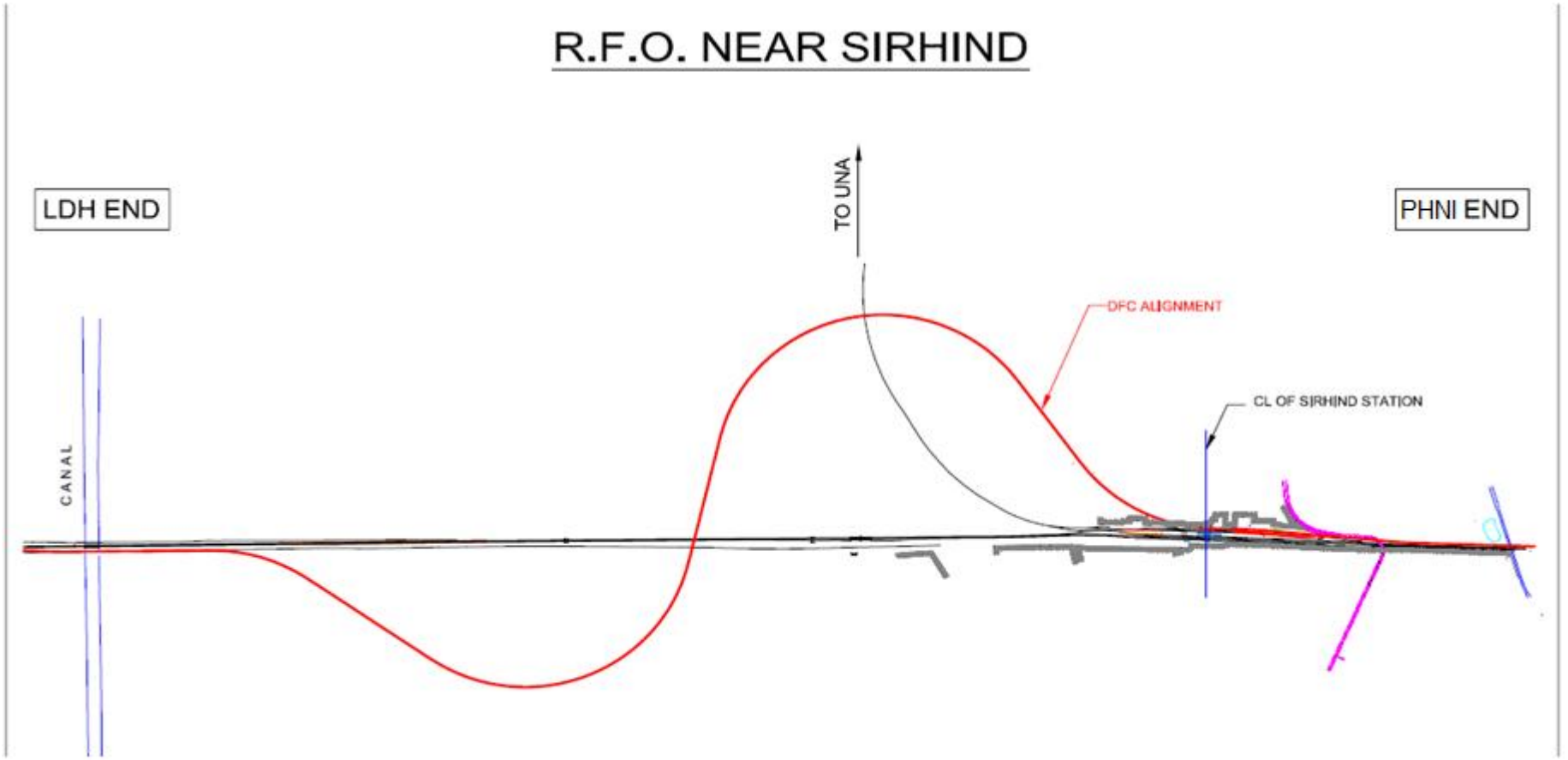


**Figure 2.5:** (c) Grade Separation / Rail Over Rail Flyover Locations At Sirhind



### 2.3.13. *Yards/Depots*

The proposed location for maintenance depot is at IR 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.

### 2.3.14. *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.

### 2.3.15. *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**.

### 2.3.16. *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 2.13: Summary Bridges / ROB or RUB Structure Detail**

| Structure type | Number |
|---|---|
| Important Bridges | 4 |
| Minor Bridges | 133 |
| Major Bridges | 44 |
| ROBs /RUBs | |
| a) ROB | 50 |
| b) RUB | 27 |

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**.**

### 2.3.17. *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.

### 2.3.18. *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.

### 2.3.19. *Electrification*

The electrification systems are proposed as per MoR and DFCCIL orders. MoR has approved adoption of a 2x25 KV electric traction system with 60 MVA transformers spaced at 60 km apart on dedicated freight corridors. The major OHE maintenance depot at every 60 km and minor depots at every 30 km are proposed. OHE will be 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.

### 2.3.20. *Electrical Sub stations*

The electrical sub stations of three types are planned namely TSS, SP and SSP. These have been planned to regulate and provide electric power to the DFC trains. The locations of these along with area required, current land use have been provided in **Table-2.14**.

**Table 2.14**: **Approved Locations for TSS/SP/SSP**

| S. No. | Type of Sub Station | Location | Approx. spacing km | Land required (Setting distance TSS-15mt SP/SSP-10mt TSS-140 m across the track) | Nearest Station/Village | Land Uses | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | SSP | 189.900/ 20000 | 11 | 25*55 | PKY/Pilkhani Bakkal | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 2 | SSP | 200.5 | 16 | 25*55 | KNZ/ Jharauli | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 3 | TSS | 216/5-7 | 13 | 85*140 | JUDW/Mandebri | Railway Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 4 | SSP | 229/3-5 | 11 | 25*55 | MFZ/Daulatpur | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 9 | SSP | 240.3 | 13 | 25*55 | Tandwal/Dadupur | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 10 | SSP | 253/7-8/61800 | 12 | 25*55 | DOKY/Smalakha | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| *11* | *SP* | *265/16-17/75500* | 19 | 30*55 | UMB/Jandli | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *12* | *SSP* | *284/7-9/93300* | 13 | 25*55 | RPJ/Ganda | Railway Land | located in Railway land, and there are no other environmental sensitivities |
| | | | | | | | |
| *13* | *SSP* | *297/12-14/106500* | 13 | 25*55 | SABJ/Bakshiwala | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| *14* | *TSS* | *310/8-10/119500* | 18 | 85*140 | SDY/Kotla Suleman | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 15 | SSP | 328/15-17/139150 | 12 | 25*55 | KNN/Alour | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |
| 16 | SSP | 340/150550 | 20 | 25*55 | CHA/Daheru | Agriculture Land | located in agriculture land, and there are no other environmental sensitivities |
| | | | | | | | |

Note : TSS- Traction Sub Station, SP - Sectioning Post, SSP- Sub Sectioning Post

It is clear from the above table that all types of substations are planned on land having current land use of agriculture. The photographs of the locations have been given in Figure 2.17 . .

### 2.3.21. *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. Agricultral land will be taken with the consent of the land owner and shall be excavated to the needs of the owner subject to other approvals. 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 initiatives

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


NEW GOBINDGARH
XING 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

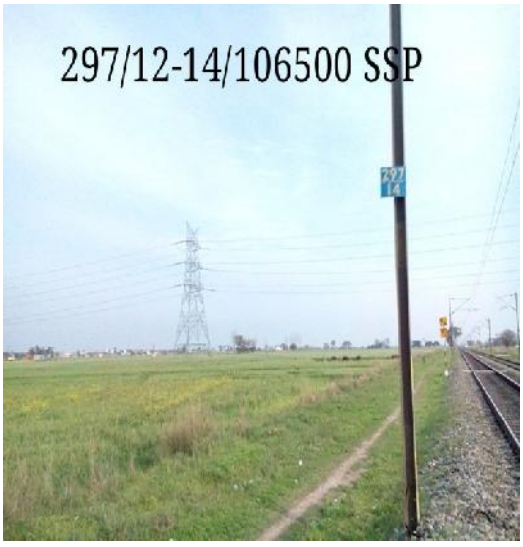

**Figure 2.16 :** View of Rajpura Junction Station (Above)

**Figure 2.17:** View of Electrical Sub Stations (Below)


SSP-km 328/15-17

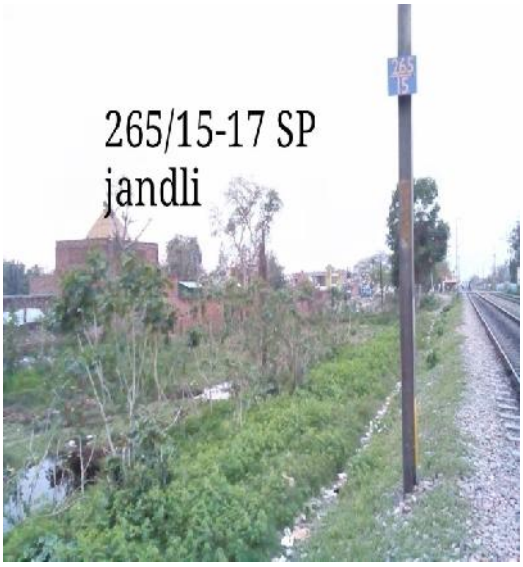

TSS-Kotla Suleman- km 310/8-10

Figures 2.18 to 2.26

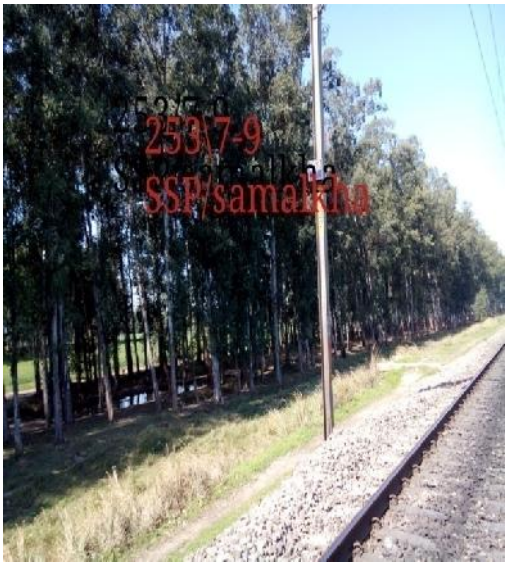



SSP-km 297/12-14


SSP Rly lans -km 284/7-9




SP Jandli-km 265/15-17




SSP Samalkha-km 253/7-9


SSP-km 240/9-11

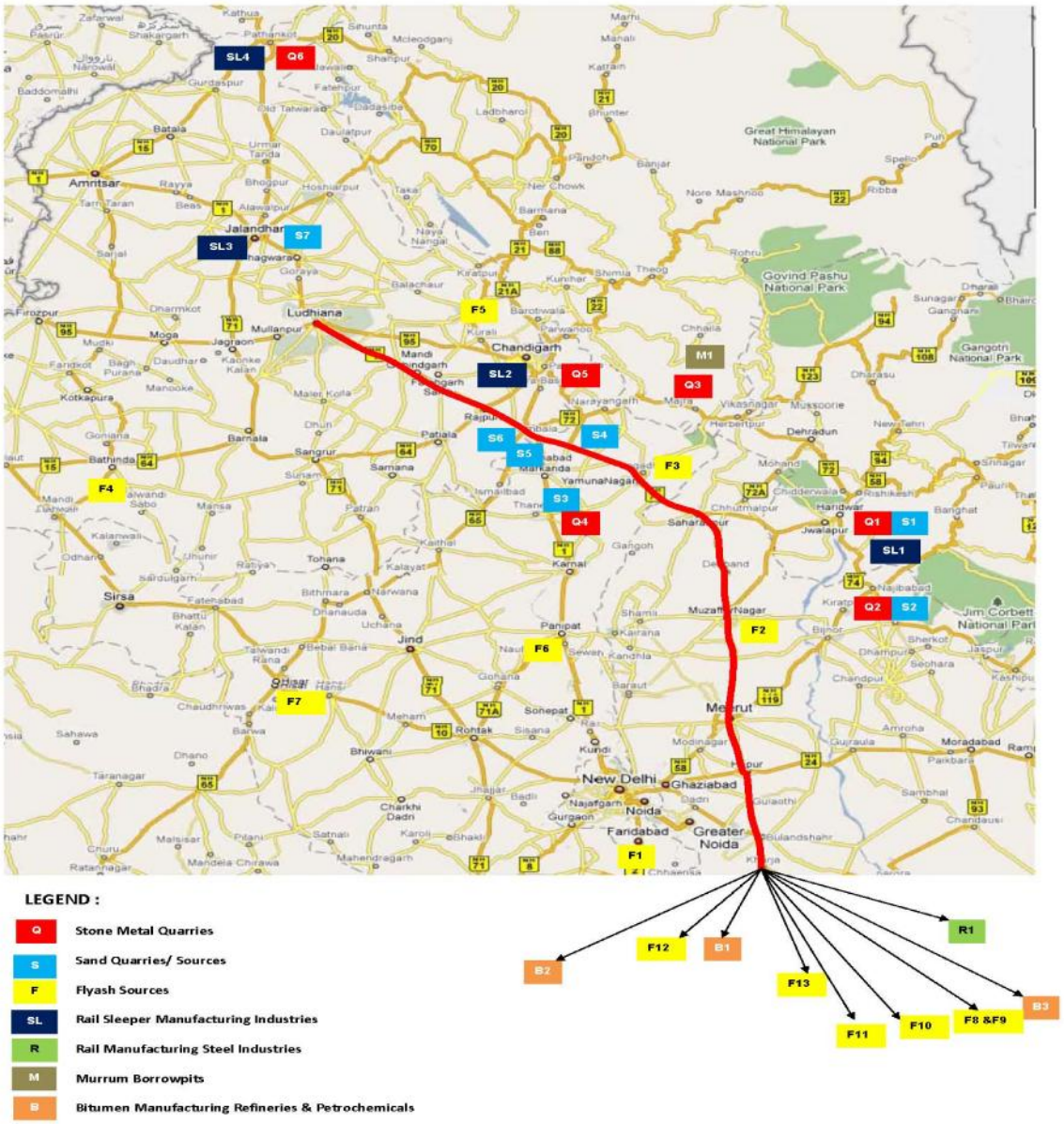

SSP-km 229/3-5


SSP-km 200/15-17


SSP-km 189/27-29


TSS-km 216/5-7

Figure 2.27: Key Map Showing Construction Material Sources

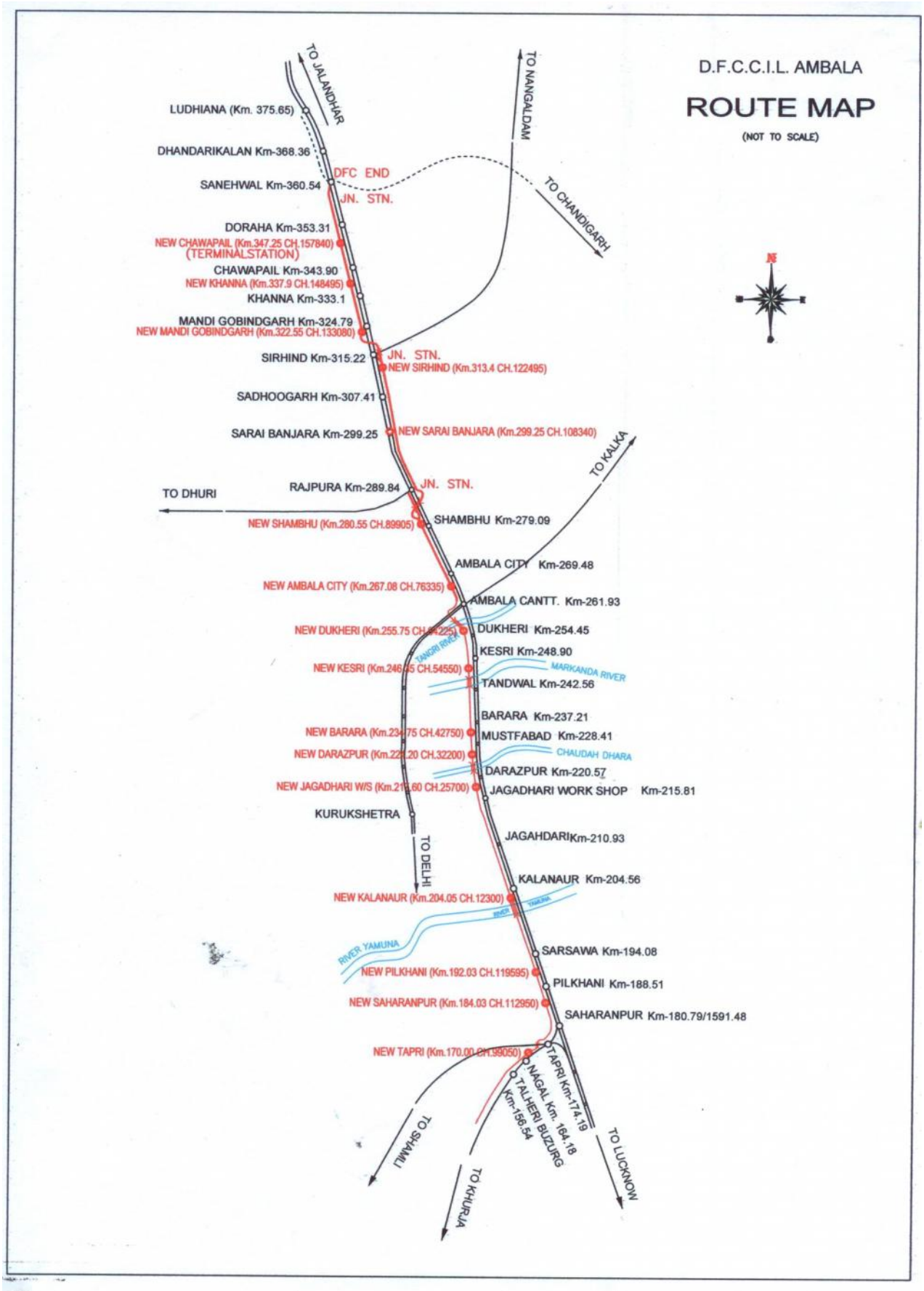


## Annexure- 2.1: Major construction Materials, its Source and Distance

| 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 | | nearest | 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 | | nearest | 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 | | nearest | 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 |

| 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 | | |
| 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 |
| 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 |

| 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 | | |
| 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. |
| 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 (Foundati-on) | 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 (Foundati-on) | 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 |
| 44 | 162/C/E | 345/27-29 | ROB |

| S.No. | Bridge No. | Location | Classification of Bridge |
|---|---|---|---|
| 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 in 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 at the time of construction 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). State Pollution Control Boards are responsible for issuance of NOC under Water Act & Air Act.

### 3.3.2. *Tree felling permissions*

Project requires cutting trees for which permission from Competent Authority/ 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. 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 through borrow / quarry | MoEF |

| S. No. | Act/Rules | Purpose | Applicability | Authority |
|---|---|---|---|---|
| | | | 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<br>The Forest (Conservation) Act. 1980<br>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 | Applicable for any 'chance find', 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 concession Rules & O.M. issued time to | For opening borrow pits, quarry. | Quarry Licenses shall be obtained by Contractors. | District Collector |

| S. No. | Act/Rules | Purpose | Applicability | Authority |
|---|---|---|---|---|
| | time | | | |
| 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 |
| 18 | Municipal Solid Wastes (Management and Handling) Rules, 2000. Municipal Solid Wastes (Management and Handling) Rules, 2000. | Management & disposal of Construction & Demolition debris | Applicable | SPCB |

Besides above, Acts/ Rules as applicable during project implementation will be followed.

## 3.4. Social Regulatory Requirements of the Govt. of India and State Govt.

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 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 | As applicable under the Act. |
| 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 near any archeologically important monument nor Reserve Forest areas through alignment modifications. The track primarily passes through parallel to existing IR & agricultural and residential areas in detour sections. The stretch crosses few major water bodies and acquisition of land is involved at few stretches.

Physical work proposed under this project is expected to cause significant Environmental & Social impacts involving large scale land acquisition (325 Ha.), significant earth work ((7.3 million $m^3$) & construction materials (0.1 $m^3$ ballast) and expected to have impact on environment (felling of 42400 trees & diversion of 175 Ha. Protective Forest land), relocation of 8 CPRs as well as construction work on 175 km linear work front involving construction equipment etc. Therefore the Project is considered as Category **'A'** as per the World Bank safeguard policy. This will help not only in making the construction stage to be more environment compliant but setting up a system for better and more environment friendly construction in the project area. DFCCIL is committed to establish the most efficient and eco-friendly systems.

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 Crushers , mixing plants 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 of State and SEIAA for Env. Clearance (EC). | Ordinary earth, borrow pits | Construction (Prior to work initiation) | 2-3 months | Concessionaire / Contractor |

| Sl. No | Type of clearance | Statutory Authority | Applicability | Project stage | Time required | Responsibility |
|---|---|---|---|---|---|---|
| 9 | Quarry lease deeds and license | Dept. of Geology and Mines of State and SEIAA for Env. Clearance (EC). | 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 overall 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 Consent 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 Environment Clearance (EC) 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 and after obtaining EC.
- 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 Total 56 structures have been identified out of which some of which may require relocation, which has been discussed in Chapter-7.

The proposed alignment is expected to involve the cutting of 42400 trees. Most of these tree species comprise common species such as Eucalptus, Popalar, Babul/ Kikar, Shisham, neem, etc., and doesn't involve cutting of any sensitive / endangered species.

**Table 4.1 : Trees to be Cut**

| State | Trees to be Cut | | | Total |
|---|---|---|---|---|
| | PF | Rly. land | Private Land | |
| Haryana | 19889 | 8523 | 682 | 29094 |
| Punjab | 1986 | 1763 | 674 | 4423 |
| Total | 21875 | 14700 | 5826 | 42401 |

## 4.5. Sensitive Receptors

Summary of sensitive receptors within 100m either side of the proposed Pilkhani-Sahnewal section of EDFC is presented below. Out of these only 13 are within the proposed RoW.

**Table 4.2 : List of Important Features along DFC Corridor**

| 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**

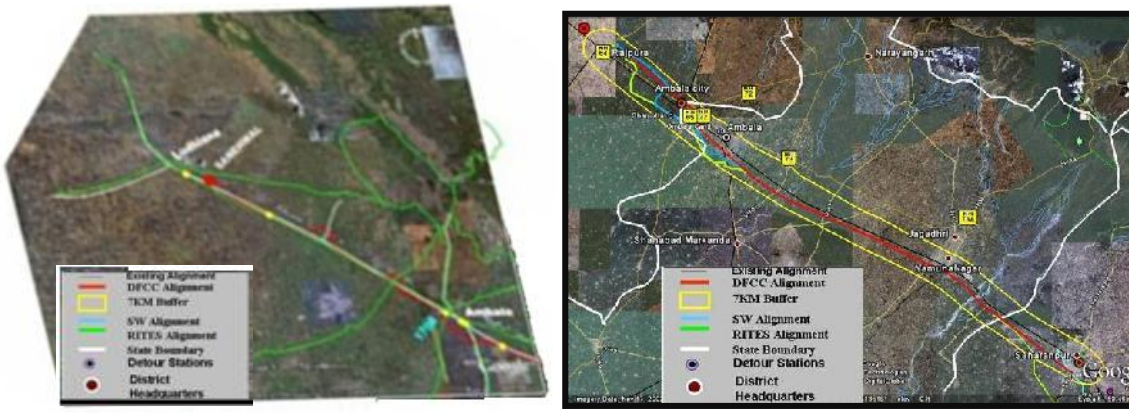
# CHAPTER 5. BASELINE ENVIRONMENTAL PROFILE

## 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. 188+500 to Ch. 274 km in UP & Haryana (one stretch),
Ch. 274 to 360 km in Punjab (one stretch)

Core zone of 100m is the Right of Way where DFC alignment will pass & railway track will be laid and direct impact is expected. Buffer zone of 7 km is for studying impact on environmental features due to DFC project. The buffer zone (or project influence area) of 7 km has been taken from the boundary of core zone along the DFCC corridor. This is based on the guidelines of Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India for the environmental impact assessment of road and rail project.

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 **42400** 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.<br>The list is enclosed in Section 4.4.8 |
| 3. | Water Bodies | Crossing Rivers – Yamuna, Markanda, Tangri and Ghaghhar<br>Crossing Canals – Western Yamuna Canal | Rivers within 7 km – Kali, Yamuna, Markanda, Tangri and Ghaghhar<br>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.<br>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. |

| S. No. | Environmental Features | Within 100 m core zone | Within 7 km buffer zone |
|---|---|---|---|
| 7. | Social | Poverty – highest in U.P. followed by Haryana and least in Punjab<br>Indigenous – none<br>HIV/AIDS – none | |

## 5.2. Physical Environment

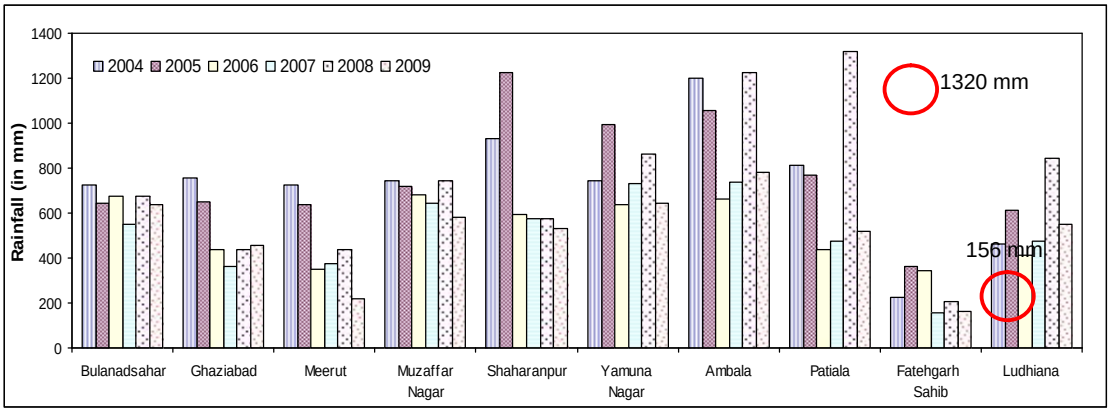
### 5.2.1. *Meteorology and Climate*

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<br>2. Yamunanagar<br>3. Ambala<br>4. Fatehgarh Sahib<br>5. Patiala<br>6. Ludhiana | Last five years (2005 – 2010) | India Meteorological Department, Delhi |
| Wind Speed and Direction<br>Temperature<br>Humidity | 1. Ambala<br>2. Patiala<br>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**

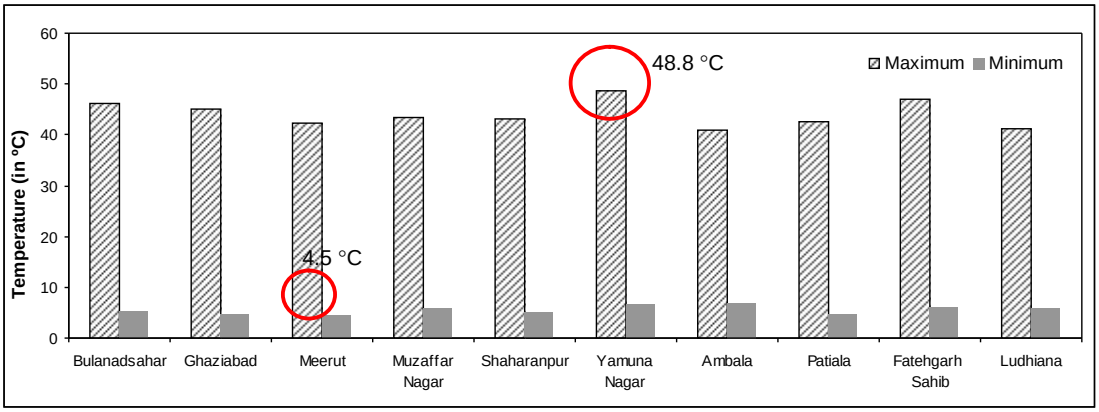



*Source: India Meteorological Department (IMD), Delhi*

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

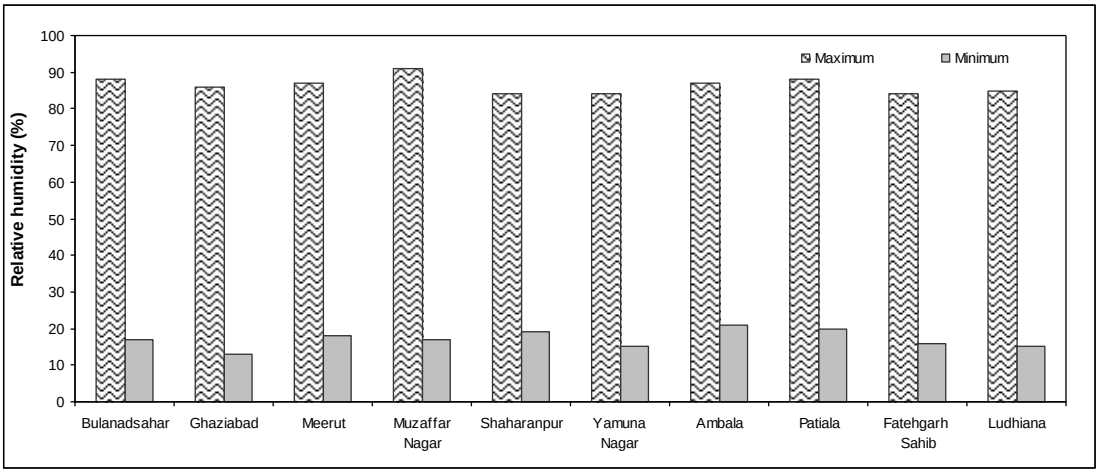
*Wind:* The wind speed & direction in the project districts is found to be varying at different locations in each season. The wind data for Ambala and Ludhiana indicate winds are mostly low (< 8 km/hr). The predominant wind direction in the project area is during the year 2009-10 are west, north-west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

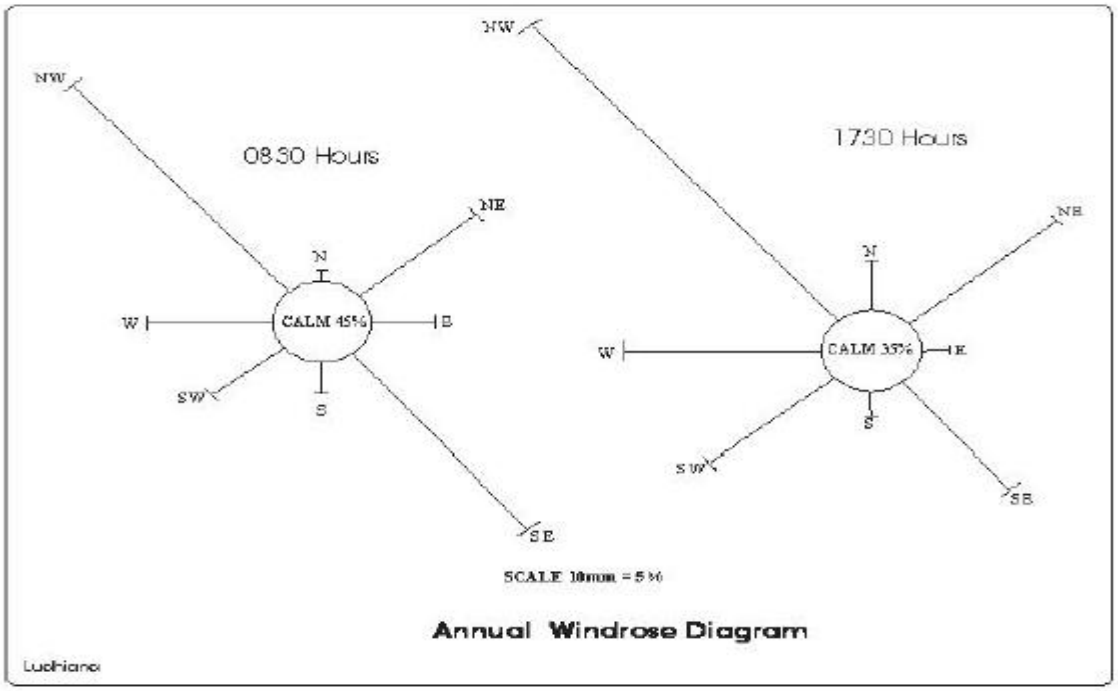



Fig. 5.5 : Wind Rose Diagram for Ludhiana IMD Observatory

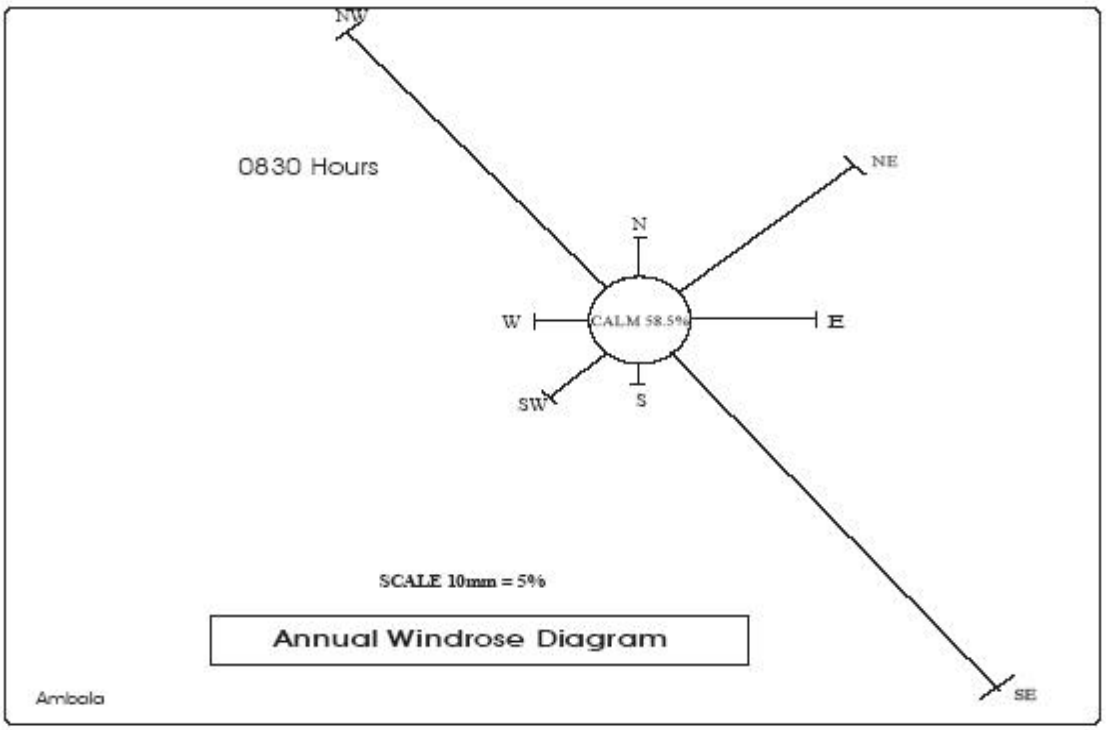



Fig. 5.6: Wind Rose Diagram for Ambala IMD Observatory(8.30 AM)

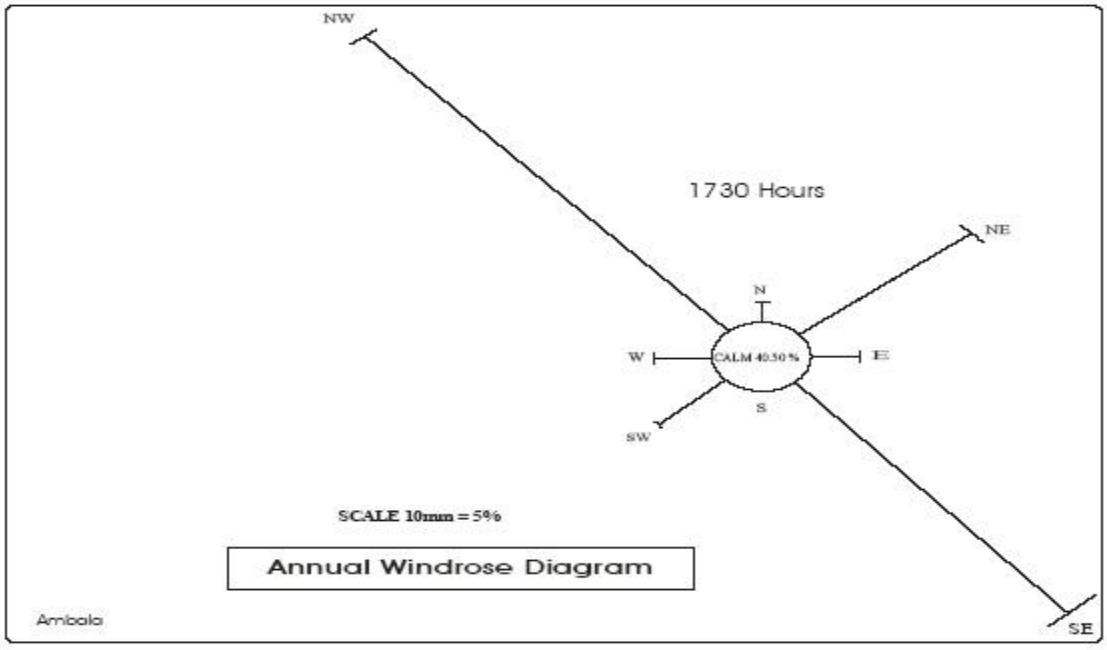



Fig. 5.7 : Wind Rose Diagram for Ambala IMD Observatory(5.30 PM)

### 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:

Fig. 5.8 : Industries along the Alignment

Fig. 5.9 : Traffic Congestion At the Level Crossings

Fig. 5.10 : Air Monitoring at Sirhind


Fig. 5.11: 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-5.14.**

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.


Fig. 5.12: Ambient noise monitoring


Fig. 5.13 : Ambient noise monitoring

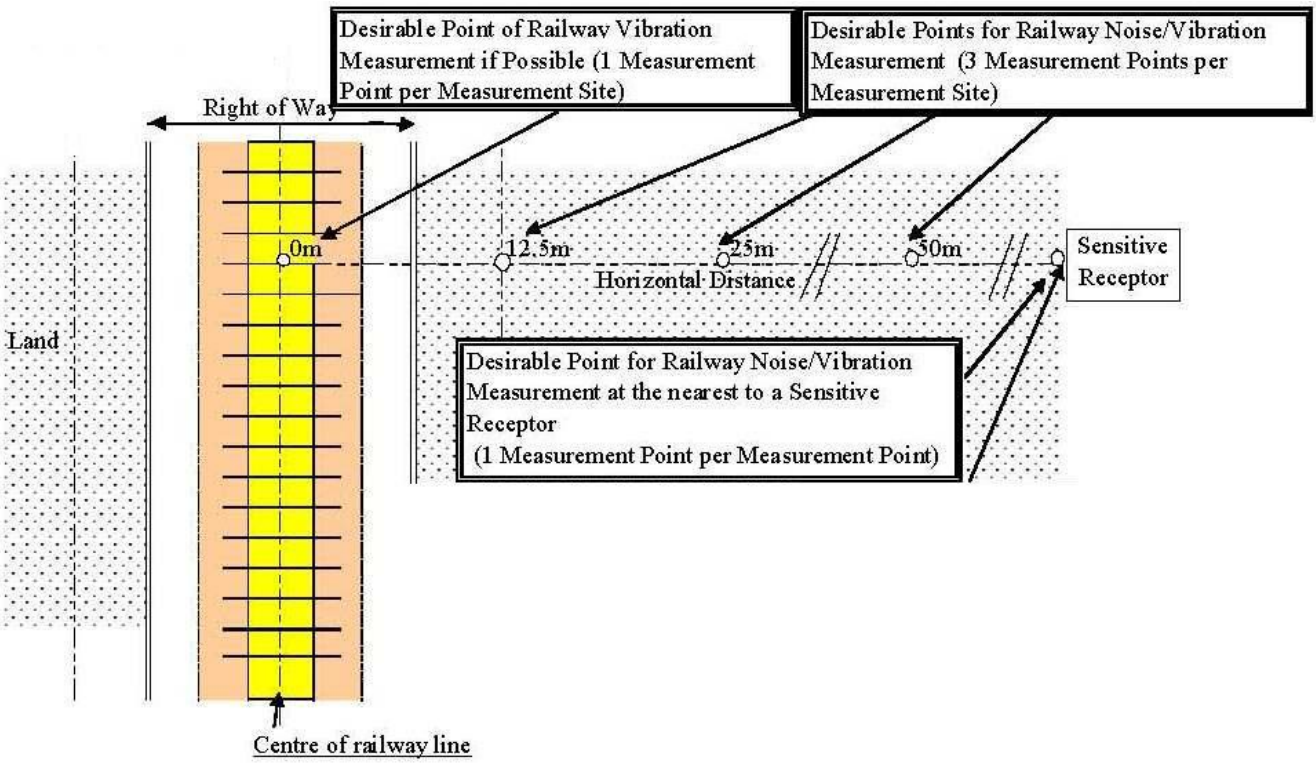



Fig. 5.14: Schematic Layout of Noise and Vibration Measurement Sites

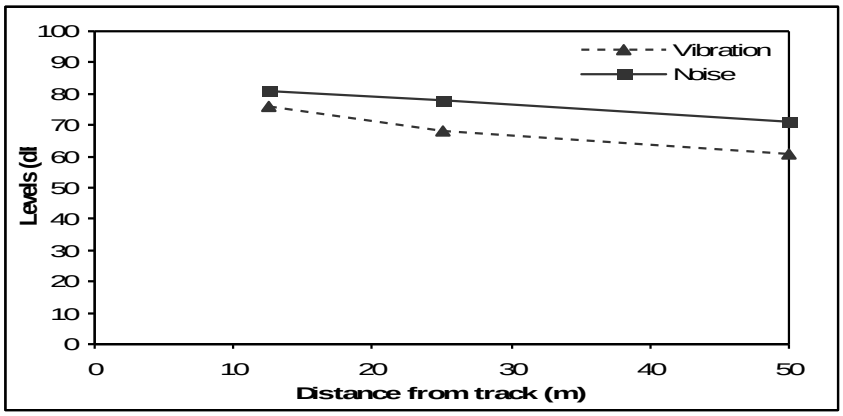
## Table 5.5 Ambient Noise Level along the Corridor

| 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 |

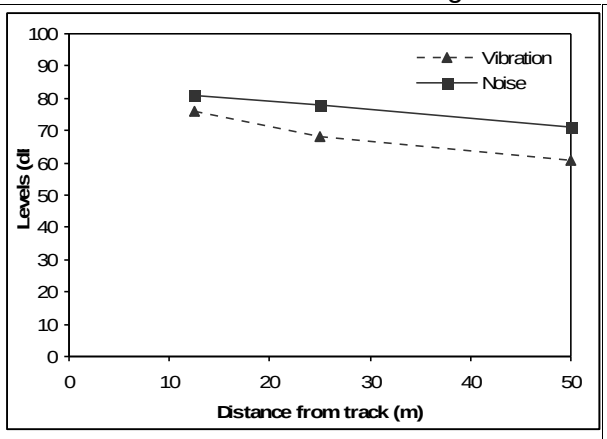
| S. No. | Locations | Zone-Core/Buffer | Category | Parameters (in dB(A)) | | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Leq Day | Leq Night | Lmax. | Lmin. | |
| 12. | Sanjivani College of Nurshing, Chawa Pail ( km 343+900) | Core | Sensitive | 57 | 43 | 82 | 32.5 | Daytime noise level is high due to heavy train traffic |
| 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 5.15**.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.

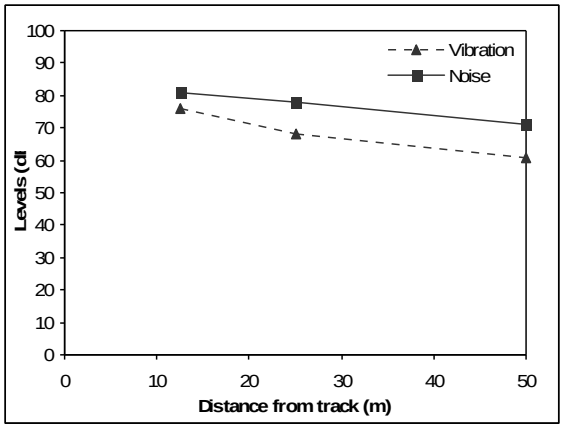
Fig. 5.15 : Attenuation Pattern of Noise & Vibration along the Alignment




Chainage 187+800 km -200 km Group




Chainage 201-300 km Group




Chainage 301-389 km Group

Source: Field Monitoring

The vibration isopleths from the centre of the track due to train movement along the alignment can be seen in **Figure 5.16**. 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.**

Fig. 5.16 : Isopleths of Ground Vibration from the Centre of Track

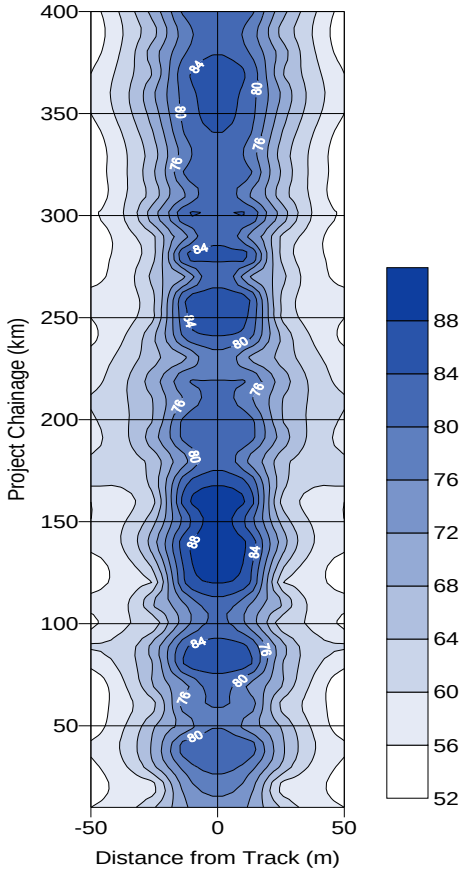



Fig. 5.17 : Vibration Monitoring Along the Alignment


**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 |

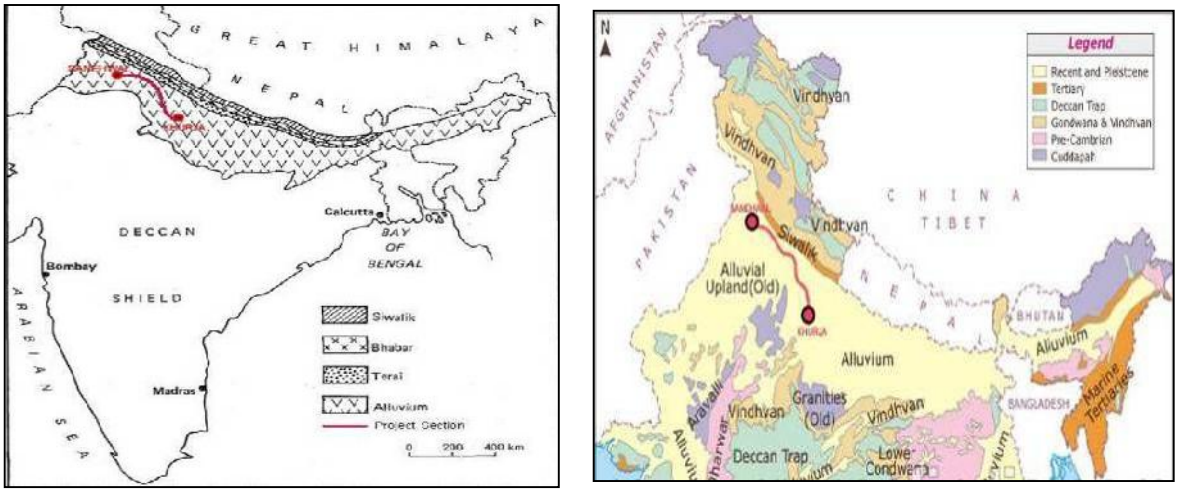
| S. No. | Location | Classification | Set-up | Towards | Type of Train | Duration of passage (in Sec) | Length of the bogies (in m) | No. of Bogies | Speed (in km/hr) | Max. LdB at 5m | Max. LdB at 12.5 m | Max. LdB at 25m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | | Semi-urban | Near proposed new flyover at Ch. 269+000 | Meerut | freight | 32 | 15 | 61 | 102.9 | 61.5 | 58.7 | 53.4 |
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Between Doraha & Chawa Pail | Rural | Temple at Ch. 348+000 | Rajpura | Freight | 35 | 15 | 60 | 92.6 | 74.7 | 71.9 | 66.6 |
| 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 (**Figure 5.18**). 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.

Fig. 5.18 : Hydrogeologic Unit in Great Indian Sedimentary Basin



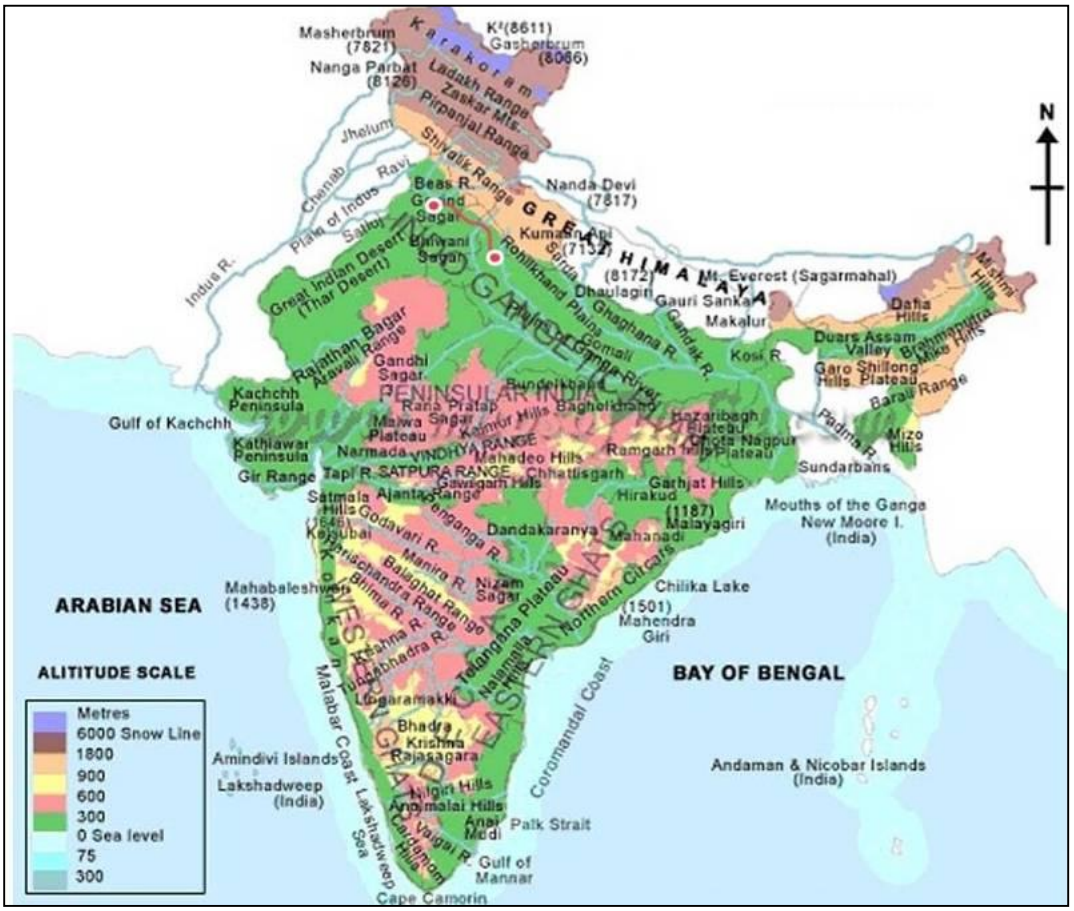

**Shivalik System**. It derived its name from the Siwalik Hills lying in the Hardwar region of Uttaranchal. The siwaliks comprise consolidated and semi-consolidated rocks namely sandstones, grits, conglomerates, pseudoconglomerates, clays and silts. They have the character of deposits formed by torrential 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.

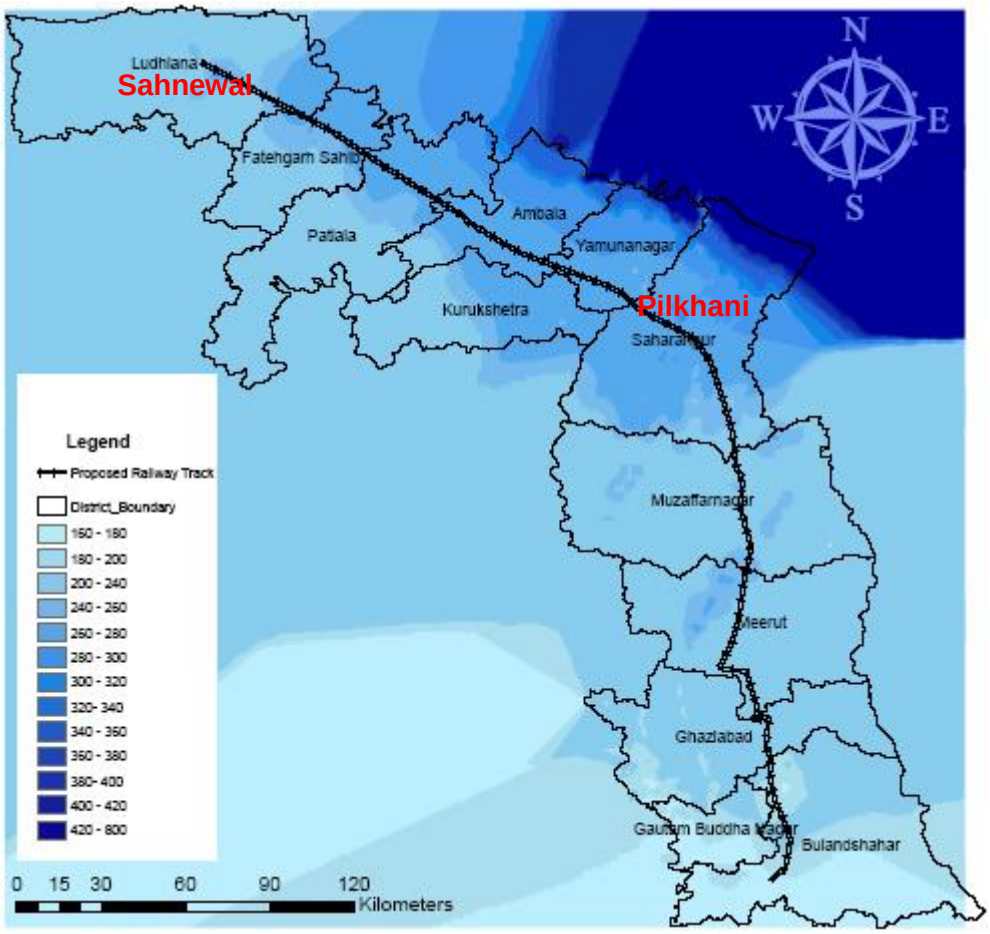
Fig. 5.19 : Topographical Map of Indian Region




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 5.19**) 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 5.20**).

Fig. 5.20 : 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.

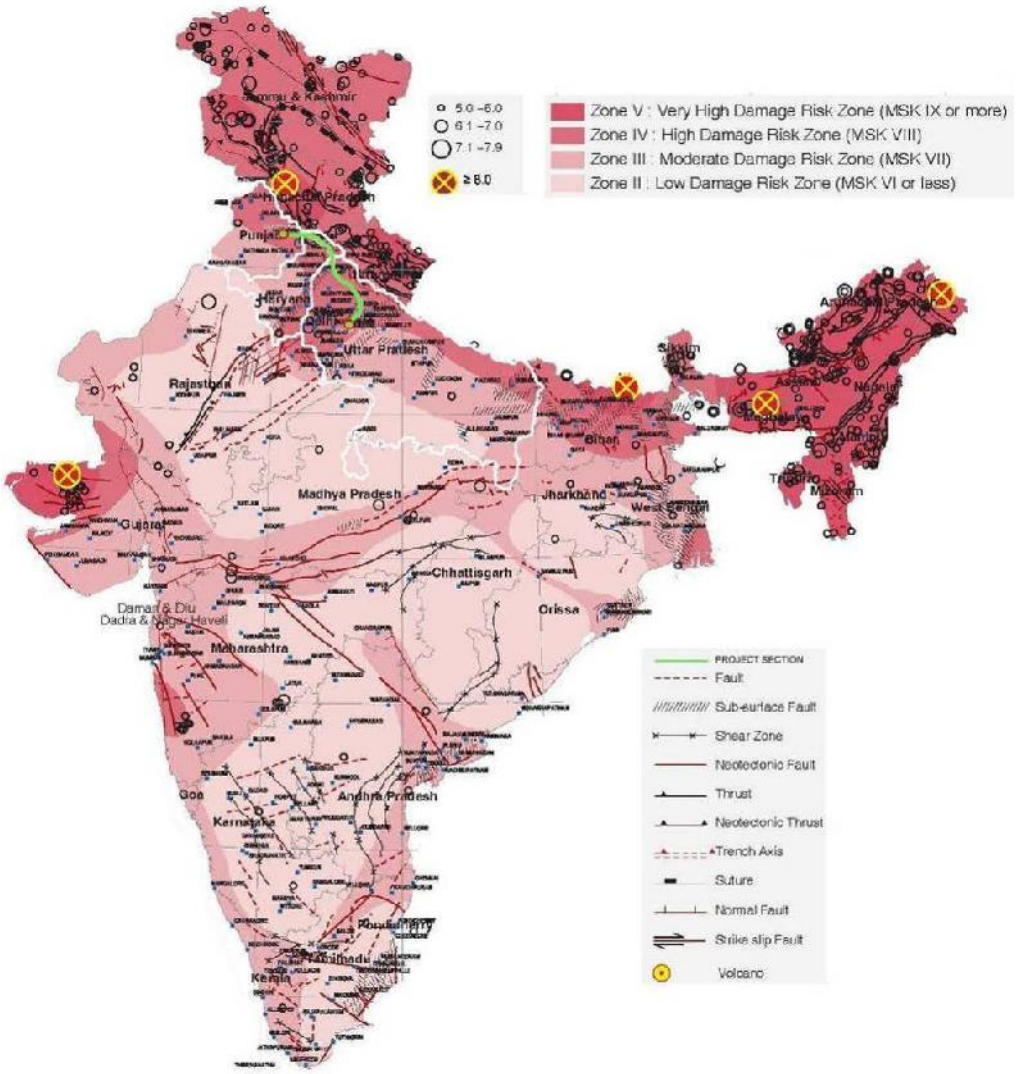
**Table 5.7 : Summary of Elevation Levels in the Core and Buffer Zone of the Proposed Alignment**

| **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 5.21**. This zone is categorized as high damaged risk zone. During detailed design, PMC will consider this aspect and design will be as per provisions in Railway codes/ standards. Details of mitigation plan are given in Chapter-8.

Fig. 5.21: Seismic Zoning Map of Indian Region




### 5.2.6. *Water Hydrology and Drainage*

**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 5.22**). 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.

***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 5.23 to 5.25.**

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**-<br><br>Yamuna River, Markanda River, Tangri, | **Major Drainage-**<br><br>Ghaghhar River |
| Buffer Zone | o NE – SW | o NE – SW, NW – SW, E – W, SSE- NNW |
| | **Major Drainage**-<br><br>Markanda River, Tangri River | **Major Drainage-**<br><br>Ghaghhar River |

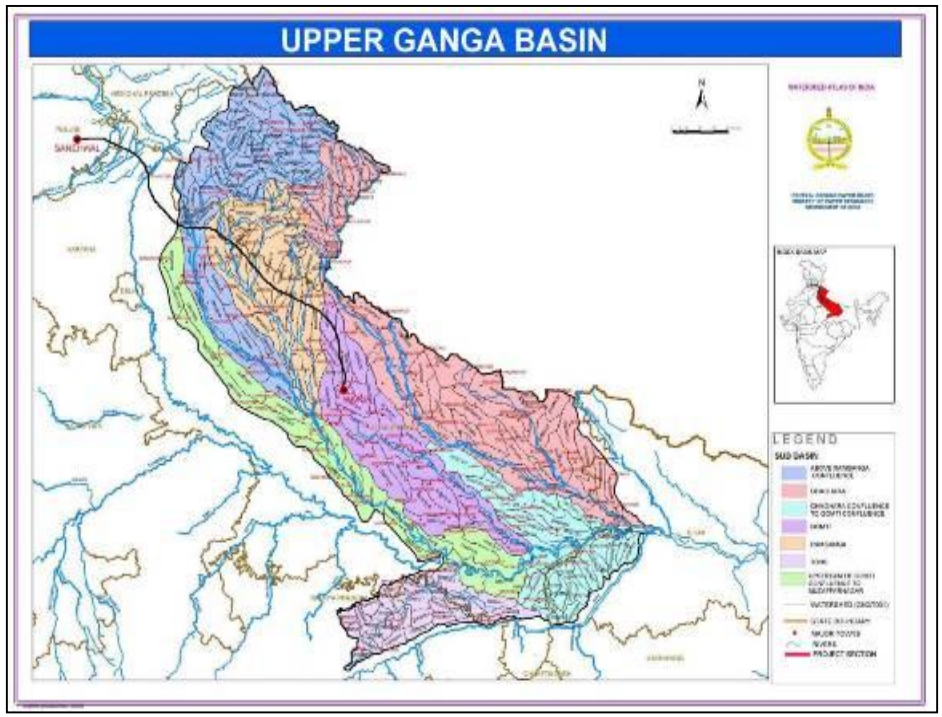
None of the above drainage system will be affected during construction or operation of Pilkhani-Sahnewal portion of EDFC. Only *Yamuna* river is perennial river in this section.

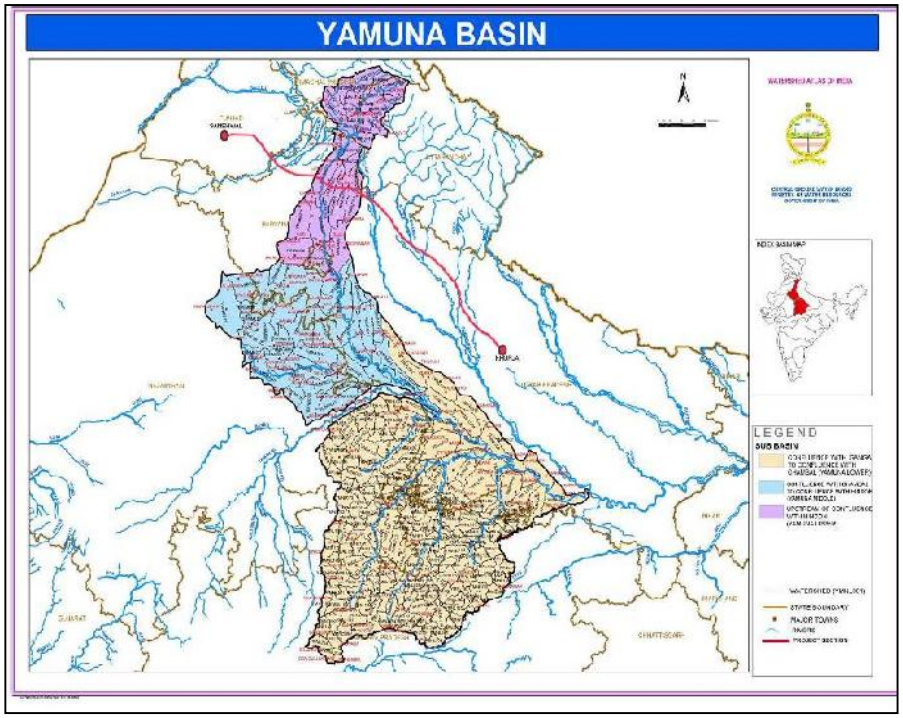
During construction as well as operational phases, it will be ensured that flow of water through existing watercourses is not restricted. This will be taken care at the design stage.

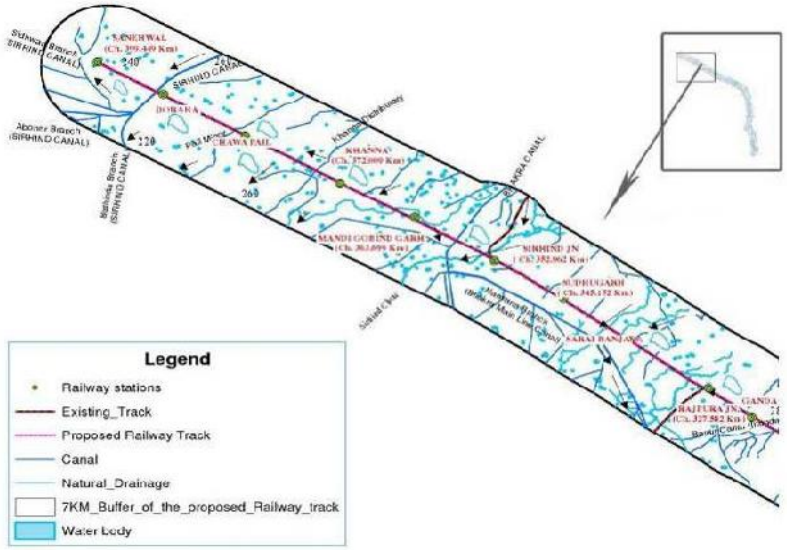
### 5.2.7. *Water Quality*

**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.

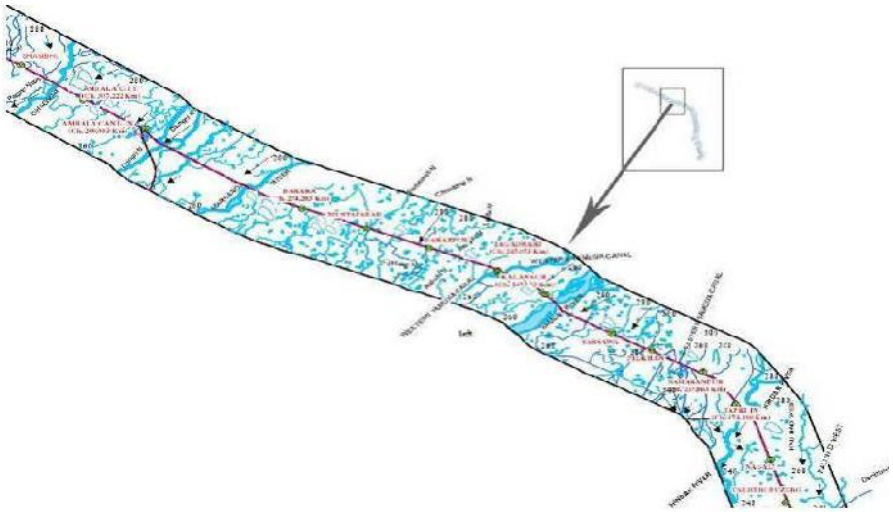
Fig. 5.22:Ganga-Yamuna Basin Map






Ch. 301 – 360 km



Ch. 187+800 – 300 km

Fig. 5.23 Drainage Map of the Proposed Alignment

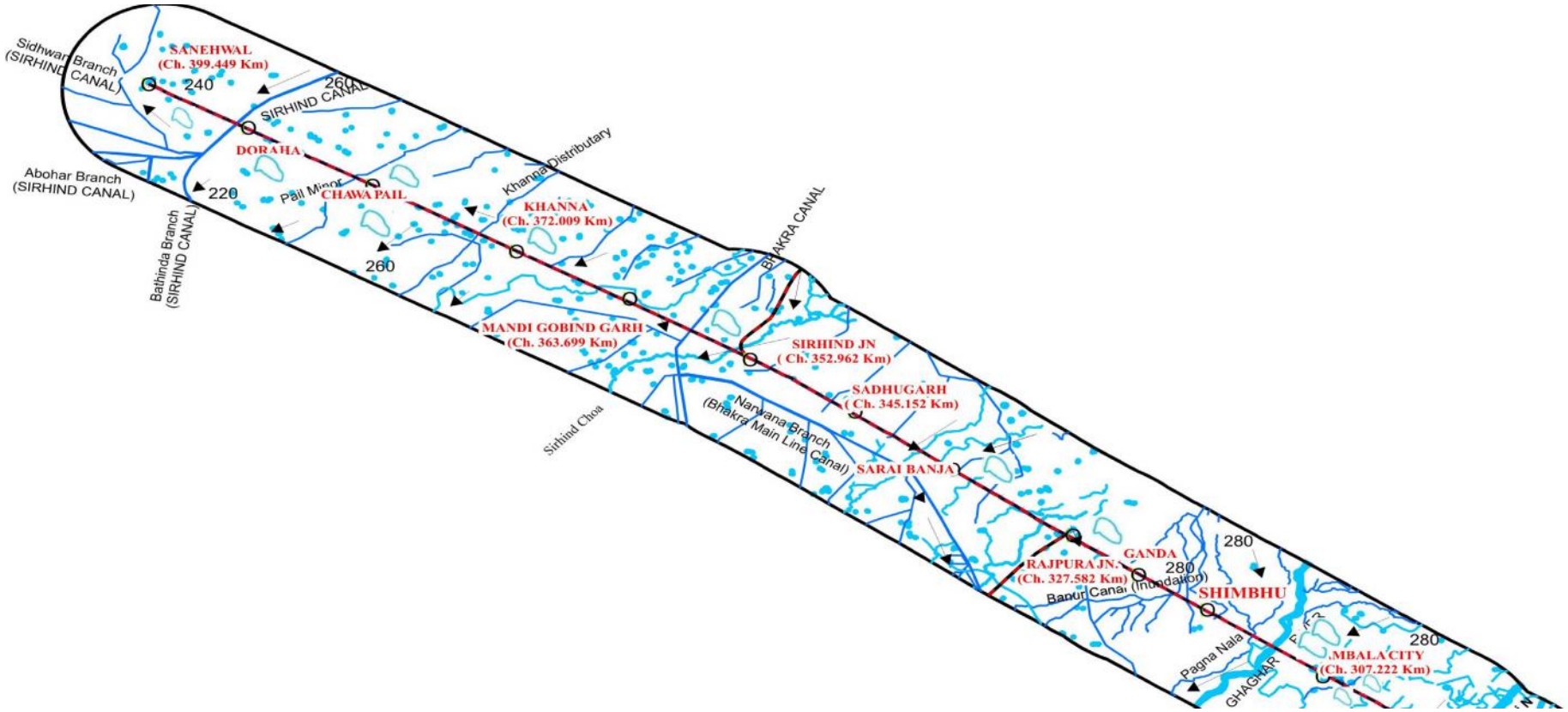



Fig.

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

Fig. 5.25: continued: Blow Up Drainage Map of Ch. 300 – 187+800 km

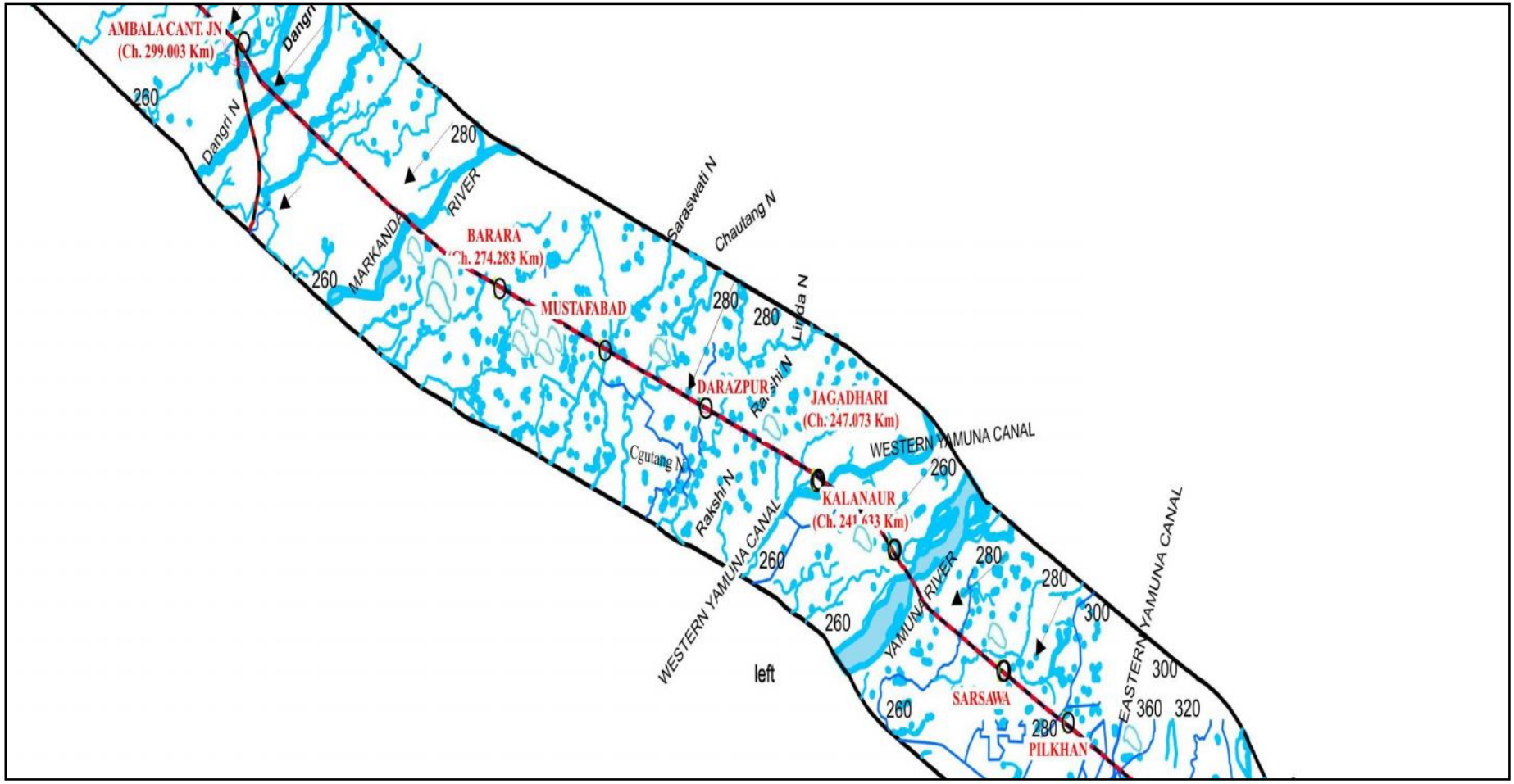


**Table 5.9 : Surface Water Quality along the Proposed Alignment**

| 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: 10500-1993 except 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 undwater 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 5.26** and **Figure 5.27** respectively.

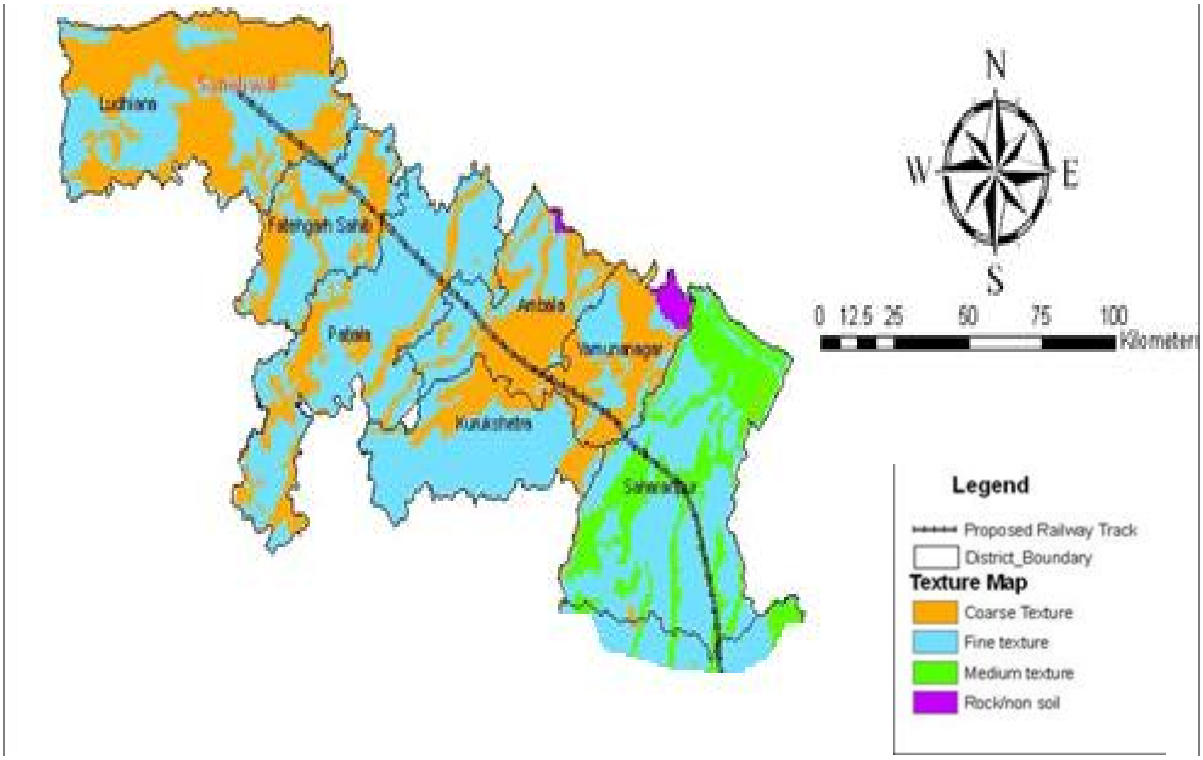



Fig. 5.26: Soil Texture Characteristic of the Proposed Alignment

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*

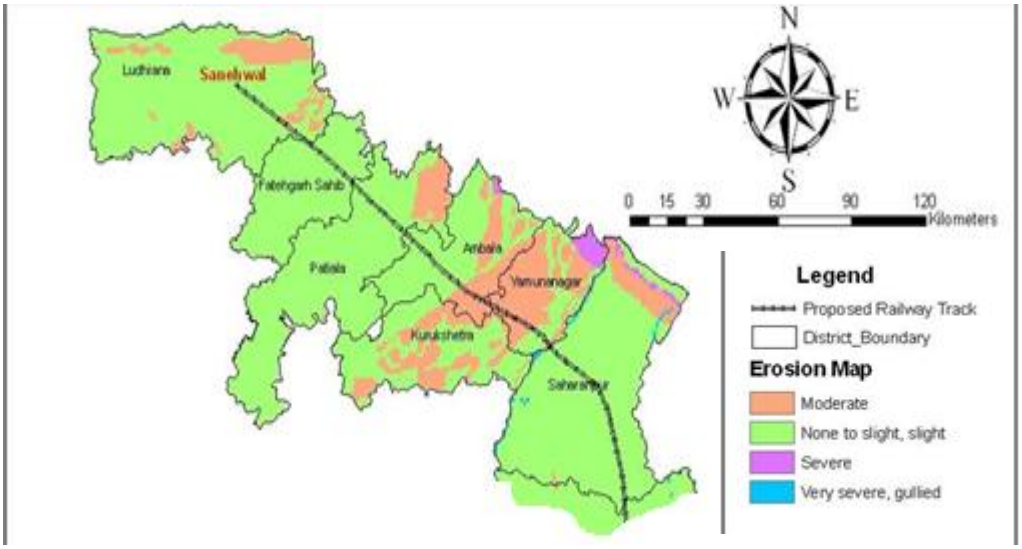



Fig. 5.27: Soil Erosion Map of the Proposed Alignment

Fig. 5.28 : Soil Sampling along the Proposed Alignment

### 5.2.9. *Land-Use*

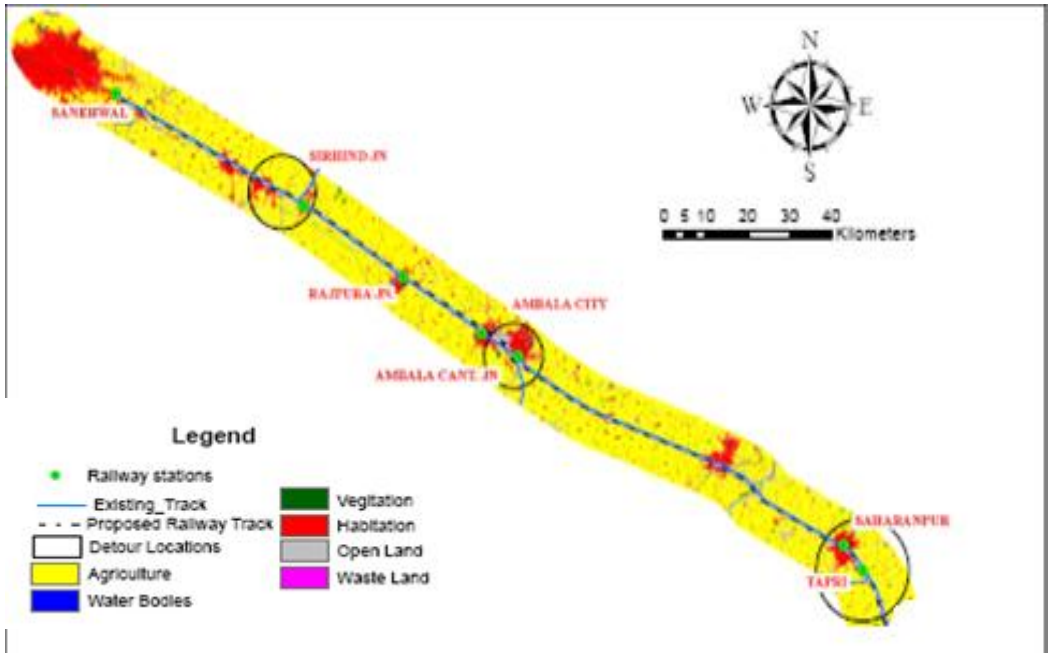
The land use study is of fundamental significance, as the land resources play a strategic role in the determination of economic, social and cultural progress of the region. Remote sensing data provides reliable accurate baseline information for carrying out the land use mapping. To delineate different 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 5.29**. 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 |

Fig. 5.29 : 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*

*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. 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, Poplar, Babool, Sheesham, Fruit bearing trees like mango etc. The plantations were observed to be done mainly by the forest department in forest areas (protected 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 and fertile agricultural land in the past. Now the entire area is under the plantation of Eucalyptus tree mainly by the forest department under social forestry.

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 42400 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 : Approx. number of Trees Present in the RoW including the detour area**

| State | Trees to be Cut | | | Total |
|---|---|---|---|---|
| | Declared Protected Forest | Railway Land | Private land | |
| UP | - | 4414 | 4470 | 8884 |
| Haryana | 19889 | 8523 | 682 | 29094 |
| Punjab | 1986 | 1763 | 674 | 4423 |
| **Total** | **21875** | **14700** | **5826** | **42401** |

The types of ownership of trees to be cut are presented In Annexure-5-11 and summarised to the following categories:

- Trees on protected forest land (PF) ( linear plantation declared as protected forest within RoW of Indian Railway land in Haryana and Punjab States) : 21875;
- Trees on newly acquired private land and trees on Indian Railway land (Yards and block section of track) : 20526

The districtwise tree species to be cut have been summarised below in Table-5.18. It is clear from this table that none of the tree species belong to rare on endangered category.

**Table 5.18 : Type of Trees Present in the Railway and Private Land (excluding PF)**

| S. No | District | Type of Trees in Land |
|---|---|---|
| 1 | Saharanpur | Arjun, Kikar, Mango, Jamun, Eucalyptus, Shisham, Simbol, Kanji, Dhak, Kachnar, Seeras, Jalebi, Shahtoot, Parking Soniya |
| 2 | Yamuna Nagar | Eucalytus, Seeras, Shisham, Beri, Shahtoot, Bel , Goolar, Dahiya, Mango, Glaur, P. Malbari, Papari, Nasura, Jamun, Amaltas, Simbal, Dhak, |
| 3 | Ambala | Shahtoot, Neem, Date, Shisham, Mango, Peepal, Guava, Beri, Amaltas, Jamun, Arjun, Kikar, Papari, Gular, Lasoda, Tandusa |
| 4 | Patiala and Fatehgarh Sahib | Malberi, Pipal, Neem, bargad, Mango, Eucalyptus, Suhanjna, Dhak, Kikar, Simbal, Teak, Bel, Muscat, Siris, Lasoda, Khair, Bohra, Jungle Jalebi, Shahtoot |
| 5 | Ludhiana | Kikar, Malberi, Sreen, Ber, Shisham, Popalar, Dhak, Pipal, Neem, Vaseta, Lasoda, Arjun, Sukhchain, Guava, Mango, Eucalyptus, Australian Kikar, Kanakchampa, Khajur, Karunda, Camri, Bel |

Number of dominant species among the trees are as follows:

i Eucalyptus - 11941
ii Poplar – 3149
iii Babul/Keelar - 2489
iv Shisham- 1947
v Peepal - 48
vi Fruit Bearing ( Mango, Jamun, Guava, etc.) - 331
vii Others- 621

Fruit bearing trees to be cut are 331 i.e., 1.6% . Compensation against fruit bearing trees will be done as per Entitlement Matrix of RAP.

The scientific and botanical names of these trees have been explained in the subsections to follow in the chapter.

### 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*

*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 5.19**)

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 5.19 : 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 |
| 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 |

| Tree Species | Relative Density | Relative Dominance | Relative abundance | IVI |
|---|---|---|---|---|
| Lasura or Lehswa- *Cordia dichotoma* | 0.23 | 0.84 | 1.97 | 3.04 |
| Pipal or Bo Tree - *Ficus religiosa* | 0.39 | 0.89 | 1.73 | 3.01 |
| Barh or Banyan- *Ficus benghalensis* | 0.42 | 0.94 | 1.64 | 3 |
| Imli or Tamarind- *Tamarindus indica* | 0.34 | 0.84 | 1.51 | 2.69 |
| Mitha Jal or Pillu- *Salvadora indica* | 0.21 | 0.79 | 1.02 | 2.02 |
| Pakori-*Ficus rumphii* | 0.21 | 0.79 | 0.96 | 1.96 |
| Jack Fruit-*Artocarpus heterophyllus* | 0.11 | 0.48 | 1.23 | 1.82 |
| Amlakhi-*Phylanthus ambilica* | 0.19 | 0.675 | 0.91 | 1.77 |
| Jujube-*Zizyphus jujuba* | 0.13 | 0.53 | 1.05 | 1.71 |
| Kadam-*Anthrocephalus cadamba* | 0.15 | 0.62 | 0.82 | 1.59 |
| Shahtoot or mulberry-*Morus albaatropurpurea* | 0.15 | 0.59 | 0.83 | 1.57 |
| Amrood or Guava- *Psidium guajava* | 0.14 | 0.55 | 0.82 | 1.51 |
| Sagwan or Teak- *Tectona grandis* | 0.09 | 0.43 | 0.95 | 1.47 |
| Deodaru-*Polialthia longifolia* | 0.06 | 0.36 | 0.51 | 0.93 |

The dominant tree species have been identified for 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 5.20**).

**Table 5.20 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 |

| Tree Species | Relative Density | Relative Dominance | Relative abundance | IVI |
|---|---|---|---|---|
| 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 5.21**) 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 5.21 : Dominant Tree Species in the Third stretch (km 201-300) Based on IVI**

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

| Tree Species | Relative Density | Relative Dominance | Relative abundance | IVI |
|---|---|---|---|---|
| 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 5.22**) in the last stretch (Km 301-360) are Populus deltoids, Eucalyptus globulus, Dalbergia sissoo, Neem- Azadirachta indica, Mangifera indica, Syzygium cumini

**Table 5.22 : 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-5.23**:

**Table 5.23 : Relative abundance and Relative Density of Shrubs and Herbs**

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

| Some small tree species: | Relative Density | Relative Abundance |
|---|---|---|
| *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. *Protected Forest in Project Corridor*

Forest cover in Haryana & Punjab hardly exists. State Govt. in these states have gone for social forestry along railway tracks and highways. The linear plantation (outside boundary limits of yards) within the RoW of Indian Railway land has been declared as Protected Forest in the State of Haryana and Punjab. In Uttar Pradesh (DFCC portion falling in Saharanpur district) linear plantation has not been declared as protected forest. The districtwise area of this declared protected forest land is as follows:

**Table 5.24: Protected Forest (PF) in Ha.**

| S. no. | State | District | PF in Ha. |
|---|---|---|---|
| 1 | U.P. | Sahranpur | nil |
| 2 | Haryana | Yamuna nagar | 51.77 |
| 3 | | Ambala | 52.698 |
| 4 | Punjab | Patiala | 26.592 |
| 5 | | Fatehgarh Sahib | 13.678 |
| | | Ludhiana | 30.4308 |
| | Total | | 175.1688<br>Say, 175 Ha. |

The first stage forest clerance for all the above mentioned declared forest areas has been accorded by the Northern Regional office of Ministry of Environment and Forest at Chandigarh wide letter no. 9-HRA283/2014-CHA dated 11-02-2015 (for Ambala and Yamuna Nagar districts) and 9-PBC309/2015-CHA dated 12-02-2015 ( for Fatehgarh Sahib, Patiyala and Ludhiana districts). The tree species in this declared linear plantation are same as mentioned in Table- 5.18 above. The pictorial view of this linear plantation has been shown below.

Since the declared forest area is land under Indian Railway poession and along the existing track so there is no existence of any wild life except domesticated fauna. There is no existence of any rare/ precious or endangered plant species/ fauna under these Protected Forests. No Reserve Forest land diversion is involved.

Photographs of PF (linear plantation) in Haryana & Punjab is given below to understand density, type of trees and its location.

Fig. 5.30 to 5.45 : Photo of Linear Social Forestrey in Haryana & Punjab


Photographs of declared protected forest (linear plantation in RoW) in Haryana






Photographs of declared protected forest (linear plantation in RoW) in Punjab






Above photographs of linear plantation in Haryana & Punjab done by respective State Forest Dept. along railway tracks & highways. The PF has locally available plant species. This does not come under normal 'forest' category. This 'Protected Forest' of total 175 Ha. needs to be diverted for DFC project. Once permission is received, DFCCIL will facilitate plantation as directed by Forest Dept.

### 5.3.10 *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. These are fauna coming to the riverine areas for water.

### 5.3.10. *Terrestrial and Aquatic Wildlife Fauna*

*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, hence seasonal. 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.

*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 along the river Yamuna etc.

*Amphibian Fauna*

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

*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**)

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

The species diversity index of the fauna in the study area is represented in **Table 5.25.**

**Table 5.25: Species Diversity Index of terrestrial fauna in study area**

| Faunal Class | Shanon | Study Zones |
|---|---|---|

| | Wiener Diversity Index | 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.

*Faunal Behaviour Pattern*

The Nilgai and the Wild Boar were found to be free living in the agricultural fields and forest patches near the Pilkhani to Sahnewal EDFC corridor track. These faunas comes under Schedule-2 of Wildlife (Protection) Act, 1972. They do not have any definite path to cross the railway track except at underpasses nearby. Nilgai & Wild Boar come close to railway track looking for crop/food & water. The general behaviourial pattern observed was that the animals used to flee or retreat due to the train approaching their location which appeared to be an instinctive act. No scientific study to assess the change in behaviour due to train movement has been done as part of the assessment.

*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.

*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.

*Identification of Endemic/ Threatened and Endangered Species*

There was **no endemic wildlife species** found in the study area, **no species of endangered species** were observed 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.

*Endangered Avian Fauna In Pilkhani to Sahnewal EDFC Corridor*

There were one vulnerable specie (IUCN Red list) found in the project area i.e. Sarus crane and one Schedule-I (IWPA 1972) species (*Gyps bengalensis*) in the area are listed in Table 5.26. Sauras Crane is found in swampy areas. The agricultural fields of Punjab and Haryana due to agriculture practices are ideahabitations of Sauras crane. The RoW acquired does not specifically have any such habitats.

The White Rumped Vulture uses trees to build habitats near human habitations. The loss of flora is distant from the human habitations. No breeding locations have been identified within the RoW.

**Table 5.26: List of Endangered/ vulnerable/ Schedule-I species**

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

*Wetland*

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

*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 found to be dependent for their livelihood on selling the fuel woods from neighbouring protected forest or naturally growing tree species along Pilkhani to Sahnewal EDFC corridor.

*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 wildlife habitat/ reserve forest areas/ sanctuary was observed 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.

*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 5.27). 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 5.27: 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* | *H* | *3.639* | *3.201* | *2.915* | *2.873* | *2.654* |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Fauna* | *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.

*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 5.28**)

**Table 5.28: 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 |
| 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 |

*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 Tor is found to be more dominant in the flood seasons because it migrates through main channel of the Yamuna River. Mahaseer was also

observed. In winter season, also *Tor 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.

*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.

*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. Tor Tor may get affected to some extent during bridge work across the river when silt due to earth work will pollute the river portion and may effect the migration.

Silt fencing, careful material storage away from the river banks (Yamuna, Tangri, Markanda and Chaudhadhara) & no construction works during monsoon season will be some measures to be undertaken during construction. Due care shall be taken not to completely block the flow of water at any stage of construction. During operational phase, there will be no impact. Necessary costfor silt fencing has been provideed in EMP cost. Mitigation plan is described in Chapter-10.

*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.

*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.

*Identification of Endemic/ Threatened and Endangered Species*

Only one fish species is found under endangered category (as categorised by NBFGR), i.e., *Tor Tor*.

*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.

*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 5.29**. The diversity both the phytoplanktons and the zooplanktons were found to be high in Yamuna River.

**Table 5.29: 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 |

*Ecological Important Areas -Aquatic*

There are ecologically important locations within the study area as represented in the following **Table 5.30**.

**Table 5.30: 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.

Fig. 5.46 to 5.59 : Photo of various Species

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.

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 5.31**)

Table 5.31: Project Area: Salient Features

| Sections | IR Chainage (km) | | Distribution of length (km) | | Total | | | |
|---|---|---|---|---|---|---|---|---|
| | From | To | Parallel | Bypass | Length | District | Village | LA (Ha) |
| CPM Ambala | 188.5 | 360.20 | 162.21 | 12.79 | 175.00 | 6 | 138 | 355.34 Say, 355 Ha. |

### 5.4.2. *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.

### 5.4.3. *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 5.32**). 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 5.32: 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%) |

### 5.4.4. *5.4.5 Agricultural land*

**Table 5.33** 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 5.33: 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%)** |

### 5.4.5. *Structures*

**Table 5.34** 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 5.34 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** |

### 5.4.6. *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 5.35**). 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 5.35: 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%)** |

### 5.4.7. *Impact on PAFs losing structure due to the Project*

Information given in **Table 5.36** 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 5.36**: **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 |

### 5.4.8. *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 5.37**). 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 5.37: Affected Community Properties Resources (CPRs)**

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

### 5.4.9. *Socio-Economic Analysis of the PAF$_s$ and PAP$_s$*

**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 5.38** that the sex ratio for this stretch is 775.

**Table 5.38: 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

**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 5.39** 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 5.39: 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%) |

## 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 5.40**. Schedule tribes are not found in the project.

**Table 5.40: 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).**

**Vulnerability**

**Table 5.41** 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 5.41**, 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 5.41 Vulnerability Status of the PAPs**

| Section | Project Affected Persons | | | | | Total |
|---|---|---|---|---|---|---|
| | Disabled / Orphan | Widow | Un Married Girls above | Below the Poverty | Person above 50 | |

| | | | 18 years | Line | 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.

**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 5.42**). 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 5.42: 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%)** |

**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 5.43: 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%)** |

### 5.4.10. *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 5.44 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 currently under revision. The entitlements which are being given or have been given earlier are in the table below:

**Table 5.45 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<br>• 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<br>• Reimbursement of | |

| Sl. No | Impact Category | No. of PAFs | Entitlements | Remarks |
|---|---|---|---|---|
| | | | stamp duty charges<br>• Transition allowance Rs. 4,000<br>• Shifting allowance of Rs. 10,000<br>• House construction assistance in case of BPL<br>• Rs 25,000 in case of business/ artisan/ self employed | |
| 3 | Affected Tenants/Lease holders | 0 | • 3 months written notice<br>• 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<br>• Shifting allowance of Rs. 10,000 | |
| **(c) Non Title holders** | | | | |
| 1 | Those loosing residential /commercial structures | 139 | • Compensation for structure loss based on Independent valuer's assessment<br>• Transitional allowance Rs. 4,000<br>• Shifting allowance of Rs. 10,000<br>• House construction assistance in case of BPL<br>• 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<br>• Training assistance of Rs. 4,000<br>• 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. *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 5.46**. All the ASI monuments are more than 1 Km away from the track.

**Table 5.46: 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 of above mentioned archaeological importance structure is much more than 300 m from the EDFC alignment central line. Therefore, no ASI structure is affected and 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 «g/m³ | PM2.5 «g/m³ | RSPM «g/m³ | $SO_2$ «g/m³ | $NO_X$ «g/m³ |
|---|---|---|---|---|---|---|---|---|---|---|
| 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.

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

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 |

| 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 | |
| 24 | *Nitzschia* | + | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1121 |
| 25 | *Stephanodiscus* | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | + | - | - | 1131 |
| 26 | *Synedra* | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1142 |
| 27 | *Melosira distans* | - | - | - | + | + | + | - | - | - | - | + | - | - | - | - | - | - | - | + | - | - | 1141 |
| 28 | *Cyclotella kutzingiana* | - | - | + | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1234 |
| 29 | *Fraigilaria capucina* | + | + | - | - | - | - | + | - | - | - | - | - | + | - | + | - | - | - | - | - | - | 1251 |
| 30 | *Synedra affinis* | - | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | + | + | 1424 |
| 31 | *Gyrosigma acuminatum* | - | + | + | + | - | - | + | + | + | - | - | - | + | + | + | + | + | - | - | - | - | 1172 |
| 32 | *Stauroneis phoenicenteron* | + | + | + | - | - | - | + | + | + | - | - | - | + | + | + | + | + | - | - | - | - | 1524 |
| 33 | *Navicula cuspidate* | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1342 |
| 34 | *Navicula halophila* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | 1612 |
| 35 | *Pinnularia interrupta* | - | - | + | + | + | + | - | - | - | + | + | + | - | - | - | - | - | + | + | + | + | 1431 |
| 36 | *Amphora ovalis* | - | + | + | - | + | + | - | - | - | - | + | + | - | - | - | - | - | - | + | + | + | 1259 |
| 37 | *Amphora veneta* | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1342 |
| 38 | *Cymbella ventricosa* | - | + | - | - | - | - | + | + | - | - | - | - | + | + | + | + | - | - | - | - | - | 1621 |
| 39 | *Cymblla hustedtii* | + | + | - | - | - | - | + | - | - | - | - | - | + | - | + | - | - | - | - | - | - | 1512 |
| 40 | *Gomphonema 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 |

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

| Sl. No. | Name | Sites | | | | | | | | | | | | | | | | | | | | | Density (Nos./L1-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 44 | *Filinia opoliensis* | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24 |
| 45 | *F. longiseta* | - | + | - | - | - | - | + | + | - | - | - | - | - | - | + | + | - | - | - | - | - | 21 |
| 46 | *F. terminalis* | + | + | - | - | - | - | + | - | - | - | - | - | - | - | + | - | - | - | - | - | - | 21 |
| 47 | *Floscularia ringens* | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 13 |
| 48 | *Keratella cochlearis* | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 15 |
| 49 | *Lecane aculeata* | - | + | + | + | - | - | + | + | - | - | - | - | - | - | + | + | - | - | - | - | - | 17 |
| 50 | *L. doryssa* | - | + | + | + | + | - | - | + | + | + | - | - | - | - | - | + | + | + | - | - | - | 12 |
| 51 | *L. elongata* | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | + | - | - | - | - | - | 13 |
| 52 | *L. eurysterna* | - | + | + | + | + | - | - | + | + | + | + | + | - | - | - | + | + | + | + | + | + | 14 |
| 53 | *L. heterostyla* | + | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | - | - | - | - | - | 21 |
| 54 | *Limnias melicerta* | - | - | - | - | + | + | - | - | - | - | + | + | + | + | - | - | - | - | + | + | + | 15 |
| 55 | *Lophocharis salpina* | - | - | - | - | - | - | - | - | - | + | - | + | - | - | - | - | - | + | - | + | + | 13 |
| 56 | *Monommata* sp. | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14 |
| 57 | *Mytilina bisulcata* | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | + | 11 |
| 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 |

| Sl. No. | Name | Sites | | | | | | | | | | | | | | | | | | | | Density (Ind/L1-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 68 | *Testudinella emarginula* | - | + | - | - | + | + | + | - | - | + | - | + | + | + | + | - | - | + | - | + | + | 14 |
| 69 | *T. patina* | - | - | - | - | - | + | - | - | - | - | + | + | + | + | - | - | - | - | + | + | + | 21 |
| 70 | *T. bicristata* | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | + | 15 |
| 71 | *T. cavia* | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | + | - | - | - | 13 |
| 72 | *T. capucina* | - | - | - | - | - | - | - | - | - | + | - | + | - | - | - | - | - | + | - | + | + | 14 |
| 73 | *T. iernis* | - | + | + | - | - | - | + | - | - | - | - | - | - | - | + | - | - | - | - | - | - | 11 |
| 74 | *T. longiseta* | - | - | - | - | + | - | - | - | - | + | - | + | - | - | - | - | - | + | - | + | + | 9 |
| 75 | *T. porcellus* | - | - | - | - | - | - | - | - | - | + | - | + | - | - | - | - | - | + | - | + | + | 10 |
| **Crustaceans** | | | | | | | | | | | | | | | | | | | | | | | |
| 76 | Cladocera | - | - | - | - | + | + | - | - | - | - | + | + | - | - | + | + | - | - | + | + | + | 23 |
| 77 | Bosminia | - | - | - | - | - | - | - | - | - | + | - | + | - | + | - | + | - | + | - | + | + | 25 |
| 78 | Daphnia | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24 |
| **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 |

| Sl. No. | Name | Sites | | | | | | | | | | | | | | | | | | | | | Density (Ind/ L1-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 90 | *Heliodiaptomus cinctus* | - | + | + | - | + | + | - | - | - | - | + | + | - | - | - | + | - | - | - | + | + | 15 |
| 91 | *Heliodiaptomus contortus* | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21 |
| 92 | *Heliodiaptomus pulcher* | - | + | - | - | - | - | + | + | - | - | - | - | + | - | - | - | + | - | - | - | - | 10 |
| 93 | *Neodiaptomus diaphorus* | + | + | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 22 |
| 94 | *Neodiaptomus strigilipes* | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 23 |
| 95 | *Phyllodiaptomus annae* | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 25 |
| 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).

## Annexure 5.11 : Type of ownership of trees to be cut

| State | Trees to be Cut | | | Total |
|---|---|---|---|---|
| | Declared Protected Forest | Railway Land | Private land | |
| UP | - | 4414 | 4470 | 8884 |
| Haryana | 19889 | 8523 | 682 | 29094 |
| Punjab | 1986 | 1763 | 674 | 4423 |
| Total | 21875 | 14700 | 5826 | 42401 |

The number of trees of dominant species proposed for felling are as follows:
1- Eucalyptus - 11941
2- Poplar - 3149
3- Babul/Keelar - 2489
4- Shisham- 1947
5- Peepal - 48
6- Fruit Bearing ( Mango, Jamun, Guava, etc.) - 331
7- Others- 621

# 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.

The construction materials to be used are ballast, sand, subgrade, steel and cement. The usage of these material will lead to permanent impact at quarry sites of sand and stone. The steel and cement usage will also have indirect impact on natural resources. During operation phase there will be no requirement of these materials. Steel and Cement will be procured from sources which produce steel in environmentally sound productionunits. Ballast, sand, subgrade will be obtained from local sources where thesec are extracted through sustainable practices. Proper quarry/borrow area management practices will be adopted to minimise the longterm and permanent impacts caused due to project.

Compensatory afforestation and tree plantation shall be taken up by DFCCIL and forest department to mitigate trees loss as detailed in Chapter-10.

The disposal of construction waste at identified location will not have any negative impact because only conventional and non hazardous waste will be disposed off at low productive and waste land. These materials will also be used for levelling the low lying areas.
Minimum agriculture land has been acquired to minimise impacts on landuse and rehabilitation and resettlement plan has been prepared to avoid social impacts.Detailed assessment of detour alignment has been given in Section -6.3.

**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. The waste disposal in Yamuna river is likely during construction of bridge. The construction materials and mud and silt may go in river if proper protection measures are not taken. In order to minimise the impacts the construction materials will not be stored near the river bank and silt fencing arrangements shall be provided. The completion of superstructure of bridge necessary protection measures will be taken so that no construction material go to the river. In order to further minimise the impacts, bridge related construction works will be taken up during lean season flow.

**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.

The alignment of Pilkhani- Sahnewal section of EDFC has been planned in most portion (162.21 km out of 175 km) through the Indian Railway own land, this has minimised the impacts on agriculture land, local community, trees, natural resources and ecology. The bridges have been planned parallel to existing bridges and in close proximity, this will avoid impacts on aquatic environment of water bodies. No additional land has been acquired at Kalanaur Reserved forest (Km 205 to 209) as EDFC rail line has been accommodated within the available RoW.

### 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. Analysis of Technical and Design Alternatives

The proposed alignment was evaluated based on technical parameters. The mandate was to reduce the land acquisition and social impacts to the extent possible. Keeping this in this in mind the alignment was kept parallel to the existing Indian Raiway track so that surplus railway land could be optimally utilised. This will ensu close coordination with the Indian Railways.

This section being single track alignment and parallel to the existing Indian Railways track, the RoW has been kept minimum possible.

At locations of major settlements detours have been proposed to avoid social impactsThe anaysis of alternatives of the planned detours has been presented below.

### 6.3.1 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. The alignment of Rajpura detour has been shown in Figure-6.2 below:


Figure 6.2 **: A view of Rajpura Detour**

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 |
| 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. The alignment of Sirhind detour has been shown in Figure-6.3 below:

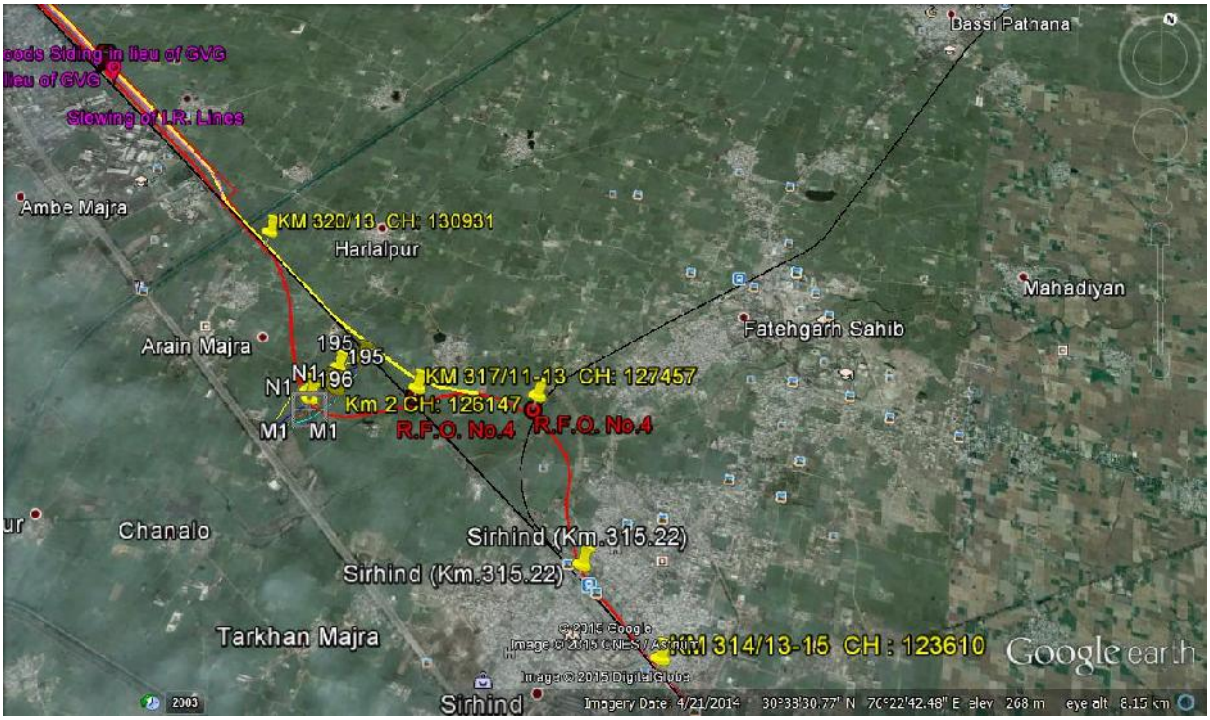



Figure 6.3 **: A view of Sirhind Detour**

### *6.3.2 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 42400 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 ($CO_2$ 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:** Part of Pilkhani – Sahnewal EDFC is located in seismic zone IV which is high damage risk zone. This may cause failure of civil structures in the event of earthquake if design consideration related to seismicity is not taken into consideration. Detail design will have to consider Seismic Zone-IV as a safety measure.

***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 «g/m$^3$ | Standards («g/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, batching & mixing plants, and idling of vehicles due to increased traffic congestion in construction areas. Traffic management will be effected by the Contractor to reduce idling of vehicles.

Batching plant, mixing plants are 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 batching, mixing plants 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. Traffic diversion will be done by the contractor in consultation with local authority to avoid as far as possible.

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.

$L_2 = L_1\text{-}20 \text{ Log } D_2/D_1$ ---------- (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:**

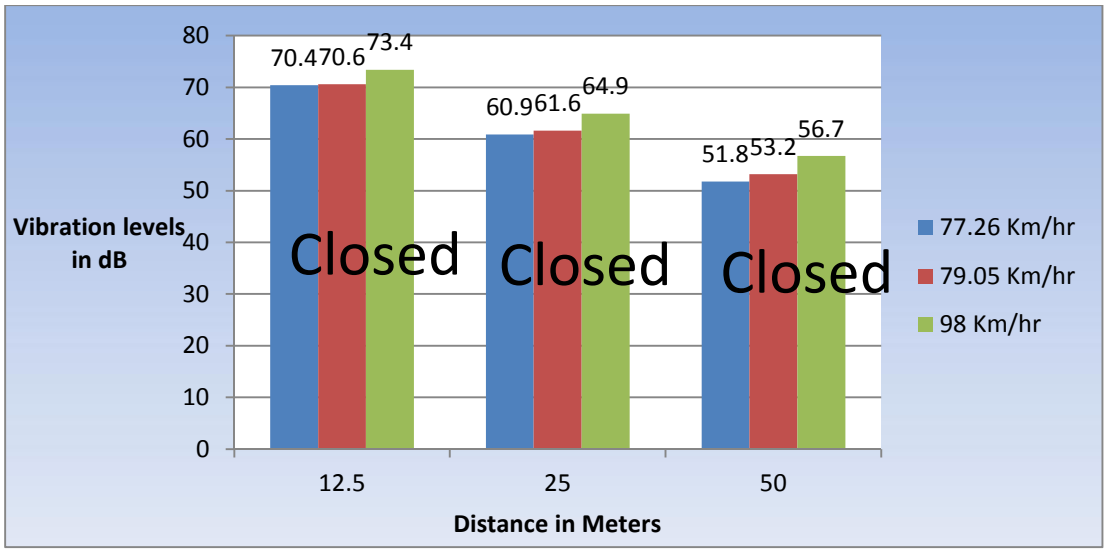
We have identified several kinds of impacts from the data collated in previous chapters. Typically, these impacts could be of following types

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. .

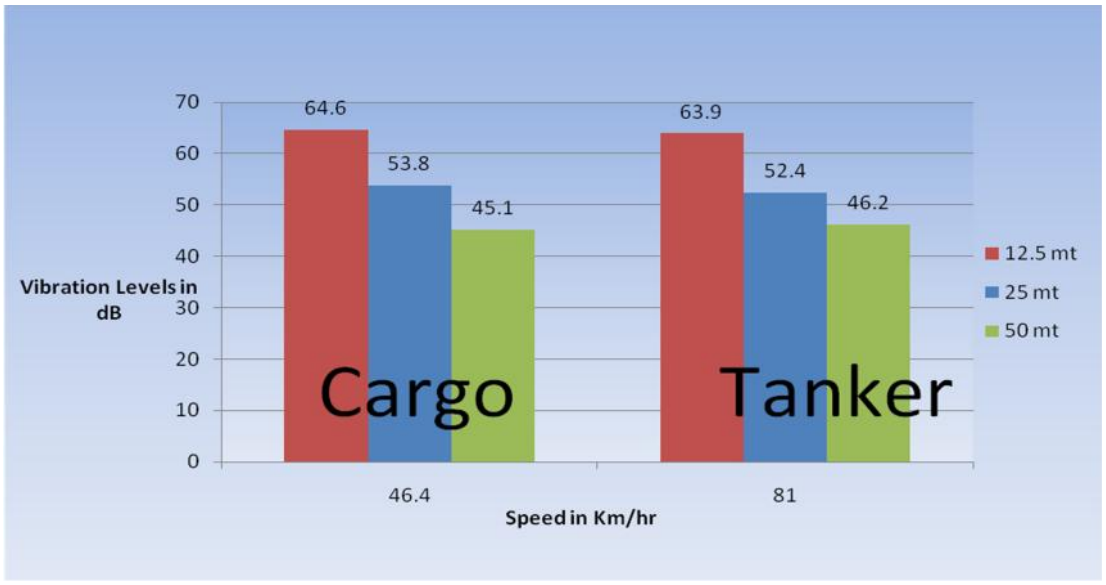
**Impacts in Plain areas vis-a-vis distances from the track**

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.

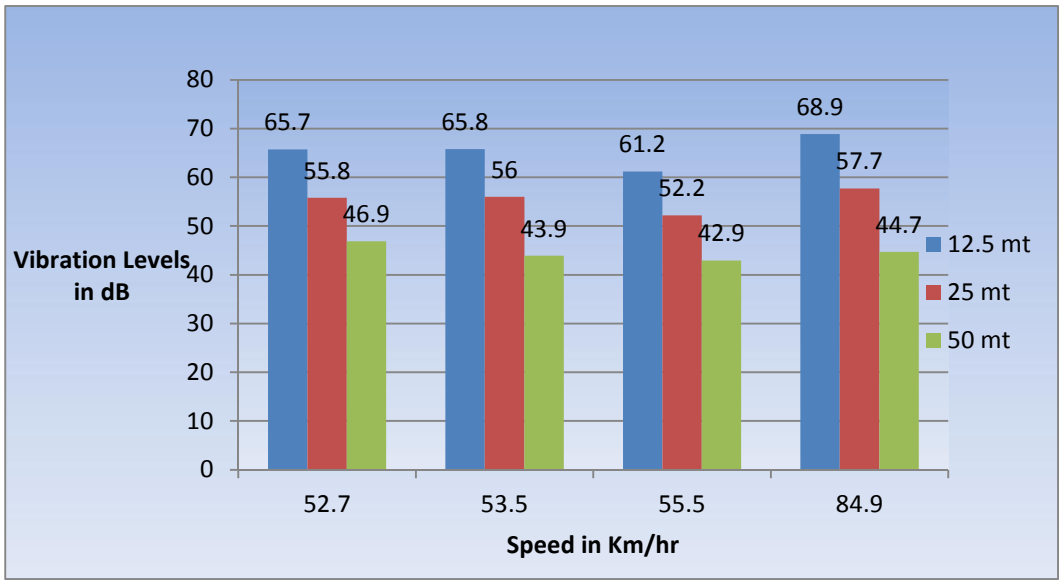
## Closed Wagon




## Tanker and Cargo




## Open Wagon

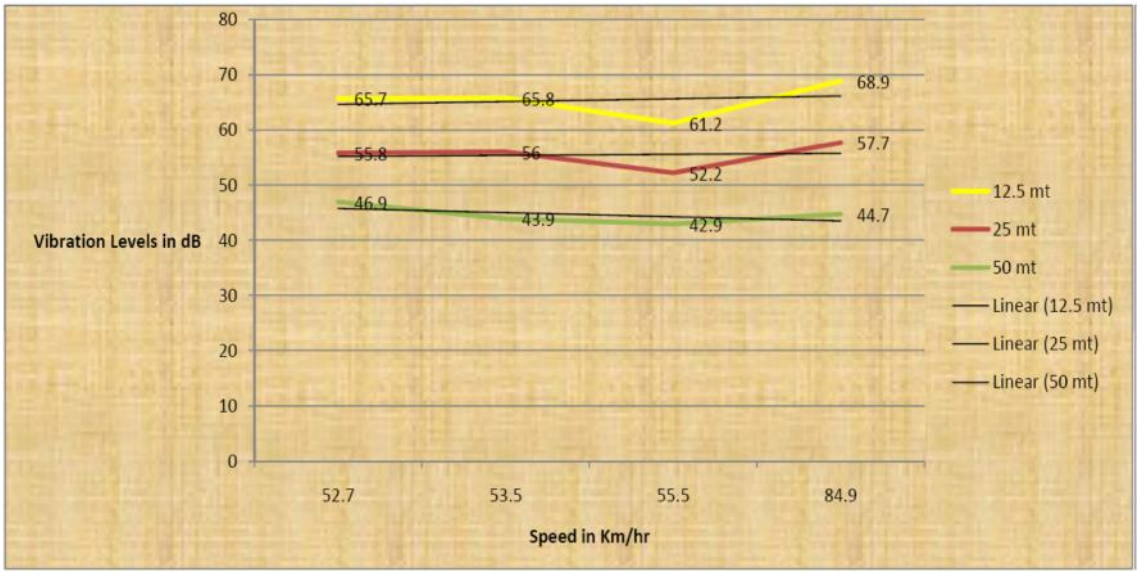


From the graphs above, we can select the highest vibration levels of all the categories of train for one distance (say 12.5, 25, or 50 meters) as the upper limit for that distance, for estimating the impact at $90^0$ to the track. This is tabulated at **Table 7.5**.

**Table 7.5 : Highest Vibration Levels for All Category of Trains**

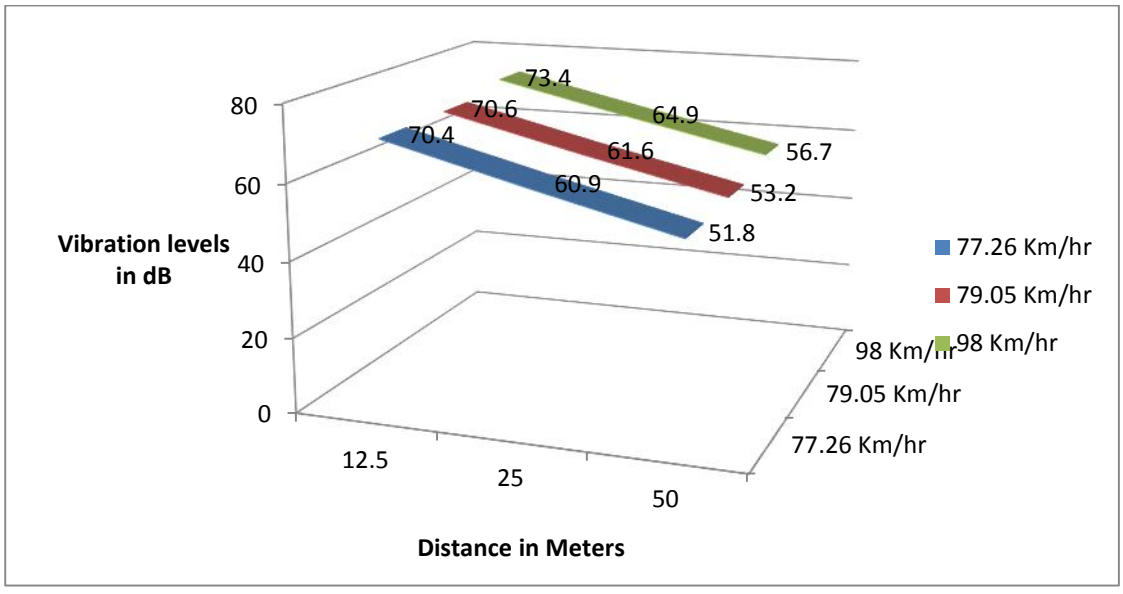
| Distance (m) | Maximum dB |
|---|---|
| 12.5 | 73.4 |
| 25 | 70.6 |
| 50 | 70.4 |

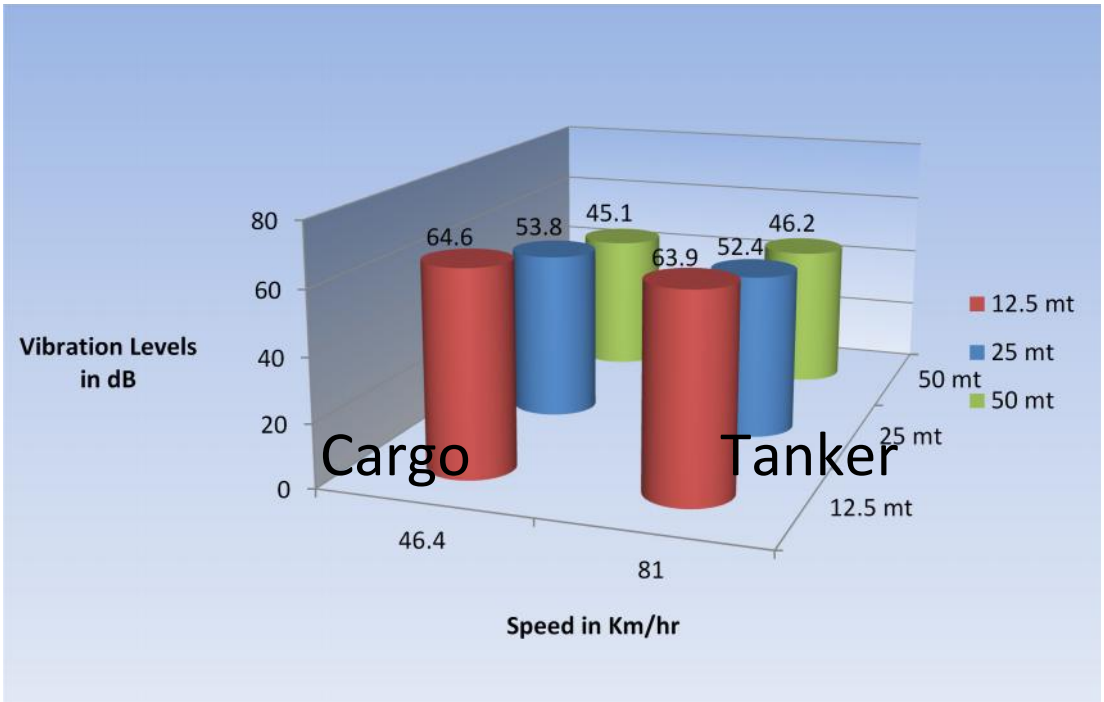
These values for all the three distances coincidentally correspond to only one categories of freight train that is **Closed Wagon**; Graph for this is as below:




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

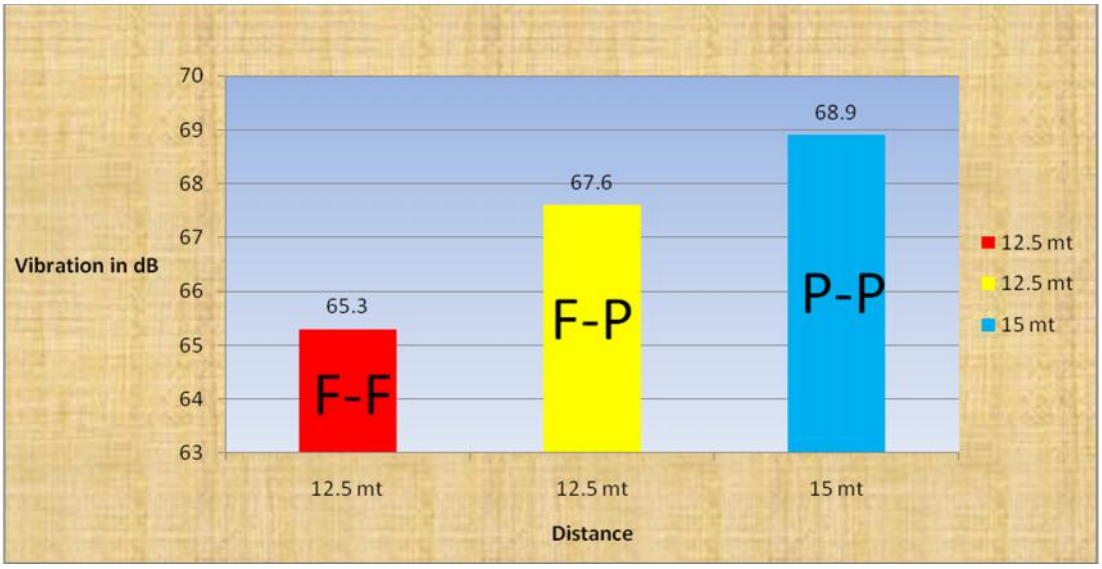
- maximum speeds of trains in each category as well as for
- maximum vibration in these categories and are as placed below:






**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). Pilkhani-Sahnewal section DFC will have single track, therefore Freight-Freight trains crossing is not involved. These crossings are representation of similar crossing likely to take place on EDFC on parallel tracks.




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^(75.3/10)-10^(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^ (75.3/10) +10^ (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

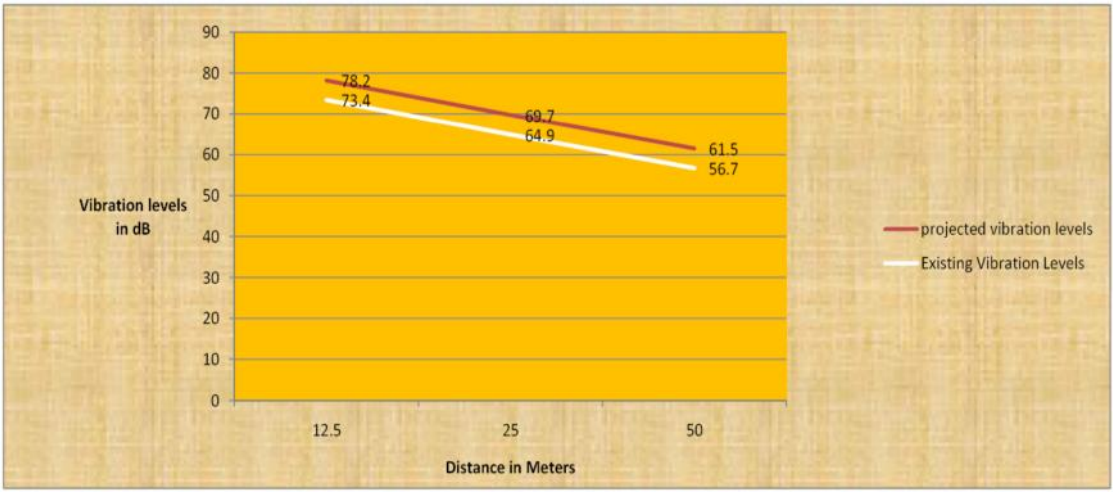
4. On the other side of two tracks, the situation will be driven by passenger train in similar four possibilities. The evaluated highest Lmax for these four possibilities are:

(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

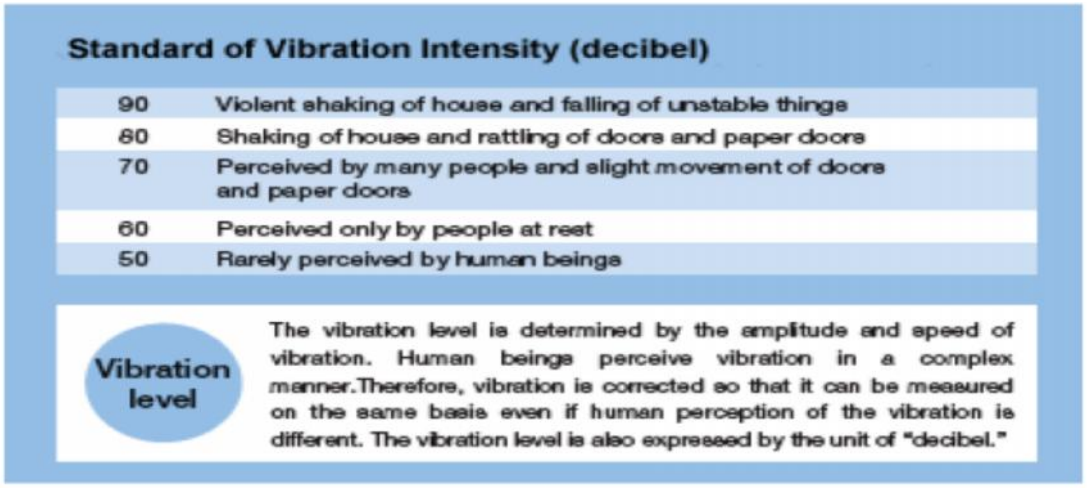
However, this value is lower than the highest Vibration Levels generated by running of Single Freight train.

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 |

### 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.

*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.

*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. .

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

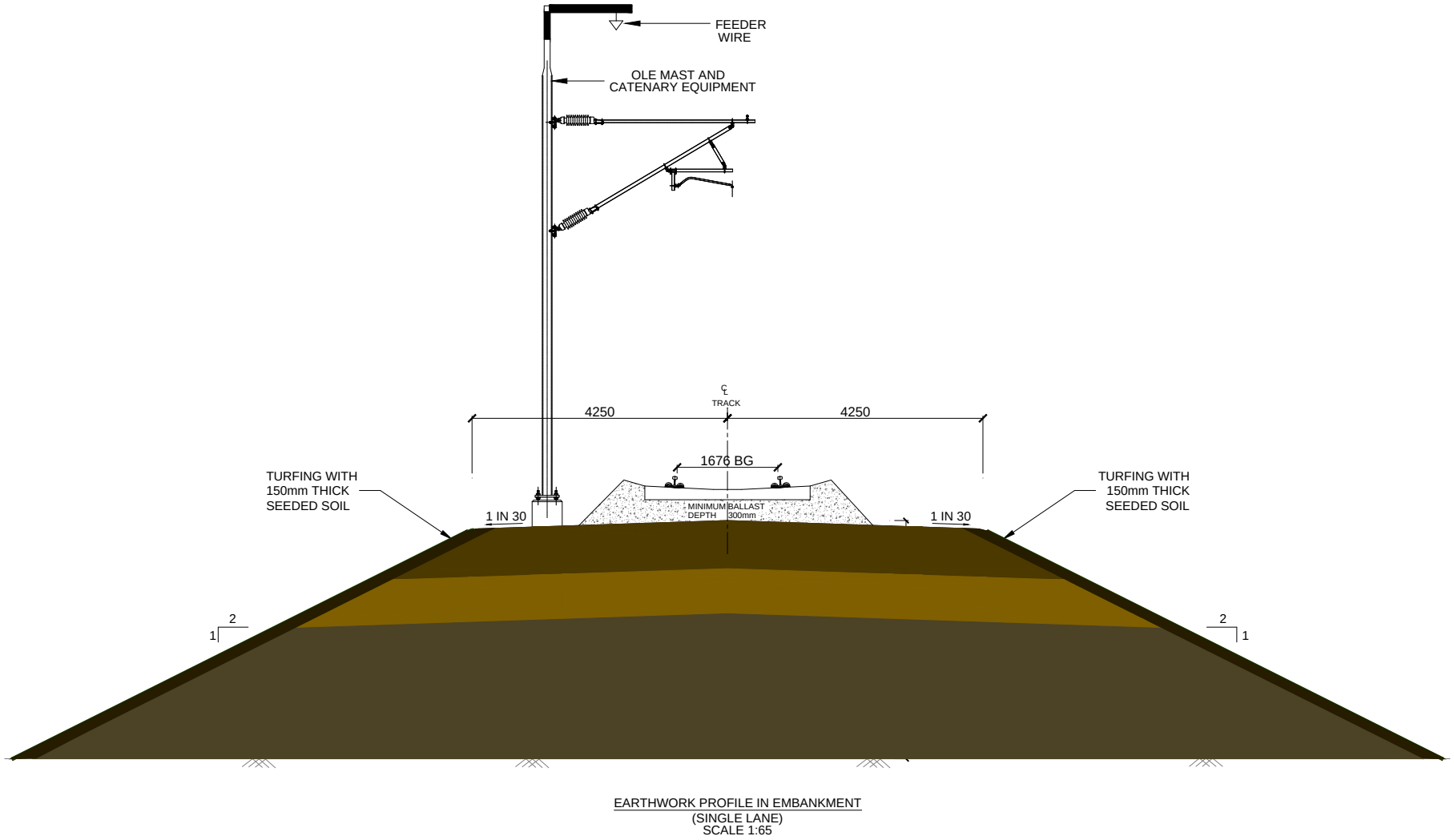



Figure 7.1 **: A View of Embankment filled with Earth Blended with Fly Ash / GGBS**

*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*

*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 $m^3$. Surface water to the extent possible will be used to meet water requirements during construction. The contractor will prepare water management plan focussing utilisation of maximum surface water and minimum use of ground water for which 25 % of the yield is allowed forindustrial purposes. The ground water can be extracted only with prior permission from CGWA and with the adequate provision of rain water harvesting.

**Water Plan**: During construction, water requirement will be met by the Contractor from Ground Water, Surface Water with prior permission from Ground Water Board or Irrigation Dept. Respectively. In case, water is sourced from privately owned bore well, required permission from the Authority will be verified & formal agreement will be done with bore well owner/ operator. Efforts will be made to use treated recycled water and rain water harvesting to recharge ground water.

***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.

*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) from 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<br>Rakshi River<br>Saraswati River<br>Markanda River<br>Tangri River | Controlled Flow<br>Non Perennial<br>Non Perennial<br>Non Perennial<br>Non Perennial | Irrigation Quality<br>Irrigation Quality<br>Irrigation Quality<br>Irrigation Quality<br>Irrigation Quality |
| 301 – 350 Km | None | Not Applicable | Not Applicable |
| 351 – 360 Km | Bhakra Canal<br>Sirhind Canal | Controlled Flow<br>Controlled Flow | Irrigation Quality<br>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.

*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 |

| Section | Chainage | Nearest Drain Present | Slope |
|---|---|---|---|
| | 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 |
| **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*

*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. 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 42400. 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* 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.

*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 near the railway line without following any definite path or route. However, these species come close to railway track looking for food & water.

***Operation Phase***

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

*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 predominantly in the agricultural fields adjoining the project area i.e. Sarus crane along with one Schedule-IV (IWPA 1972) species i.e. *Grus antigone which may be affected due to the construction work*.

***Operation Phase***

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

### 7.4.3. *Aquatic Ecology*

*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 of bridge or culverts will affect the fish diversity and abundance in the Rivers, canal and water body areas. The construction waste as per current construction practices ranges around 2-3 % (based on discussion with the construction contractor) of construction materials used. The total construction material to be used is 8388077 m3( 7342282 $m^3$ earth work and 1045795 $m^3$ blanket material). The waste likely to be generated is 209701 $m^3$. This entire material will not be discarded as some portion will be used in filling of borrow pits during borrow area rehabilitation and balance will be disposed off at the identified waste disposal site. The contractor will prepare a comprehensive waste management plan. Necessary precautions as enumerated in guidelines will be followed. The waste disposal locations will be approved by the environmental specialist of PMC. The hazardous waste ( mainly discarded fuel, lubricants, greases, etc.) will be disposed off as per provisions of Hazardous Waste ( Management, Handling and Tran boundary ) Rules, 2008. The locations of disposal of waste will be closely monitored so that waste does not enter water bodies, agriculture fields, Kalanaur protected forest and areas used for grazing. A guideline on Construction wastes & debris management is given at Annexure 10.3 for the Contractor to prepare its plan for construction period.

***Operation Phase***

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

*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. Construction wastes/ debris management will be as per guideline as described above.

***Operation Phase***

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

*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.

*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.

*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, 8 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-constrn. 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 | C | C: marginal impact is likely to occur There will be requirement of about 2000 litres/day for every 15 km length; ground water use will be kept minimum, maximum use of surface water will be ensured. | C: 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. 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<br>▪ Plantations<br>▪ 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<br>▪ Stationary noise making equipment placed away from populated areas<br>▪ Provision of temporary noise barrier<br>▪ PPEs to workers<br>▪ 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<br>▪ 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 approaches | Moderate | ▪ Top soil preserved and reused for plantations<br>▪ Repairing of River banks after construction<br>▪ Cross drainage structures to prevent water logging and thus soil erosion<br>▪ Turfing of embankment slopes<br>▪ Surface slope stabilization prior to seeding | Insignificant |

| Activity | Environmental Issue/ Component | Nature of Impact | Remedial Measures | Residual Impacts Level after Mitigation Measures |
|---|---|---|---|---|
| Quarrying | Impact on soil and land topography | Insignificant | ▪ Borrow area management<br>▪ 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<br>▪ Fuel and lubricants to be stored at the predefined storage location<br>▪ "Oil Interceptors" at the wash-down and re-fuelling areas to avoid soil contamination<br>▪ Proper solid waste management at construction camps | Insignificant |
| **Water Resources** | | | | |
| Water quality (Surface and Ground) | Impact on surface and ground water quality<br>Depletion of ground water<br>Contamination of water due to construction waste<br>Contamination of water from fuel and lubricants | Significant | ▪ Provision of Rainwater harvesting structures<br>▪ Collection of rainwater in sumps<br>▪ Septic tanks shall be provided to treat the domestic sewage from construction camps.<br>▪ Construction work close to the channels or other water bodies to be avoided.<br>▪ Construction camps to be located away from water bodies and habitated areas<br>▪ All necessary precautions to be taken to construct temporary devices to prevent water pollution due to increased siltation and turbidity.<br>▪ Oil and grease traps to be provided at fuelling locations, to prevent contamination of water.<br>▪ Slopes of embankment leading to water bodies to be modified and screened so that contaminants do not enter the water channel/ water body.<br>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 | Insignificant |

| Activity | Environmental Issue/ Component | Nature of Impact | Remedial Measures | Residual Impacts Level after Mitigation Measures |
|---|---|---|---|---|
| | | | ▪ Prevention of blockage of cross drainage structures | |
| **Terrestrial Ecology** | | | | |
| Disturbance to vegetation | Cutting of 42400 trees in core zone during project intervention | Significant | • Minimization of tree cutting.<br>• Compensatory tree plantation preferably on the basis of 2 trees plantation against each tree cut from non-forest land in double the extent of area of forest land used.<br>• Monitoring of survival rates of trees planted during afforestation programme. The maintenance will be carried out by DFCCIL in DFC land once civil contract ends. | Insignificant |
| Forest fragmentation and destruction | There is diversion of protected forest land to the extent of 175 Ha. There is no forest fragmentation the forest is a linear plantation within RoW of Railway land which has been declared protected forest. | Moderate | ▪ Afforestation as per provisions of sanction<br>▪ Monitoring of survival rates of trees planted during afforestation programme<br>▪ Forest Land diversion proposal submission and necessary cost provision for compensatory afforestation and NPV. The afforestation program prepared by the forest department and land identified. The number of trees to be planted shall vary asper site but would average around 1,50,000. | Insignificant |
| Endangered species | Only one vulnerable species of Sarus crane | Insignificant | ▪ No impacts on account of loss of habitats as these have not been observed in RoW. | 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<br>▪ Silt fencing during bridge work<br>▪ Minimizing the noise during the construction<br>▪ Flow of water in the Rivers and canals shall be maintained | Insignificant |

| Activity | Environmental Issue/ Component | Nature of Impact | Remedial Measures | Residual Impacts Level after Mitigation Measures |
|---|---|---|---|---|
| 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<br>Impact on livelihood due to land acquisition | Significant | Compensation planned. The resettlement Action plan has been prepared. | Positive impact |
| Safety | Risk of accidents and safety near rail tracks and at crossings | Significant | ▪ Adopt safe working practices<br>▪ Trainings to workers<br>▪ Adequate lighting and fluorescent signage shall be provided at construction sites.<br>▪ Signage in local language<br>▪ Setting up of speed limits<br>▪ Pedestrian passageways<br>▪ PPEs to workers | Insignificant |
| Construction Camp | Improper siting and management may lead to adverse effects on environment | Significant | ▪ No productive land shall be utilised for setting up of construction camp<br>▪ Proper Location of construction camp with minimum distance of 500 m from habitation, water bodies through traffic route and 1000m from forest areas.<br>▪ Proper sanitary facilities at camps<br>▪ LPG cylinders as fuel sources | Insignificant |

| Activity | Environmental Issue/ Component | Nature of Impact | Remedial Measures | Residual Impacts Level after Mitigation Measures |
|---|---|---|---|---|
| Occupational Health and safety | Risks of accidents due to moving trains, noise and vibrations, Fatigue | significant | ▪ Training to workers on personal track safety procedures<br>▪ Blocking train traffic on lines where maintenance is occurring<br>▪ Reduction of internal venting of air brakes to a level that minimizes noise<br>▪ Use of PPE if engineering solutions are not feasible.<br>▪ Railway operators should schedule rest periods at regular intervals and during night hours, to the extent feasible, to maximize the effectiveness of rest breaks. | Insignificant |
| **OPERATION PHASE** | | | | |
| Climate | Contribute positively in GHG Reduction | Significant Positive Impact | None Required | Significant Positive Impact |
| **Natural Hazard** | - | - | No impact, no mitigation | - |
| Air Quality | Fugitive dust emissions due Loading and unloading of cargo | Moderate | ▪ Guidelines shall be formulated for material handling practices (particularly for loading and unloading)<br>▪ Covered areas used for loading and unloading<br>▪ Covered vehicles for transportation<br>▪ PPEs to Workers | Insignificant |
| Noise and Vibration | Train movement – source of noise and vibrations | Moderate | ▪ Thick tree plantation around the sensitive location<br>▪ 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<br>▪ Monitoring of rehabilitation plan of borrow areas<br>▪ Inventorization of soil erosion prone areas<br>▪ Carrying out periodic check to assess effectiveness of stabilization measures viz. turfing, | Moderate |

| Activity | Environmental Issue/ Component | Nature of Impact | Remedial Measures | Residual Impacts Level after Mitigation Measures |
|---|---|---|---|---|
| | | | stone pitching measures | |
| Water resources | Stress on Ground water as abstraction for domestic purpose | Insignificant | ▪ Augmentation through rainwater harvesting<br>▪ Rainwater collection sumps<br>▪ 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 felling management to ensure minimal tree cutting<br>▪ Selection of healthy sapling; selection of fertile land for plantation; provision of fertilizers (Bio-fertilizer or artificial-NPK); provisioning of fencing in the plantation area; arrangement of watering facility after plantation<br>▪ Tree survival audit | Insignificant |
| 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 where possible. | Insignificant |
| **Aquatic Ecology** | | | | |
| Disturbance to aquatic ecology | None | Insignificant | None | Insignificant |
| **Socio-Economic** | Employment opportunities & 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: Impact & Mitigation Measures for land**

| 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<br>• 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<br>• Construction of new bridges and culverts<br>• quarry and borrow areas | • Embankment protection<br>• For Emb, ht.>3 m stone pitching,<br>• Emb ht. < 3m. turfing<br>• Residual spoil need to be disposed properly<br>• silt fencing need to be provided,<br>• quarries need to be reclaimed |
| 5 | Contamination of soil | Direct, long term negative impact | • Scarified bitumen wastes<br>• Oil & diesel spills<br>• Emulsion sprayer and laying of hot mix<br>• Production of hot mix and rejected materials<br>• Residential facilities for the labor and officers<br>• Routine and periodical maintenance | • Hazardous Waste (Management and Handling Rules, 1989) to be enforced.<br>• Oil interceptor will be provided for accidental spill of oil and diesel<br>• Rejected material will be layed in village roads or as directed by engineer<br>• Septic tank will be constructed for waste disposal |
| 6 | Soil quality monitoring | | • Effectiveness / shortfall (if any) | • Measures will be revised & improved to mitigate / |

| | | | | |
|---|---|---|---|---|
| | | | • Any unforeseen impact | 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.

(i) In no case the depth of borrow area should exceed 2m from the existing ground level.
(ii) Borrow pits slope should be maintained, no steeper than 1 Vertical: 2 Horizontal.
(iii) Water pooling to be avoided/managed so that NO disease spread due to water stagnation.
(iv) Precautionary measures as the covering of vehicles will be taken to avoid spillage during transportation of borrow area.
(v) The unpaved surfaces used for the haulage of borrow materials should be maintained properly for dust suppression.
(vi) 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.
(vii) 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. Siting plan guideline is given as annexure in Chapter-10.
- 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 : Impact on Water & Mitigation Measures**

| 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<br>• Relocation of ground / surface water sources |
| 2 | Alternation of cross drainage | Very low impact | • One major bridge over existing causeway<br>• 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<br>• Reduction in ground | • Silt fencing to be provided<br>• Recharge well to be provided to compensate the loss of previous |

| Sl. No. | Item | Impact | Impact (Reason) | Mitigation / Enhancement |
|---|---|---|---|---|
| | | | recharge<br>• Increased drainage discharge | surface<br>• 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.<br>• Water requirement of labour | • Contractor needs to obtain approvals for taking adequate quantities of water from surface and ground water sources. This 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<br>• Oil & diesel spills<br>• Emulsion sprayer and laying of hot mix<br>• Production of hot mix and rejected materials<br>• Residential facilities for the labour and officers<br>• Routine and periodical maintenance | • Hazardous Wastes (Management & Handling) Rules, 1989 to be enforced<br>• Oil interceptor will be provided for accidental spill of oil and diesel<br>• Rejected material will be layed in village roads or as directed by engineer<br>• Septic tank will be construction for waste disposal |
| 6 | Water quality monitoring | | • Effectiveness / shortfall (if any)<br>• 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.

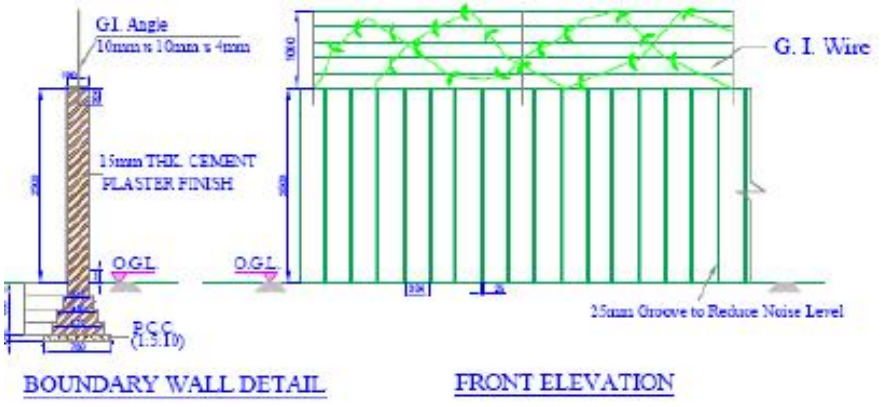
### 8.1.7. *Noise Environment – Mitigation Measures*

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 : Noise Impacts & Mitigation Measures**

| 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<br>• Establishment of labor camps onsite offices, stock yards and construction plants | • Area specific and for short duration<br>• Machinery to be checked & complied with noise pollution regulations.<br>• 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<br>• Community residing near to the work zones<br>• 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.<br>• 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. |

**Figure: 8.1: Typical Design of Noise Barrier**




### 8.1.8. *Sensitive Receptors – Mitigation Measures for Vibration*

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

**Table 8.4 : Impacts due to Vibration & Mitigation Measures**

| 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- |
| 10 | Temple | Doraha | 394 | 79 | -do- |
| 11 | Gurdwara | Doraha | 394 | 79 | -do- |

DFCCIL may consider use of improved versions of resilient fasteners at the locations of the sensitive receptors to reduce vibration levels further.Due care is to be taken at the design stage. Mitigation MeasureIndian Railways are already using such Fastners to reduce vibration and DFCC project of EDFC will use better version of the same. They shall be replaced based on their lifecycle. Indicative sketch of the device is given below. Sensitive receptors & houses/ structure along the alignment will be benefitted in the process.

**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.

### 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.

### 8.1.10 *Water management Plan*

During construction, water requirement will be met by the Contractor from ground water, surface water with prior permission from Ground Water Board or Irrigation Dept. respectively. In case, water is sourced from privately owned bore well formal agreement will be done with bore well owner/ operator. Efforts will be made to use treated recycled water and rain water harvesting to recharge ground water. A water management plan for construction activities is given at Annexure 10.4. Contractor will develop its own plan for adoption during construction.

### 8.1.11 *Seismic Risk Management*

Earthquakes and earthquake damage are quantified by specifying magnitude and/or intensity. Magnitude is a measure of earthquake size based on the amplitude of seismic waves recorded instrumentally and is a characteristic of the earthquake at its source. Magnitude is stated as a decimal, typically to the nearest tenth. Intensity is a measure of the intensity of ground shaking at a particular location, determined according to criteria based on observations involving varying degrees of subjectivity. Several intensity scales have been formulated. In general the lower intensities are based on perceptions of ground motion and the higher intensities on the extent of damage. Intensities for an earthquake usually decrease, with increasing distance, from a maximum near the source to the minimum value in the scale.

Damage to the railway and adjacent areas include severe liquefaction and lateral spreading of embankments which are likely to result in vertical and horizontal track geometry issues, abutment movement caused by embankment liquefaction, severe track buckle.

A part of Pilkhani-Sahnewal alignment falls under Seismic Zone IV in Punjab. Rules of Indian Railways. IRC 6, published by the Indian Road Congress, deals with highway bridges and its seismic loading provisions have been modified in 2006, to bring them in line with the IS 1893(Part 1):2002. Bureau of Indian Standards code, IS 1893(1984) has provisions for highway as well as railway bridges. Existing Bridge Rules of the Indian Railways has derived its seismic loading provisions from IS 1893. These rules have been revised by RDSO and circulated in January, 2015. Following Codes/ Rules/ Guidelines are followed:

- Formation/ Embankment : It is designed as per RDSO-GE-0014 for heavy haul loading.
- Ministry of Road Transport and Highways Specification for Bridge works, 4th edition.

- Report on "Guidelines for use of Geosynthetics on Railway Formation including specifications" (Provisional) Report No. RDSO/2007/GE:G-0009 (D) July 2008.
- Concept and Design of Reinforced Earth Structures Report No. GE:R-73 June-2005, Ministry of Railways guidelines for Earthwork in railway Projects, guidelines No. GE:G-1.

### 8.1.12 Mitigation Measures for Terrestrial Ecology

**Flora:** About 30,000 trees are to be planted against cutting of 20525 trees on private, railway/ Govt. land and these will be planted by the contractor. Plantation will be done on available railway, DFCC land and plants/ saplings will be maintained by the Contractor for three years from the year of planting & thereafter by DFCCIL. In addition, Forest Dept. of respective states will plant almost 1,50,000 trees in lieu of diversion of 175 Ha. protected forest land in which 21875 trees are to be cut for the project. DFCCIL will deposit demanded money to the forest department towards compensatory afforestation as well as maintenance of the trees. A tree planatation plan is given at Annexure 10.5. Measure to be taken during the work as described below. Following table gives details of plantation:-

**Table 8.5 : Trees to be Cut & Compensatory Plan**

| State | Trees to be Cut | | | Total | Compensatory Plantation | |
|---|---|---|---|---|---|---|
| | Declared Protected Forest | Railway Land | Private Land | | By Forest Department | By DFCCIL |
| UP | - | 4414 | 4470 | 8884 | 8438 (Saharanpur District) | 9330 (Junction station, Yard and space in RoW and community land in consultation with district authorities and community) |
| Haryana | 19889 | 8523 | 682 | 29094 | 103540 ( at Muzadwala PF, Sugh PF, Kalanaur RF, Deogarh PF, Dadupur canal side, along Khera railway line, along Chetan drain) | 20600 (Junction station, Yard and space in RoW and community land in consultation with district authorities and community) |
| Punjab | 1986 | 1763 | 674 | 4423 | 50337 (at Bir Kheri Gujjaran, Bir Mazal, Bir Sanaur, Bir Miranpur Ghoghpur | |
| Total | 21875 | 14700 | 5826 | 42401 | | |

***During Construction:*** During the construction the contractor will ensure that no tree or vegetation is disturbed other than those marked for felling. In order to minimise impacts on terrestrial ecology, the contractor will ensure that no construction waste is disposed off in open / grazing land /agriculture land. The environmental expert of PMC will conduct a training program for the construction workers for sensitization including not to hunt the animals and damage trees. The contractor will make available LPG or kerosene for cooking so that workers do not depend on fuel wood for cooking.

The compensatory plantation will be carried out and survival rate will be monitored and any short fall below 95 % will be made up before the onset of next monsoon.

***During Operation*** **:** During the operation phase the DFCCIL either through the appointed contractor or through its own resources will monitor survival rate of trees for the first three years. By this time the plants will grow and will sustain through natural process.

**Fauna**: Necessary civil design features like an underpass to allow movement of animals across the tracks shall be ensured.

### 8.1.13 Mitigation Measures for damage to property

DFCCIL shall regularly review the state of the tracks and carry out maintenance work to improve them where necessary, so it is unlikely that the condition of the tracks would cause any damage to nearby buildings. At sesnsitive receptor locations no vibration impacts have been identified during EA. However, if it is found that the vibrations from trains running near the property is causing structural damage, an investigation can be taken up.

To assess the impacts of vibrations on structures baseline will be established through time stamped Videography and study of structural stability.. Sensitive Receptors would also be vedeographed so that a comparison can be made during the operation phase.

### 8.1.14 Traffic management

The project involves construction of 50 ROBs and 27 RUBs which is likely to cause traffic congestion and idling of vehicles during the construction phase. The traffic is to be managed by providing suitable alternate routes to reduce the idling time in consultation with the local administration. It shall be done as per the railway guidelines. Suitable information dissemination campaign shall be taken up in the area to build awareness.

## 8.2. Chance Find

Any archaeological article or structure found during construction shall be as per the provision of the Act/ Rules and as per OP 4.11 of World Bank Safeguard.

# 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 & January 2012 and Stake-holders' discussions in 2013 & 2014. 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. It is noted that the Project alignment has not undergone any change since PCMs held last in 2012. Further, stake-holders' discussions were conducted in 2013 & 2014 as well.

## 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. PCM was again conducted in select locations in 2013. 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<br>• Technical information related to the project<br>• 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.<br>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<br>Proper disposal of waste generation during construction stage<br>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<br>• Afforestation Policy<br>• Procedure for permission<br>• 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.<br>On reviewing DFCC alignment the |

| Date and Venue | Institution | Participants | Issues Discussed | Outcome |
|---|---|---|---|---|
| | | | | forest officials confirmed that it will pass through PF.<br>They suggested forest land diversion should be minimised<br>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<br>• Environmental issues related to existing industries<br>• NOC Required | All the officers are apprehensive of increase in water and air pollution levels in the area near daurala, mansurpur, deoband and 9-4aharanpur 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.<br>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.<br>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 | Kulvindar Singh,Ramsarup, | • Problem of access through | Since the proposed track is parallel to |

| Date | Location | Participants | Issues | Outcomes |
|---|---|---|---|---|
| | Station and nearby areas along the track | Raghuveer Singh, Rajesh Kumar, Pitam Singh,Panjab Singh, Avatar Singh, Om Prakash Verma<br>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 | the existing level crossing.<br>• Problem of traffic congestion.<br>• No sewerage facility.<br>• Since the habitation is very close to the track, accidents are frequent.<br>• Problem of noise and vibration that affects studies of children. | the existing one, at most of the locations, the residents staying close to it were concerned about safety of their children.<br>People were concerned about expected demolition of Robin model school, which is very near to the existing track in this section of DFC alignment.<br>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.<br>Thus, they demanded safe and separate access for themselves.<br>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 | • Problem of access through the existing level crossing.<br>• Problem of traffic congestion.<br>• No sewerage facility.<br>• Since the habitation is very close to the track, accidents are frequent.<br>• Problem of noise and vibration, which affects studies of children. | • Welcomed the project but want these issues to be addressed before planning its construction.<br>• 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. |

| Date | Location | Participants | Issues | Outcomes |
|---|---|---|---|---|
| | | Singh, Daljit Kaur, Jasveer Singh | | |
| 22-12-2009 | Yamuna Nagar and nearby area along the track | D.B. Batra, Satish Kumar, A.N.Singh, Jaipal | Environmental problem due to nearby industries<br>Impact on living standards | People were highly concerned about existing environmental problems due to heavy industries.<br>People were hopeful that the proposed project of DFC would decrease the vehicular pollution due to road traffic.<br>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<br>• 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.<br>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.<br>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)<br>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 December 2013*

The summary of consultations carried out during December 2011 and January 2012 is given below in **Table-9.4**. The details of village level consultations carried out in the year 2013 have been summarised in **Table-9.5.**

**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, | • Vibration will be minimized using plantation, and constructions of boundary, and using suitable fasteners. These measures elaborated in EMP. Pilkhani-Sahnewal section will be single track, therefore much less vibration due to crossing of two trains at a time. During construction, earthfilling, movement of construction equipment will not cause significant vibration to cause any damage to the houses. Moreover, depending on location of houses, videographing of such selected houses will be done by the Contractor for finding any damage caused later due the DFC project. Action will be taken accordingly. |
| | • Project officials should provide correct information,<br>• Loss of source of livelihood because of loss of fertile agricultural land,<br>• Loss of access to the agriculture field especially in Detour sections,<br>• Loss of religious and other common properties,<br>• Division of habitation and cultural properties because of DFC tracks,<br>• Increase in accidents and suicide because of construction of tracks.<br>• Cutting of trees and removal of water supply sources ( Wells, Tube wells should be minimised) | • Communication will be done with the help of NGOs and community based organizations,<br>• Loss of livelihood is addressed in RAP,<br>• Underpasses/RUB is proposed at suitable locations.<br>• Religious properties will be relocated in consultation with communities.<br>• This type of community properties have been connected through underpasses, foot Over Bridges,<br>• Accidents hotspots will be identified and remedial measures taken.<br>• The water supply sources will be relocated. Tree cutting minimised by planning alignment in most portion along the existing track. |
| Expectati-ons from the Project | • Provision of Job in lieu of compensation,<br>• Compensation as the replacement value of lost assets,<br>• Gramsabha land should be given as resettlement site,<br>• Job to landless families,<br>• Compensation on the norms of private acquisition,<br>• Compensatory plantation should be taken up in vacant space<br>• 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.<br>• Compensation at replacement value under revised EM.<br>• 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.<br>• Entitlement Matrix has been revised. To offer latest rates for Compensation as per the new EM given in RAP.<br>• Compensatory plantation will be taken up as per directive of Forest Department.<br>• 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 Alternativ- | • Water pipeline and underground pipe damage should be minimised<br>• Width of land for DFCC Track | • Lost pipeline will be replaced,<br>• Width of Land is reduced to 17 meters at many locations to minimize the impact, |

| Category | Key Concerns Raised | Consideration in Project Implementation |
|---|---|---|
| es | should be reduced to minimize land acquisition,<br>• Underpasses should be constructed near important crossing especially near school,<br>• Foot over bridges (FOB) should be given at important locations<br>• Remodeling of yard and platform to minimize RoW | • About 86 underpasses/RUB are planned (mainly on detours) to compensate loss of connectivity,<br>• 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. |

**Table 9.5 : Village Level Consultations During January 2013 to December 2013**

| Village and date of Consultation | Key Concerns Raised | Consideration in Project Implementation |
|---|---|---|
| Village Sayliba for villages Sayliba, Darajpur and Kalapur (District Yamuna Nagar, Haryana) Date 10-04-2013 | PAPs demanded compensation for land at market rate<br>Small holding of land should be acquired at full rate<br>Demarcation of land should be done along the track<br>• PAPs demanded that as per Haryana Government policy land acquisition ( additional compensation in the form of rent for the land for 33 years) DFCC should also pay rent over and above the compensation. | • The compensation being paid as per R&R policy of the project<br>• The project authorities are making payment for small landholding at full rate<br>• Land demarcation at site is done after making payment to PAPs and boundary pillars have also been put the RoW boundaries at site.<br>• The project does not have provisions for the payment of the rent over and above compensation, so this cost can not be paid. |
| Village Ajnali, District Fatehgarh Saheb on March 03, 2013 | • Small landholding should be acquired at full rate<br>• PAPs demanded that at least one member of a family should be provided employment in DFCC<br>• The access to agriculture farms should be provided as at many a places access is being acquired for the project.<br>• Tube well connection cost for the land purchased | • The payment for small land holding is being made as per the project policy<br>• The project R&R policy does not allow provision of job as part of compensation so this demand can not be met.<br>• The DFCC project will not obstruct access to agriculture fields and farmers will not have any problem on this account.<br>• The tube well connection at location of new purchased location of land not in the ambit of R&R policy of the project so this can not be considered. |

The list of participants and signature has been provided in Annexure-9.1 .

### 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.

Photo of PCMs conducted – Figures 9.1 to 9.10


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


Consultation with villagers at Sayliba in Yauna Nagar district

Consultation with villagers at Sayliba in Yamuna Nagar district on 10-04-2013

Consultation with villagers at Ajnali, District Fatehgarh Saheb on 03-03 2013

**Table 9.6**: **Consuiltations during 2013**

| Sr. No. | Description | Outcome/ Issue raised by participants | Remarks |
|---|---|---|---|
| | Project Impacts | • Cracks in houses due to vibration from high speed loaded goods trains.<br>• Project officials should provide correct information.<br>• Loss of source of livelihood due to loss of fertile agricultural land.<br>• Loss of access to the agriculture field especially in detours<br>• Loss of religious and other common properties<br>• Division of habitation and cultural properties because of DFC tracks<br>• Increase in accidents and suicide because of construction of tracks. | • Measures to minimise vibration & its impact in design and by plantation & construction of boundary wall as agreed in EMP.<br>• Communication will be done with the help of NGOs and community based organizations,<br>• Loss of livelihood is being addressed in RAP,<br>• Underpasses/RUB is being proposed at suitable locations.<br>• Religious properties will be relocated / replaced in consultation with communities.<br>• This type of community properties will be connected through underpass<br>• Accidents hotspots will be identified and remedial measures will be taken to prevent such cases |
| | Expectations from the Project | • Provision of Job in lieu of compensation,<br>• Compensation as the replacement value of lost assets<br>• Gramsabha land should be given as resettlement site<br>• Job to landless families,<br>• Compensation on the norms of private acquisition, | • Provision of job has not been decided upon yet.<br>• Compensation at replacement value under revised Entitlement Matrix.<br>• Since Land Acquisition for DFC project is a linear acquisition, there is no mass displacement. Moreover, the surplus land is not available with Ministry of Railways. Therefore, resettlement site has not been planned for DFC project.<br>• As given at top<br>• Entitlement Matrix has been revised to offer latest rates for Compensation as per the new EM, |
| | Design and Alternatives | • Pipeline and underground pipe should be constructed,<br>• Width of land for DFCC Track should be reduced to minimize land acquisition,<br>• Underpasses should be | • Lost pipeline will be replaced<br>• Width of Land is reduced to 17 meters at many locations to reduce the impact, |

| Sr. No. | Description | Outcome/ Issue raised by participants | Remarks |
|---|---|---|---|
| | | constructed near important crossing especially near school,<br>• Foot Over Bridge (FOB) should be given at important locations<br>• Remodeling of yard and platform to minimize ROW | • Underpasses/RUB are planned (mainly in detours) to compensate loss of connectivity,<br>• Location of FOB will be finalized in consultation by facilitating NGO during the course of implementation. Since FOBs will cross existing IR Track, it will be finalized with close coordination with MOR .<br>• As replied above |

## 9.7 Proponent's response

Project proponent responded to participants'/ villagers' queries and apprehensions which are listed in the above table.

Photo of PCM conducted for Social & Environment in 2013- Figures 9.11 to 9.15

Consultation with inhabitants near Khanna

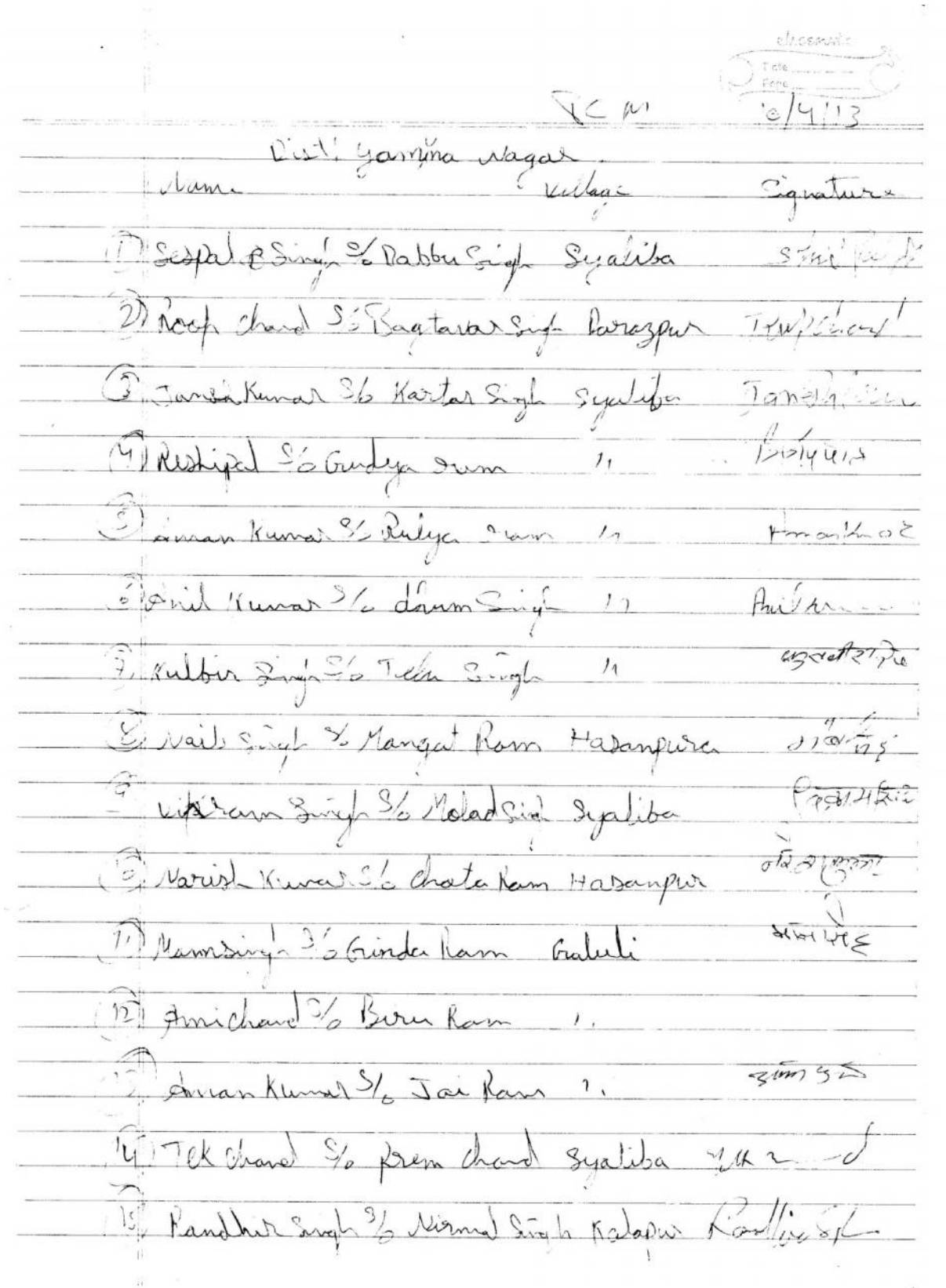
Ambala (Brara) on 04.03.2013

Ambala (Dukheri) on 04.04.2013

Fatehgarh Sahib (Sirhind) on 03.06.2013

Yamunanagar (Kalanaur) on 11.04.2013

Annexure 9.1 : List of Participants and Signatures

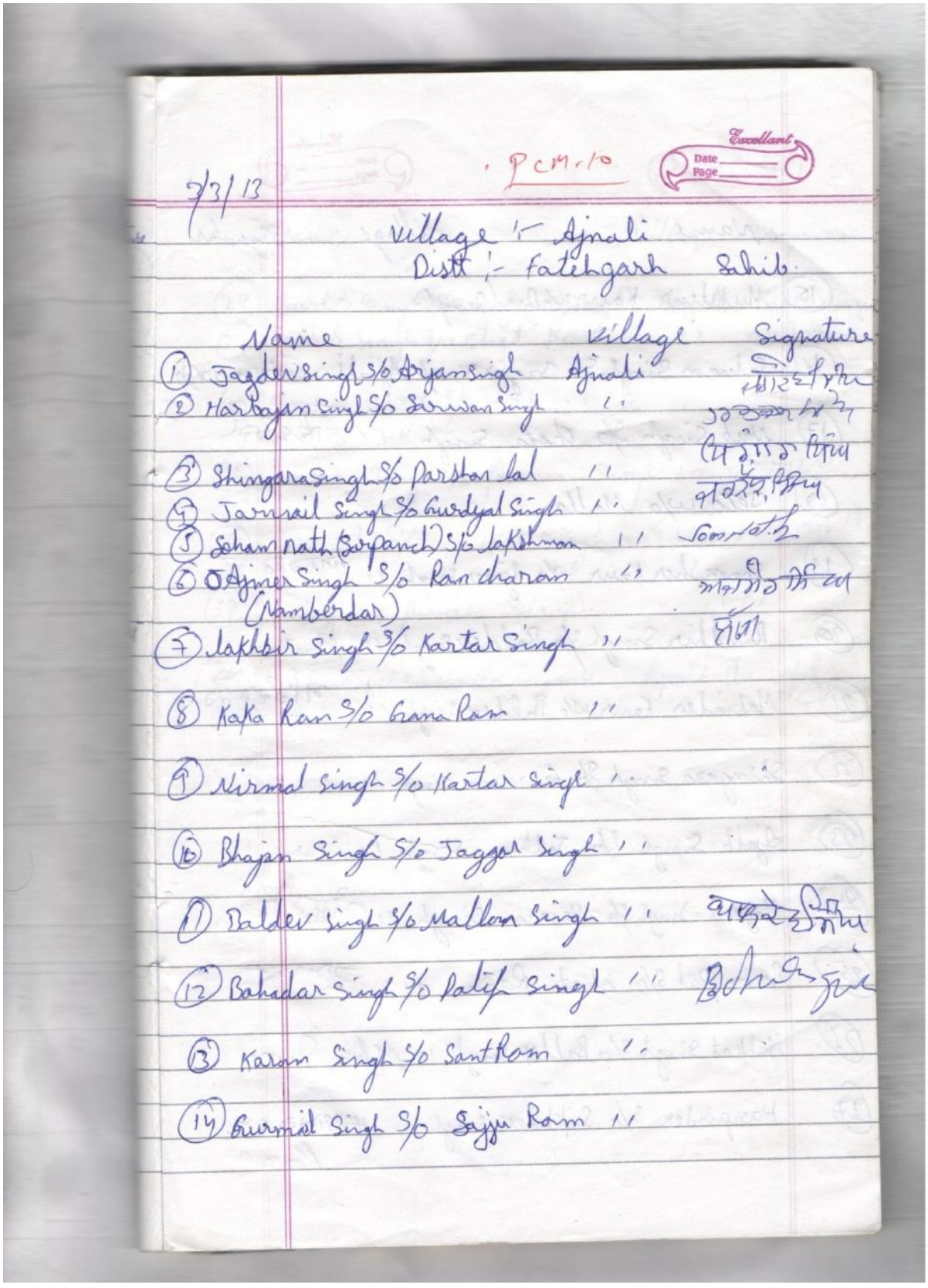


Dist. Yamuna Nagar.

| Name | Village | Signature |
|---|---|---|
| 1) Sohpal Singh S/o Babbu Singh | Syaliba | |
| 2) Roop chand S/o Bagtawar Singh | Barazpur | |
| 3) Jarnail Kumar S/o Kartar Singh | Syaliba | |
| 4) Rishipal S/o Gurdya ram | " | |
| 5) Aman Kumar S/o Rulya ram | " | |
| 6) Anil Kumar S/o Daam Singh | " | |
| 7) Kulbir Singh S/o Teka Singh | " | |
| 8) Naib Singh S/o Mangat Ram | Hasanpura | |
| 9) Kishan Singh S/o Molad Singh | Syaliba | |
| 10) Harish Kumar S/o Chota Ram | Hasanpur | |
| 11) Mamsingh S/o Ginda Ram | Gaduli | |
| 12) Amichand S/o Bura Ram | " | |
| 13) Arjan Kumar S/o Jai Ram | " | |
| 14) Tek Chand S/o Prem Chand | Syaliba | |
| 15) Randhir Singh S/o Nirmal Singh | Kalapur | |

| | Name | village | Signature |
|---|---|---|---|
| 16 | Anil Kumar S/o Ram Kyar | Gabuli | Anil Kumar |
| 17 | Manish Rana S/o Pawan Kumar | Syaliba | Manish Rana |
| 18 | Ravinder S/o Kulbir Singh | Syaliba | |
| 19 | Ram Kuwar S/o Ram Ramchad | " | |
| 20 | Antwari S/o Radhwa | " | |
| 21 | Kala w/o | | |
| 22 | Sardari w/o Antwari | " | |
| 23 | Samarjeet w/o Kala | " | |
| 24 | Kartaru w/o Nemchand | " | |
| 25 | Shripal S/o Sardara | " | |
| 26 | Sam Singh S/o Hari Singh | Sardarjiwa | |
| 27 | Jaipal Singh S/o Raja Ram | Syaliba | |
| 28 | Kiranpal S/o Tehi Ram | " | |
| 29 | Jaipal Singh S/o Surjeet Singh | " | |
| | Mahindra S/o Kishna Singh | " | |

Participants Lists



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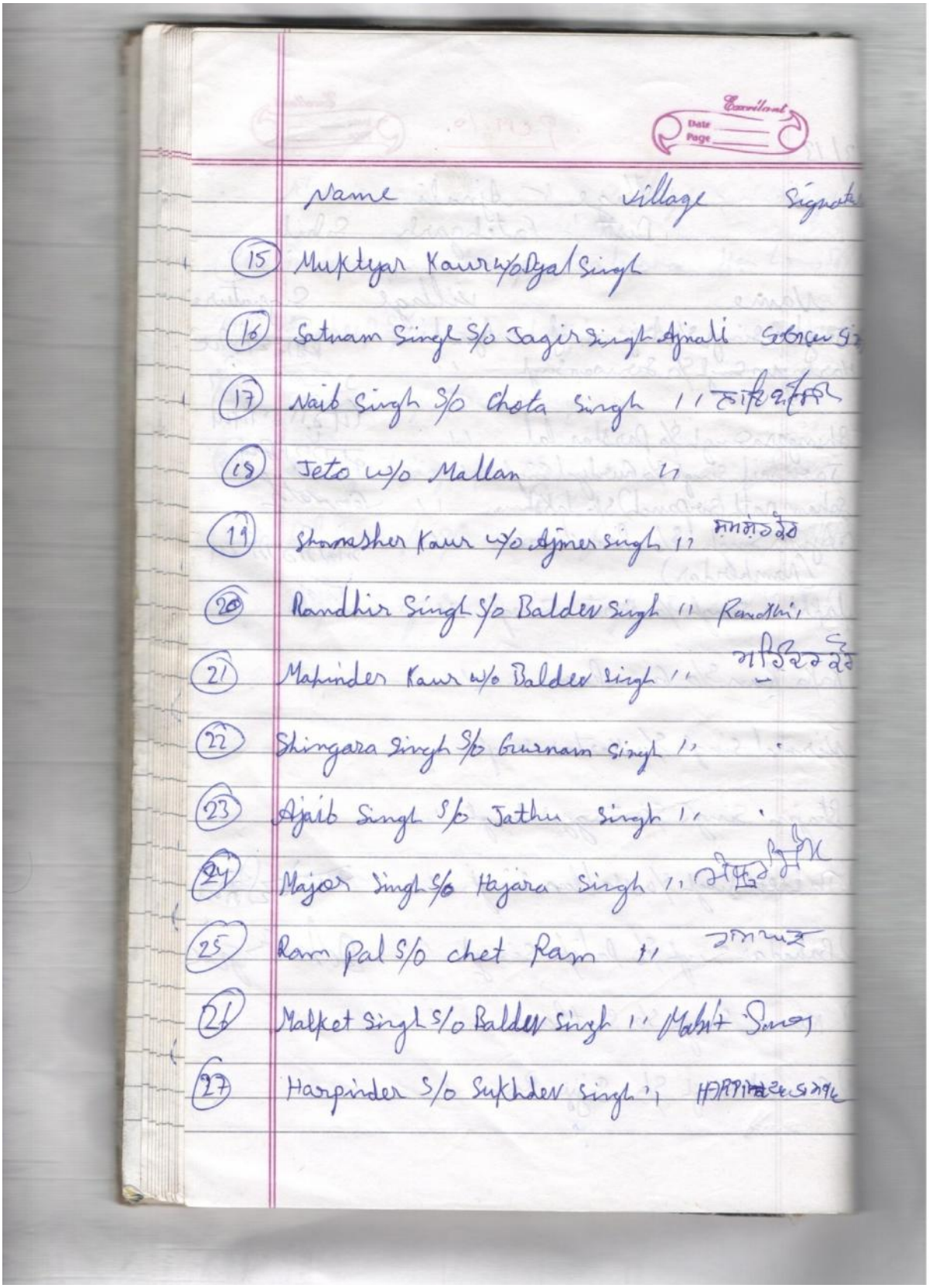
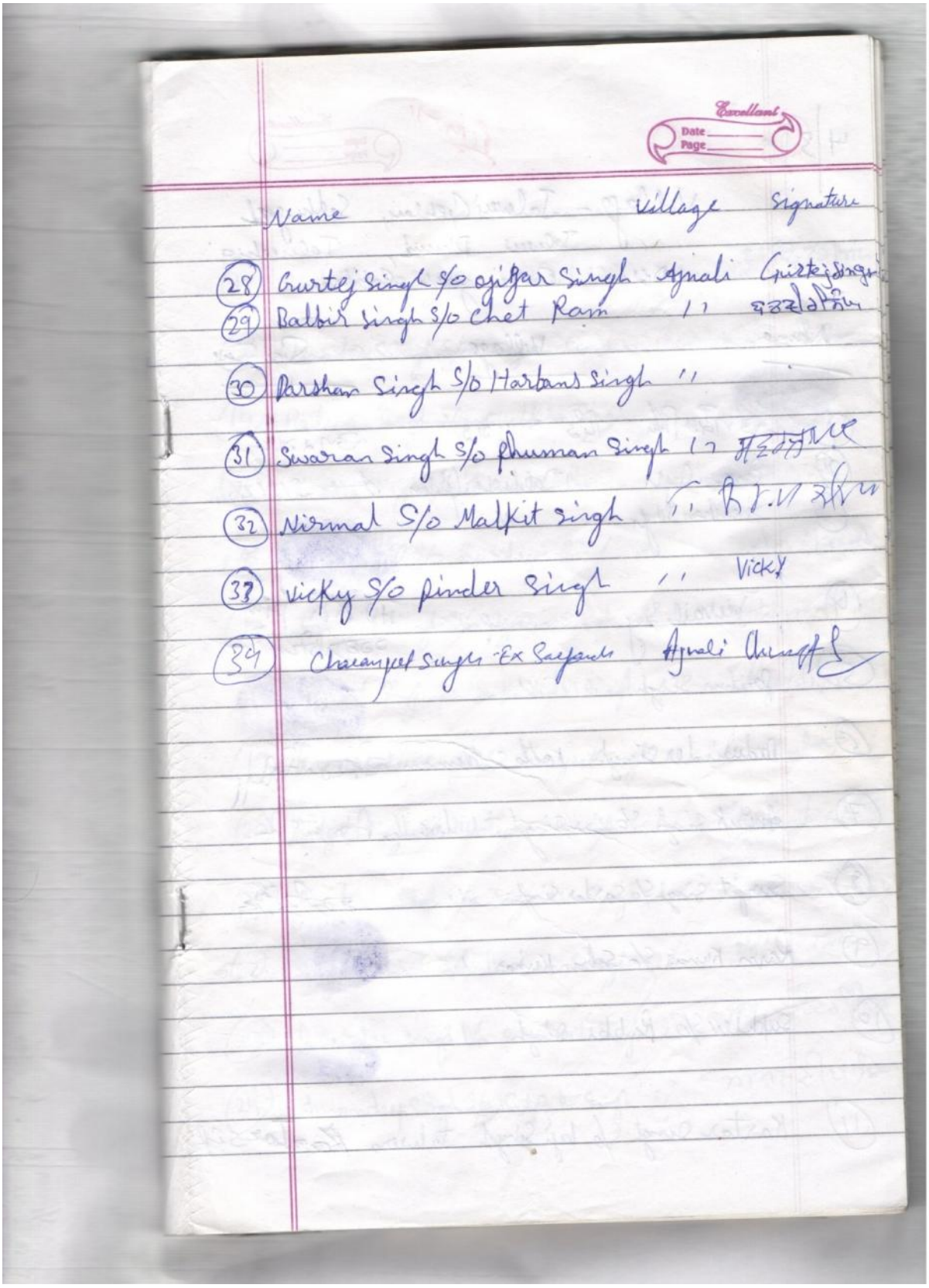
Village :- Ajnali
Distt :- Fatehgarh Sahib.

| | Name | Village | Signature |
|---|---|---|---|
| (1) | Jagdev Singh S/o Arjan Singh | Ajnali | |
| (2) | Harbajan Singh S/o Sarwan Singh | " | |
| (3) | Shingara Singh S/o Partap Lal | " | |
| (4) | Jarnail Singh S/o Gurdyal Singh | " | |
| (5) | Soham Nath (Sarpanch) S/o Lakshman | " | |
| (6) | Ajmer Singh S/o Ram Charan (Numberdar) | " | |
| (7) | Jakhbir Singh S/o Kartar Singh | " | |
| (8) | Kaka Ram S/o Gana Ram | " | |
| (9) | Nirmal Singh S/o Kartar Singh | " | |
| (10) | Bhajan Singh S/o Jaggar Singh | " | |
| (11) | Baldev Singh S/o Mallon Singh | " | |
| (12) | Bahadar Singh S/o Datu Singh | " | |
| (13) | Karan Singh S/o Sant Ram | " | |
| (14) | Gurmail Singh S/o Sajju Ram | " | |



| | Name | village | Signature |
|---|---|---|---|
| (15) | Muktyar Kaur w/o Dyal Singh | | |
| (16) | Satnam Singh S/o Jagir Singh | Ajnali | |
| (17) | Naib Singh S/o Chota Singh | 〃 | |
| (18) | Jeto w/o Mallan | 〃 | |
| (19) | Shamsher Kaur w/o Ajmer Singh | 〃 | |
| (20) | Randhir Singh S/o Balder Singh | 〃 | |
| (21) | Mahinder Kaur w/o Balder Singh | 〃 | |
| (22) | Shingara Singh S/o Gurnam Singh | 〃 | |
| (23) | Ajaib Singh S/o Jathu Singh | 〃 | |
| (24) | Major Singh S/o Hajara Singh | 〃 | |
| (25) | Ram Pal S/o chet Ram | 〃 | |
| (26) | Malket Singh S/o Balder Singh | 〃 | |
| (27) | Harpinder S/o Sukhdev Singh | 〃 | |



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Date
Page

| | Name | Village | Signature |
|---|---|---|---|
| 28 | Gurtej Singh S/o ajitpar Singh | Ajnali | Gurtej Singh |
| 29 | Balbir Singh S/o Chet Ram | " | |
| 30 | Darshan Singh S/o Harbans Singh | " | |
| 31 | Swaran Singh S/o Phuman Singh | " | |
| 32 | Nirmal S/o Malkit singh | " | |
| 33 | Vicky S/o pinder Singh | " | Vicky |
| 34 | Charanjeet Singh Ex Sarpanch | Ajnali | |

# 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 forest which is on railway land and extensive agricultural land are likely to be acquired for the project.
- At the outset as a part of the Land Acquisition Plan, the Right of Way (RoW) along the entire EDFC alignment has to be established and confirmed from the State Forest, Agriculture and Land Revenue Departments.
- Diversion of 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.

A guideline for siting / establishing these plants are to be prepared by Contractor with approval of Engineer (of PMC) as given at Annexure 10.2 & will be followed at site by the Contractor.

## 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, clearance from Engineer 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. It is to be as per the conditions imposed in the grant of approval for excavating the earth.

## 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.* Compensatory Plantation and Green Belt Development

Forest area is being diverted for the project and involves cutting of around 42400 trees. Out of the total number of trees 21875 number of trees are on protected forest land and the remianing 20526 trees are present on Private and railway land. To compensate the loss of trees c vevelopment of a green belt in the vacant spaces of the yards, crossing stations and the junction points has been recommended as one of the major components of the EMP. Forest Department will undertake compensatory afforestation on 350 ha of degraded forest land. A plantation plan is placed as **Annexure 10.5**. The plantaion plan 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.

The project

### 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 10.1** 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 10.1 : Environmental Management Plan**

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| **Pre-construction phase** | | | | |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| 1. | Permission for Removal of Trees | 42400 Trees are likely to be felled in the existing and acquired area for the proposed corridor<br>Forest land 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)<br>Required area of land may be provided for Forest Dept. For Compensatory afforestation.<br>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<br>Number of Project Affected Persons (PAPs) to be identified<br>Resettlement Action Plan to be prepared for the PAPS and provide compensation in compliance with National Resettlement and Rehabilitation (R&R) policy<br>Information dissemination and community consultation | DFCCIL | State Revenue Dept / DFCCIL |
| 3. | Relocation of Cultural and Religious Properties | 8 CPRs shall be shifted only after public consensus.<br>Relocation shall be completed before construction work is taken up. | Construction Contractor | DFCCIL |
| 4. | Impacts of Vibrations on structures | To assess the impacts of vibrations on structures baseline will be established through time stamped Videography and study of structural stability.. Sensitive Receptors would also be vedeographed so that a comparison can be made during the operation phase. | 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.<br>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.<br>Rehabilitation of borrow area may be taken under the project.<br>Construction work may be avoided during rainy season to evade erosion and spreading of loose | Construction Contractor | DFCCIL through Engineer |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| | | material.<br>Top soil removed from agricultural land may be stored separately in bunded areas and utilized during plantation or refilling of excavated area. | | |
| 2. | Water Requirement | Surface water to the extent possible will be used to meet water requirements during construction. The contractor will prepare water management plan focussing utilisation of maximum surface water and minimum use of ground water for which 25 % of the yield is allowed forindustrial purposes. The ground water can be extracted only with prior permission from CGWA and with the adequate provision of rain water harvesting. | -do- | -do- |
| 3. | 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.<br>Silt fencing may be provided near water bodies particularly for important bridge work.<br>Proper cross drainage structure may be planned at the crossing of the canal in consultation with Irrigation Department<br>Proper drainage may be planned in the area to avoid water logging | -do- | -do- |
| 4. | 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.<br>Compensatory planting as per statute for trees felled in other than forest area needs to be done as per Plantation Plan<br>Trees falling outside the RoW should not be felled.<br>Compensation must be provided before initiating construction activity.<br>Fruit bearing trees may be compensated including 5 years fruit yield.<br>Labour Camps and office site may be located outside & at least 1 km away from Forest area<br>Green belt development may be undertaken in the wasteland near railway line to enhance aesthetic and ecological value. Social | -do- | -do- |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| | | 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/DFCCIL. | | |
| 5. | Fauna | Borrow areas can be also developed as ponds with grasses and shrubs planted around it.<br>Silt fencing may be used near water bodies to avoid runoff into the water bodies.<br>Construction activity may be avoided during night hours in forest area.<br>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.<br>Awareness program on Environment and Wildlife Conservation may be provided to the work force. Forest Act, 1980 and Wildlife Act may be strictly adhered.<br>Design features to allow cross over of animals. | Construction Contractor | DFCCIL through Engineer |
| 6. | Archaeological structure/ article | There is no archaeological structure affected, directly or indirectly, on the alignment. However, '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. | Construction Contractor /ASI | -do- |
| **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.<br>Plantation activity may be undertaken at the construction sites<br>Workers may be provided with mask to prevent breathing problems<br>Trucks carrying soil, sand and stone may be duly covered to avoid spilling.<br>Low emission construction equipment, vehicles and generator sets may be used<br>Plants, machinery and equipment shall be handled to minimize | Construction Contractor | DFCCIL through Engineer |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| | | generation of dust.<br>All crusher used in construction should conform to relative dust emission devises<br>Air quality monitoring maybe conducted at construction sites as per monitoring plan. | | |
| 2. | Water | Silt fencing may be provided near water bodies to avoid spillage of construction material.<br>Discharge of waste from construction / labour camp into water bodies may be strictly prohibited.<br>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.<br>Project design takes care of irrigational canal and proper culverts may be proved so that irrigation setup is not disturbed | -do- | -do- |
| 3. | Soil | Asphalt emulsifier must be handled with caution and any leakage detected must be immediately rectified.<br>Construction work should not be done during rainy season to avoid erosion and spreading of loose material<br>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. | -do- | -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 material produced may be utilized for refilling of borrow areas.<br>Rainy season may be avoided to minimize spreading of loose materials.<br>Solid waste management may be framed for camp areas. Dustbins may be provided in the Camps.<br>The Contractor must provide proper sanitation facilities in Camp. | -do- | -do- |
| 5. | Noise & Vibration | Modern technologies producing low noise may be used during construction.<br>Construction equipment and vehicles must be in good working condition, properly lubricated and maintained to keep noise within permissible limits.<br>Temporary noise barriers installed | Construction Contractor | DFCCIL through Engineer |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| | | at settlements and forest area, if required<br>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.<br>Plantation may be carried at the work site.<br>Headphones, ear-plugs shall be provided to the workers at construction site.<br>Noise level monitoring shall be conducted during construction phase.<br>All vehicles, equipment and machinery used in construction should be fitted by exhaust silencers.<br>Equipments shall be maintained regularly and soundproof gadgets shall be used.<br>Temporary sound barriers shall be installed near sensitive locations near settlements and Forest area, of required<br>Provision of ear-plugs to heavy machinery operators<br>Plantation along the DFC shall be maintained. | | |
| 6. | Land Subsidence | Plantation must be carried to control erosion | -do- | -do- |
| 7. | Bottom Sediment | Silt fencing will be provided to avoid runoff into the River.<br>Construction activity shall be taken in dry season to avoid spreading of construction material and minimize impact on water quality | -do- | -do- |
| **Operation Phase** | | | | |
| 1. | Maintenance Plantation | Provision for maintenance of plantation must be made for at least three years.<br>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.<br>Lopping of branches may be undertaken to remove obstruction, if any | DFCCIL | DFCCIL |
| 2. | Air Quality | Plantation should be carried out and maintained along EDFC. Green belt development with proper specifies shall be undertaken on priority basis.<br>AAQ monitoring shall be carried out at all locations identified in monitoring plan. | DFCCIL | SPCB / DFCCIL |

| S. No. | Environmental Issue | Action to be Taken | Implementation By | Supervision By |
|---|---|---|---|---|
| 3. | Water Quality | Waste Collection facility shall be provided at all Junction station<br>Proper drainage system should be provided at all Junction station<br>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.<br>On receiving any complaint comparision will be made with the baseline data generated during pre construction phase. | DFCCIL | SPCB / DFCCIL |

## 10.5. Environmental Monitoring

The environmental monitoring shall be undertaken during construction and operation phases as per the details in **Table 10.2**. 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 10.3**.

## Table 10.2 : 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- |
| 6. | Plantation | Survival rate | Minimum 95% survival should be maintained. Any loss should be made up during monsoon | Site specific to be decided | Annually, starting at the end of embankment construction | -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 | CPM/DFCCIL office through Accreditted Laboratory | DFCCIL |
| 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 | -do- | -do- |
| 3 | Vibration level | Vibration on dB scale respectively | 70 dBA | Locations of sensitive receptors (13) | Once a year for 3 years | -do- | -do- |
| 4 | Plantation | Survival rate | Survival rate may be calculated annually. Minimum 95% survival should be maintained. Any loss should be made up during monsoon | At compensatory afforestation site | Annually for 3 years | CPM/DFCCIL | -do- |
| 5 | Water Quality | As per IS:10500 standards | CPCB standards | Surface water sources- Western Yamuna Canal, Yamuna River<br>Ground water- Saharanpur, Sarsawa, Jagadhari, Barara, Shambhu, Ambala, Rajpura, Sirhind and Doraha | Once in a season for 3 years (Excluding Monsoon Season) | -do- | -do- |
| 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 | -do- | -do- |

**Table 10.3 Roles and Responsibilities of Officers**

| Officer | Responsibility |
|---|---|
| General Manager (SEMU) | • Overview of the project implementation<br>• Ensure timely budget for the EMP.<br>• Coordination with different state level committee, to obtain regulatory clearances.<br>• Participate in state level meetings<br>• Monthly review of the progress.<br>• Reporting to various stakeholders (World Bank, Regulatory bodies) on status of EMP implementation |
| Chief Project Manager (DFCC ) | • Overall responsible for EMP implementation<br>• Coordination with PIU Staff .<br>• Assisting GM (SEMU) to reporting various stakeholders (World Bank, Regulatory bodies) on status of EMP implementation<br>• Responsible for obtaining regulatory Clearances<br>• Review of the progress made by contractors<br>• Ensure that BOQ items mentioned in EMP are executed as per Contract provisions.. |
| Dy.CPM | • Assisting CPM in overall implementation of EMP<br>• Review of periodic reports on EMP implementation and advising CPM in taking corrective measure.<br>• Preparing environmental training program and conducting the same for field officers and engineers of contractor.<br>• Conducting need-based site inspection and preparing compliance reports and forwarding the same to the Environmental Management Unit (DFCCIL) |
| Engineer (PMC) | • Act as an “Engineer” for supervising EMP implementation<br>• Responsible for maintaining quality of EMP envisioned in detail Project Report<br>• Maintaining progress reports on EMP implementation<br>• Periodic reporting to PIU-DFCC about the status of EMP implementation<br>• Work in close coordination with Asst. Project Manager (package unit) and contractor. |
| Asst. Project Manager (Env)-designated | • Working as site-representative of APM(Env)<br>• Conducting regular site inspection to all onsite and offsite works<br>• Maintaining records of all necessary statutory compliance, to be obtained from contractor.<br>• Maintaining records of EMP implementation including photographic records<br>• Attending environmental and social training programs<br>• 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:

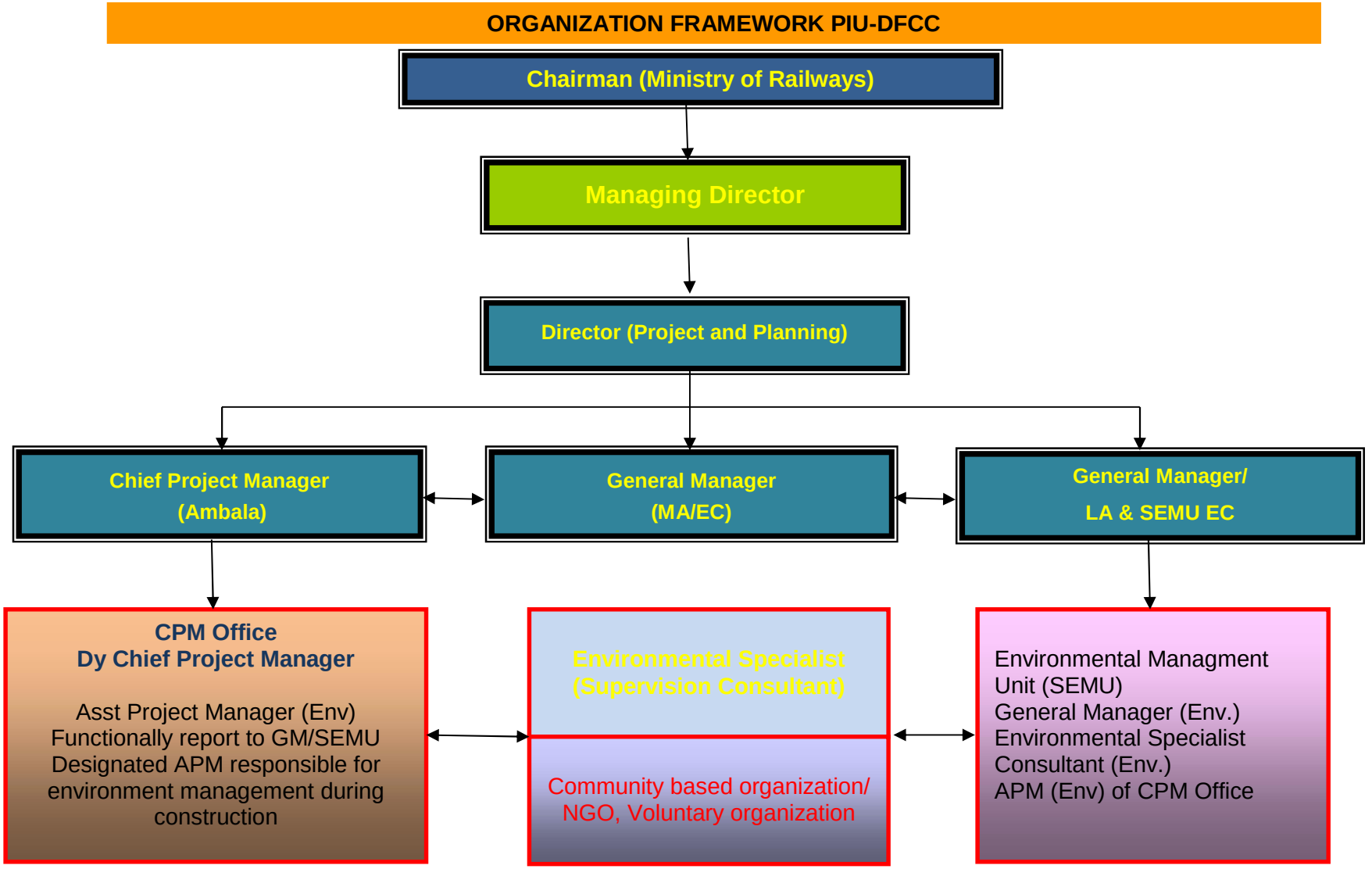
ORGANIZATION FRAMEWORK PIU-DFCC
Chairman (Ministry of Railways)
Managing Director
Director (Project and Planning)
Chief Project Manager
(Ambala)
General Manager
(MA/EC)
General Manager/
LA & SEMU EC
CPM Office
Dy Chief Project Manager
Asst Project Manager (Env)
Functionally report to GM/SEMU
Designated APM responsible for environment management during construction
Environmental Specialist
(Supervision Consultant)
Community based organization/
NGO, Voluntary organization
Environmental Managment Unit (SEMU)
General Manager (Env.)
Environmental Specialist
Consultant (Env.)
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 10.4.**

**Table 10.4 : 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 | 42400 | 42,40,000 | Covered under regulatory clearances |
| 2. | Forest Clearance and land diversion cost | ha | 220000 | 175 | 35,00,00,000 | 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** | | | | | **9,35,17,40,000** | |
| **B. CONSTRUCTION PHASE** | | | | | | |
| 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 by the contractor |

| Sl. No. | Item | Unit | Rate (in INR) | Quantity | Cost (in INR) | Remarks |
|---|---|---|---|---|---|---|
| 1.2 | Silt Fencing at 4 major bridge locations across Rivers | Number | 1,50,000 | 4 | 6,00,000 | By the contractor at bridge construction locations |
| 1.3 | Soak pits for construction camp @ 2 soak pits at each camp | Number | 20,000 | 10 | 2,00,000 | -do- |
| | ***Sub-total*** | | | | ***10,00,000*** | |
| **2.** | **Tree Plantation and Protection** | | | | | |
| **2.1** | **Avenue plantation including compensatory plantation** | | | | | |
| 2.1.1 | Plantation, protection and maintenance of saplings for 3 years (ten Trees per km on either side) and compensatory plantation of 30,000 trees | Number | 2000 | 30000 | 6,00,00,000 | |
| 2.1.2 | Permenant protective tree guard | Number | 1750 | 30000 | 5,25,00,000 | |
| | ***Sub-total*** | | | | ***11,25,00,000*** | |
| **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 | |

| Sl. No. | Item | Unit | Rate (in INR) | Quantity | Cost (in INR) | Remarks |
|---|---|---|---|---|---|---|
| 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** | | | | | **11,67,00,000** | |
| **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** | | | | | | |
| 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 | |

| Sl. No. | Item | Unit | Rate (in INR) | Quantity | Cost (in INR) | Remarks |
|---|---|---|---|---|---|---|
| 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 SRs, Total 12 Receptors) and one relocation. | m<br><br>relocation | 10,000<br><br>10,00,000 | 1200<br><br>1 | 1,30,00,000 | Initial 3 Years maintenance |
| **Sub-total for D** | | | | | **1,45,40,000** | |
| **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 9,55,49,25,000/-** | |

| Sl. No. | Item | Unit | Rate (in INR) | Quantity | Cost (in INR) | Remarks |
|---|---|---|---|---|---|---|
| | | | | | **Say, Rupees 9554 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

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.

**Dust Containment Enclosures for Stone Crusher Mills and Batching/ Mixing 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.

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.

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.

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.

### 2.4 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.

**ANNEXURE 10.2**

## GUIDELINES FOR SITING, MANAGEMENT AND REDEVELOPMENT OF CONSTRUCTION CAMPS

### A. OVERVIEW

Construction camp accommodates a mix of activities, which are highly polluting in nature causing considerable environmental impact and its proper siting, management and redevelopment is crucial to avoid, minimize and mitigate those impacts. The EMP clearly distinguishes between various impacts that may occur at various stages of the camp like

- Siting,
- Setting up,
- Operation and
- Closure / redevelopment and provide respective mitigation measures to some extent.

In addition to that, this guideline has been prepared to provide the Contractor with comprehensive and systematic information on the various steps to be undertaken during these four stages, so that s/he can execute his/her role in an environmentally sound manner. Various mitigation measures have been synthesized into this guideline so that it serves as a single and stand alone document for the Contractor.

### B. CRITERIA FOR SITING THE CAMP

To the extent, possible barren land or wastelands shall be preferred during site selection and fertile land and agricultural land shall be avoided. All such sites must be above the HFL with adequate drainage facility. In areas prone to floods, cyclones, cloudbursts or heavy rainfall, selection of the site should be made keeping in mind the safety of the camp and the workers. In addition, the Contractor should take care of the following criteria for locating the site:

- A minimum of 250 m away from any major settlement or village in downwind direction.
- A minimum of 200 m of any major surface water course or body
- [1]Not within 500 m from ecologically sensitive areas like wildlife sanctuary, mangroves etc.
- Sufficiently wide access roads (at least 5.5 m Wide) for heavy vehicle movements

After identification of the site the Contractor should prepare site details and submit the same for approval to the Project Management Consultants ( PMC) without which any activity shouldn't be started on the site.

### C. FINALIZATION OF SELECTED SITES

After identification of the site, the Contractor shall submit details of site (such as location map, distances from habitations, water bodies, ecological sensitive areas, etc.) and submit the same for approval to the PMC. Environmental Engineer of PMC shall approve the selected site/s, after considering the compliance with the EMP clauses. No agreements or payments shall be made to the landowner/s prior to receipt of a written approval from the PMC. Any consequence of rejection prior to the approval shall be the responsibility of the contractor and shall be made good at his own cost. After obtaining a written approval from the PMC for the selected site, the contractor has to enter into an agreement with the landowner to obtain his/her consent before commencing any operation / activities in the land. The agreement should also mention its type, duration, amount and mode of payment as well as the preferences of the owner regarding site maintenance and redevelopment.

### D. DESIGNING OF CAMP / PREPARATION OF LAYOUT PLAN

The contractor should design a layout plan of the camp with adequate space for (i) site office along with store room, rest area and sanitary facilities, (ii) plants, machineries, (iii) workshops, (iv) vehicle washing area, (v) fuel handling area, (vi) room for raw material

[1] In the absence of site meeting the stipulated criteria, an alternate site can be selected specifying the reasons. In such a case, the construction camp management plan should incorporate additional measures specific to the site as suggested by the CSC.

unloading and stocking, (vii) space for storage and handling of solid wastes, ( viii) Concrete batching plant, (ix) mixing plant, (x) security cabin etc. The laying out of these should be undertaken in such a manner that it facilitates smooth functioning of both man and machine. Fuel pumps, storage facility for inflammable and hazardous chemicals/ materials shall be provided inside the camp, but at a safe distance from office. Electric safety practices shall be integrated/ incorporated during the lay-out plan preparation.
Prevailing wind direction shall be kept in mind while planning out the lay-out of internal facilities. Cutting of trees should be minimum and the existing ones need to be integrated into the lay-out plan with proper planning. The roads within the camp should be well planned with adequate space for movement of vehicles and their parking.

**E.SETTING UP OF CONSTRUCTION CAMP**

(i)Site preparation: The stripping, stacking and preservation of top soil will be mandatory in case of farm lands and fertile areas and absolutely no material stacking or equipment installment or vehicle parking or any other activity should be allowed prior to the satisfactory completion of this activity as per guidelines in EMP. Thereafter, the site should be graded and rendered free from depressions such that the water does not get stagnant anywhere. A compound wall of 2.4 m height should be constructed all around the camp to prevent the trespassing of humans and animals. The approved layout plan should be strictly adhered to while setting up the camp.
(ii)Setting up of plants and machineries: Adequate arrangements should be made for avoiding fugitive emissions from plants and camp premises. This will include (i) control of air pollution through provision of in-built dust extraction systems like bag filter, damper and cyclone filter for bitumen hot mix plant, (ii) a chimney of appropriate height (as per SPCB guideline) from ground level attached with dust extraction system and scrubber for the hot mix plant, (iii) a chimney of appropriate height for the DG set (iv) water sprinkling facilities for the concrete batching plant, wet mix macadam plant as well as in the camp premises and (v) garden net to prevent fugitive emissions from storage place of cement and aggregates. It has to be also ensured that effluent from the sludge tank of the scrubber is recycled and reused and the sludge is used for land filling with top soil spread on it.
To ensure that noise levels are within the limit, all plants and machineries should have their own silencers or any other noise control devices. All pollution control devices should be provided with backup power. Following conditions should be complied regarding the sound level conditions:
The sound level (Leq) measured at a distance of 1 m from the boundary of the site shall not exceed 55dB (A) during day time (6am - 6pm) and 45 dB (A) during night time (6 pm - 6am).
The total sound power level of the DG set shall be less than 96+10 log 10(kava) dB(A) where kVA is the nominal power rating of DG set.
The DG set shall be provided with acoustic enclosure/acoustic treatment with an insertion loss of minimum 25 dB (A).
The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB (A).
A proper, routine and preventive maintenance procedure for the DG set shall be set and followed in consultation with the DG set manufacturer.
Concrete flooring with slope drains and oil interceptors should be proposed for hot mix plant area and workshop, vehicle washing and fuel handling area as per EMP, so that oil and lubricants that may spill on the floor does not contaminate any soil or water body. In case of any oil spills, it should be cleaned properly. There shall also be provisions for storage of used oil until it is disposed as per comprehensive waste management plan prepared by Contractor and approved by PMC.
(iii) Sanitation Facilities: Adequate no. of toilets shall be provided separately for males and females (depending on their strength), screened from those of men and provided with markings in vernacular language. All such facilities must have adequate water supply with proper drainage and effluent treatment system like septic tank with soak pit. Soak pit should have a sealed bottom, honey comb wall and 75 cm. thick, 2 mm sand envelope around that. The sewage system for the camp must be properly sited, designed, built and operated so

that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place.

Portable toilets may be brought to use and the night soil from such units has to be disposed through designated septic tanks so as to prevent pollution of the surrounding areas. In the construction camp, no night soil or sewerage shall be disposed of at any place other than the septic tanks constructed at the site.

(iv) Waste Disposal: While preparing the layout plan, the Contractor should allocate adequate space for storage and handling of various wastes generated until they are disposed off in pre-identified disposal sites. The Contractor should provide separate garbage bins for biodegradable, non-biodegradable and domestic hazardous wastes in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner. No incineration or burning of wastes shall be carried out by the Contractor. The disposal of any biodegradable matter shall be carried out in pits covered with a layer of earth within the camp site. Discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, hessian, metal containers, strips and scraps of metal, PVC pipe scrubber and poly urethane foam, auto mobile spares, tubes, tires, belts, filters, waste oil, drums and other such materials shall be either reused or sold /given out for recycling. POL (petroleum, oil and lubricants) waste shall be disposed off by transfer only to recycler/ re-refiners possessing valid authorization from the State Pollution Control Board and valid registration from the Central Pollution Control Board. Used lead batteries, if any, should be disposed as per the Batteries (Management and Handling) Rules 2001.

(v)First aid / safety facilities: At every camp site, a readily available first-aid unit including an adequate supply of sterilized dressing materials, appliances and basic medicine should be provided. Workplaces which are remote and far away from regular hospitals should have indoor health units with one bed for every 250 workers. Details of nearest clinics as well as major hospitals like their location, distance from camp, phone nos. facilities offered by the hospital should be displayed in the camp office at clearly visible location in a legible manner. Suitable transport should be provided to facilitate taking injured and ill persons to the nearest hospital. Adequate personal protective equipments and fire fighting equipments as detailed out in EMP should be made available in the camp and provided to the staff / workers. Operation manuals and training should be provided to machine operators. Warning signs should be placed at accident prone areas as well as at the entrance of the site.

(vi)Training to workers: Workers shall be trained in smooth operation of plants and machines, their regular maintenance and various safety measures to be followed as well as about the need for adherence to these measures.

(vii)Information dissemination: There should be a sign board of size 6’ x 4’ mentioning the project details and Contractor’s details to disseminate the information to the public. There should be a second sign board displaying the latest air and noise monitoring data against the standards specified.

Warning signboards should be set up at the entrance gate for the public as well as at other required places for the workers to alert them about the nature of operation being undertaken at those respective places.

Once the construction camp is set up, the date of commissioning of the camp should be intimated to the Head Office and concerned District Office of the TNPCB.

**F.OPERATION OF CONSTRUCTION CAMP**

During the operation phase of the camp it is important to ensure that all vehicles and machineries are maintained regularly and their PUC certificates are renewed at regular intervals. All pollution control devices should be monitored and maintained properly at regular intervals. In case of process disturbance/ failure of pollution control equipments, the respective units should be shut down and should not be restarted until the control measures are rectified to achieve the desired efficiency. All units should operate only between 6 am and 10 pm. or as specified by State Pollution Control Board ( Punjab/Haryana/Uttar Pradesh) in the consent letter.

Oil and grease waste generated from garages in construction camps should be drained out through oil interceptors and they should be maintained properly. Necessary arrangements

should be made for regular sprinkling of water for dust suppression. Raw materials and products should be transported with proper cover to prevent spreading of dust.

Hygienic environment must be ensured by (i) provision of safe drinking water, (ii) proper maintenance of toilets including daily cleaning and disinfection using proper disinfectants, (iii) regular cleaning of drains by removing the silt and solid waste, (if any) and iv) appropriate waste management practices. While it is of utmost importance to ensure that fire fighting equipments like fire extinguishers are in working condition, it should also be monitored that construction workers use the personal protective equipments provided to them and they are replaced when necessary. All these facilities should be inspected on a weekly basis to achieve the desired levels of safety and hygiene standards.

Environmental monitoring should be undertaken by the Contractor as stipulated in the EMP. If any standard is set by SPCB for batch mix plant, hot mix plant, etc., the Contractor should collect samples of emission from all the chimneys and analyze for the parameters at least once in a month. The Consent to Operate (CTO) certificate from the concerned State Pollution Control Board should be renewed at regular intervals and the same should be intimated to PMC.

A register should be maintained at the site office which provides (i) a one page format for each migrant laborer which will give their personal profile (including name, age, sex, educational qualification, address, blood group and any major illness), along with a copy of any ID proof and an original photograph, (ii) a copy of the ID card of local laborers. A copy of the details of the migrant laborers should be submitted to the local police station.

**G. PREPARATION OF CONSTRUCTION CAMP MANAGEMENT AND REDEVELOPMENT PLAN**

After the site for the construction camp has been finalized and approved by PMC, the Contractor shall prepare a construction camp management plan to be submitted to PMC for approval prior to setting up of the camp and it should comprise the following details:

Section–1: Details of site: Copy of approved site identification report along with location plan on a village map or an FMB, showing the site, its survey no., access road, project stretch, distance from the project stretch, surrounding features and land use like residences, agricultural land, water bodies etc., photograph of the site showing the topography and other existing features.

Section-2: Site preparation: Activities that will be undertaken for preparing the site based on EMP and this guideline.

Section-3: Arrangements/ facilities within the camp: List of plants / machineries to be set up within the camp like hot mix plant, batching plant, DG set etc., and other facilities to be provided like site office, store room, rest room, toilet room, material stocking yard etc, layout plan showing all these details along with vehicular movement path, green belt etc. Species wise no. of trees to be cut shall be provided.

Section-4: Mitigation measures that will be undertaken as per the EMP and this guideline while setting up of the camp and operation of the camp should be separately listed out here.

Sectoin-5: Other details: Any other relevant detail like list of trainings to be provided to workers, details of information dissemination, date of CTE certificate from SPCB, its validity, additional conditions laid down in it etc. should be included.

Section 6: Re-development plan, which should indicate the following points: (i) List of structures to be demolished and list of the cleanup activities that needs to be undertaken, (ii) Proposed use of the land after demobilizing and (iii) Presence of facilities that could be put in use by the land owner if it is a leased out private land or community in case of a public property.

Section-7: Annexure-(a) Working drawings: Electrical plan showing the electrical network planned for the site, location of plants, generators, master switch boards etc. and plumbing drawing showing the network of water supply lines, sewerage line and drainage line, (b) Copy of certificates / permissions obtained from regulatory authorities / local governing body /community etc. as applicable, (c) Copy of agreement entered with the owner of the site if it is a leased out land.

All the drawings should have north direction marked in it along with prevailing wind direction. Necessary dimensions and specifications should be provided where ever necessary. The construction camp management plan should be submitted to the PMC for a written approval

before any physical work (includes storage of materials, equipment etc.) is undertaken on a particular site. The PMC shall carefully examine the proposals considering the specific conditions of each site as well as various EMP and regulatory provisions and provide suggestions, as necessary to the Contractor who shall incorporate it in the management plan.

Contractor needs to prepare this document for each different site identified and PMC shall undertake a thorough analysis of the said management and redevelopment plan through a site investigation and suggest additional mitigation measures depending on the site and as demanded by the features of the specific site.

**H.DEMOBILIZATION AND REDEVELOPMENT OF THE SITE**

The Contractor should clear all temporary structures; dispose all building debris, garbage, night soils and POL waste as per the approved debris management plan. All disposal pits or trenches should be filled in, disinfected and effectively sealed off. All the areas within the camp site should be leveled and spread over with stored top soil. Residual topsoil, if any will be distributed or spread evenly in plantation sites, on adjoining/near-by barren land or affected agricultural land adjacent to the RoW that has been impacted on account of any accidental spillage. Entire camp area should be left clean and tidy, in a manner keeping the adjacent lands neat and clear, at the Contractor's expense, to the entire satisfaction of landowner and PMC.

These activities should be completed by the Contractor prior to demobilization. Once the Contractor finishes his job, he needs to obtain a certificate from the owner, stating that the site has been re- developed to his/her satisfaction and in tune with the agreement. Then following documents needs to be submitted to the PMC by the Contractor:

Copy of approved site identification report

Photographs of the concerned site 'before' and 'after' setting up the camp.

Certificate from the owner stating his/her satisfaction about status of re-development of the site.

PMC shall ensure, through site verification that all clean-up and restoration operations are completed satisfactorily and a written approval should be given to the Contractor mentioning the same before the 'works completion' certificate is issued/recommended. The PIU shall ensure through site inspection that the Contractor and PMC have complied with all these provisions. The site can then be handed over to the concerned owner or local bodies or for local communities as the case may be.

Certification/documentation pertaining to approval for clean-up and restoration operations and thereafter handing-over to the owner shall be properly maintained by the Contractor, Engineer (of PMC).

**ANNEXURE 10.3**

## GUIDELINES FOR PREPARING COMPREHENSIVE WASTE & DEBRIS MANAGEMENT PLAN

A.OVERVIEW

A comprehensive waste management plan shall be prepared by the Contractor prior to initiation of any works. The purpose of the plan is to provide standardized procedures for the clearance, removal and disposal of debris caused by major debris / waste generated during the construction work as well as to establish the most efficient and cost effective methods to resolve debris disposal issues.

B.PREPARATION OF COMPREHENSIVE WASTE MANAGEMENT PLAN

The Contractor shall prepare a Comprehensive Waste Management Plan to be submitted to PMC for approval prior to setting up of construction and labor camp and it should comprise the following details:

- Categorization of waste into degradable, biodegradable and hazardous categories and list of different types of waste that falls in each of these categories.
- Estimates about the quantity of waste generated in each category and type of storage units required.
- Detail the provisions for storage and handling of waste until disposed. A plan of the respective camps / areas like construction camp, labor camp etc. to be attached indicating in it the space allocated for storage and handling of wastes.
- Detail the precautions to be taken while storing, handling and disposing each type of waste, trainings to be imparted to workers to create awareness about waste management.
- Details of each debris disposal site: Copy of approved site identification report along with location plan on a village map or an FMB, showing the debris disposal sites, site, its survey no., access road, project stretch, distance from the project stretch, surrounding features and land use like residences, agricultural land, water bodies etc., photograph of the site showing the topography and other existing features.

C.TRAINING FOR PROJECT STAFF AND WORKERS

All staff and workers involved in the DFC construction shall be imparted training about comprehensive waste management plan including the need for such a plan, its components and measures adopted by the Contractor for implementing it. In addition, all personnel involved should be made aware about various steps and measures each of them has to follow so as to ensure the compliance to the comprehensive waste management plan.

D. PRECAUTIONS TO BE ADOPTED DURING DISPOSAL OF DEBRIS/WASTE MATERIAL

The Contractor shall take the following precautions during transportation and disposal of debris/waste material:

- A register should be kept for recording the details of the waste generated and their disposal.
- The pre-designated disposal sites should be a part of Comprehensive Solid Waste Management Plan and should be identified as per the EMP clauses prior to initiation of any work on a particular section of the road.
- The Contractor will take full care to ensure that public or private properties are not damaged/ affected during the site clearance for disposal of debris and the traffic is not interrupted.
- All arrangements for transportation during dismantling and clearing debris, considered incidental to the work, will be implemented by the Contractor in a planned manner as approved and directed by the PMC.
- In the event of any accidental spill or spread of wastes onto adjacent parcels of land, the Contractor will immediately remove all such waste material/s and restore the affected area to its original state to the satisfaction of PMC.

- Contractor shall ensure that any spoils/materials unsuitable for embankment fill shall not be disposed off near any water course; water body; agricultural land; natural habitats like grass lands, wet lands, flood plains, forests etc. pasture; eroded slopes; and in ditches, which may pollute the surrounding including water sources.
- Contractor shall ensure effective water sprinkling during the handling and transportation of materials where dust is likely to be created.
- Materials having the potential to produce dust will not be loaded beyond the side and tail board level and will be covered with a tarpaulin in good condition.
- Any diversion required for traffic during disposal of debris shall be provided with traffic control signals and barriers after discussion with the local body and as approved by PMC.
- During the debris disposal, contractor will take care of surrounding features and avoid any damage to trees and properties.
- No hazardous and contagious waste material shall be disposed at such locations.

E.WASTE DISPOSAL IN CONSTRUCTION CAMP

- Concrete flooring and oil interceptors should be provided for hot mix plant area, concrete batching plants, workshops, vehicle washing and fuel handling area.
- POL (petroleum, oil and lubricants) waste shall be stored safely in separate containers and should be disposed off by transfer only to recycler/ re-refiners possessing valid authorization from the concerned State Pollution Control Board and valid registration from the Central Pollution Control Board.
- Used lead batteries, if any, should be disposed as per the Batteries (Management and Handling) Rules 2001.
- Water separated and collected from oil interceptor should be reused for dust suppression.
- There should be a register to record the details of the oil wastes generated at the workshops and oil storage areas.
- The Contractor will provide separate garbage bins in the camps and ensure that these are regularly emptied and disposed off in safe and scientific manner as per the Comprehensive Solid Waste Management Plans approved by the PMC.
- No incineration or burning of wastes shall be carried out.
- Discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, hessian, metal containers, strips and scraps of metal, PVC pipes, rubber and poly urethane foam, auto mobile spares, tubes, tires, belts, filters, waste oil, drums and other such materials shall be either reused or will be sold /given out for recycling.
- Septic tank must be provided for toilets and the sludge should be cleared by municipal exhausters.

F.WASTE DISPOSAL IN LABOUR CAMP

- The Contractor shall provide separate garbage bins in the camps for bio-degradable, non- degradable and domestic hazardous waste and ensure that these are regularly emptied and disposed off in safe and scientific manner.
- The disposal of kitchen waste and other biodegradable matter shall be carried out in pits covered with a layer of earth within the camp site to avoid smell and pests. The Contractor may use the compost from such wastes as manure in the plantation sites.
- Noon-biodegradable waste like discarded plastic bags, paper and paper products, bottles, packaging material, gunny bags, hessian, metal containers, strips and scraps of metal, PVC pipes, rubber and poly urethane foam, auto mobile spares, tubes, tires, belts, filters, waste oil, drums and other such materials shall be either reused or should be sold /given out for recycling.
- No incineration or burning of wastes should be carried out.
- Effluent treatment system like septic tank with soak pits provided for toilets should be sited, designed, built and operated in such a way that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place.
- Soak pits must be provided to collect waste water from bathrooms and kitchen.

G.DISPOSAL OF BITUMINOUS WASTE

- At locations identified for disposal of residual bituminous wastes, the disposal will be carried out over a 60 mm thick layer of rammed clay so as to eliminate the possibility of leaching of wastes into the ground water.
- The contractor will suitably dispose off unutilized non-toxic debris either through filling up of borrows areas located in wasteland or at pre-designated disposal sites, subject to the approval of PMC.
- Debris generated from pile driving or other construction activities along the rivers and streams drainage channels shall be carefully disposed in such a manner that it does not flow into the surface water bodies or form puddles in the area.

H.DISPOSAL OF NON HAZARDOUS WASTE

- Non hazardous wastes other than fly ash may be dumped in borrow pits (preferably located in barren lands) where such borrow pits are not suitable to be re-developed as an economic source like pisciculture or a source of irrigation. Such borrow pits can be filled up with non-hazardous wastes and then covered with a minimum 30 cm layer of the soil, where plantation of trees and shrubs will be taken-up by the Contractor as a part of site rehabilitation.
- Local tree species suitable for such re-habitation work shall be selected in consultation with local community.

I. HAZARDOUS WASTE DISPOSAL

All hazardous wastes will be disposed as per the Rules only.

**ANNEXURE 10.4**

## GUIDELINES FOR WATER MANAGEMENT DURING CONSTRUCTION AND OPERATION

### A. OVERVIEW

A ' Water Management Plan' will be prepared by the contractor to conserve the water during the construction and to maximise use of recycled water. The plan will indicate the requirement of water, the various sources and all measures to be taken at the time of drawl and at end of the construction of the project. This water management plan will be approved by DFCCIL or its representatives.

### B. IDENTIFICATION OF WATER SOURCES FOR CONSTRUCTION

The contractor will identify the water resources (surface or ground water) to be used for construction in each of the construction package. The extraction of ground water from various sources, shall as far as possible be avoided in Jagadhari and Mustabad areas of Yamuna Nagar, and Doraha, Khanna and Rajpura areas of Punjab state as in these areas ground water blocks are critical or over exploited. Use of surface water should be priority and ground water can be used minimum possible because of scarcity.

### C. RECOMMENDED SOURCES OF WATER FOR CONSTRUCTION

The ground water availability is not an issue in Saharanpur district and no major perennial surface water source is available so ground water can be utilised from km 188.510 to 200.000, Yamuna River from km 200.000 to km 225.000, Tangari and Markanada Rivers from km 225.000 to 270.000 and for the portion from km 270.000 to 360.000 Bhkara main canal, Ghaggar River and Sirhind Canal. For the purpose of drinking water requirements boreholes may be operated at the workers camp and construction camp. Due permissions, where required as per statute from the concerned authority shall be obtained. However, effort should be to use surface water to maximum extent and ground water can be used to minimum possible, with prior permission of the authority.

The other alternative is that the contractor may obtain water from the municipal authorities close to the project site for the drinking water purposes.

### D. RECOMMENDED WATER CONSERVATION MEASURES DURING CONSTRUCTION AND OPERATION

- Run-off from the construction camp/workers' camp is to be utilized for artificial recharge to ground water unless risk of contamination exists or area is water logged. This will be more rigorously followed in the State of Punjab at construction workers camp;
- The runoff from the construction camp/workers camp after sedimentation shall be utilized for harvesting/storage also, apart from recharge;
- The project design for parallel and cross stations and other project related structures shall have provisions for rain water harvesting and ground water recharge;
- As part of DPR, water balance shall be prepared and necessary budget for ground water recharge shall be made in overall project cost;
- All building complexes will have waste water treatment facilities and treated water shall be recycled for green areas and for sanitation purposes; and
- The suggestion of State Ground Water Authority shall be incorporated in project design for the water conservation and recharge.

### E. PERMISSIONS REQUIRED FOR GROUND WATER ABSTRACTION AND FOR WATER WITHRAWAL FROM SURFACE WATER SOURCES

During the construction phase, DFFCIL will facilitate permissions and No Objection Certificates (NOCs) from River and canal authorities, central and State authorities.

**ANNEXURE 10.5**

# TREE PLANTATION PLAN

## REGULATORY FRAMEWORK

The tree cutting permission for non forest areas and private land trees has been obtained from the concerned authority in whose jurisdiction the project stretch falls. The linear plantation declared as protected forest area in Haryana and Punjab State, tree cutting will be carried out by the concerned state forest department and forest land diversion and cutting are under the provisions of The Forest ( Conservation) Act, 1980.

Compensatory plantation in lieu of trees to be cut from the private land and non-forest lands will be undertaken as per the statutory conditions imposed by the state governments in the vacant space of project land. For trees to be cut from the declared protected forest, the compensatory afforestation shall be taken up by the State Forest Department as per the provisions of the Forest ( Conservation) Act, 1980.

## FUNDING MECHANISM FOR COMPENSATORY PLANTATION

- *Forest lands:* The Ministry of Environment, Forests and Climate Change (MoEFCC) under their order dt. the 24th, April, 2004 have constituted an authority known as Compensatory Afforestation Fund Management and Planning Authority (CAMPA) for the purpose of management of money received from user agencies for compensatory afforestation. DFFCIL, being the user agency in this project will be required to deposit the money as estimated by the State Forest Department to the CAMPA for the compensatory plantation. CAMPA shall release funds to the State in predetermined installments through the State Level Management Committee as per the Annual Plan of Operations drawn by the State Forest Department
- *Other areas:* The compensatory plantation for the trees on private land and non-forest land will be taken up as part of project cost. This cost will be built part of EMP cost in the overall project cost. The plantation work will be taken up by the civil contractor as part of the project work.

## COMPENSATORY AFFORESTATION BY FOREST DEPARTMENT

The compensatory afforestation scheme would be implemented by the State Governments once the final approval for the diversion of forest land is granted by the Government of India. State Governments obtain funds from the Government of India into their CAMPA account based on their annual plan of operations. All districts include their proposals for taking up compensatory afforestation in the annual plan of operations. Once the plan is approved by the Regional and State level of the CAMPA authorities, plantation is taken up.

Plantation activity shall be taken up by the concerned forest department on 209 ha in Haryana and 141 ha in Punjab as per the state norms. The site specific details are as below:

| **State** | **Trees to be Cut** | **Total Number of Trees to be cut Including Private and Non Forest Railway Land** | **Compensatory Plantation** |
|---|---|---|---|
| | Declared Protected Forest | | **Forest Department** |
| Haryana | 19889 | 29094 | At Muzadwala PF, Sugh PF, Kalanaur RF, Deogarh PF, Dadupur canal side, along Khera railway line, along Chetan drain (103540 number of trees to be planted) |
| Punjab | 1986 | 4423 | At Bir Kheri Gujjaran, Bir Mazal, |

| State | Trees to be Cut | Total Number of Trees to be cut Including Private and Non Forest Railway Land | Compensatory Plantation |
|---|---|---|---|
| | Declared Protected Forest | | Forest Department |
| | | | Bir Sanaur, Bir Miranpur Ghoghpur (50337 number of trees to be planted.) |

DFCCIL would actively pursue the case with the forest department for early plantation in the areas identified for the purpose. The tree species to be planted by the forest department outside project area will be finalised by the Forest Authorities based on local site conditions. The areas will be monitored by the concerned forest department and the MoEF through its regional offices to ensure the compliance of conditions for diversion of the forest land.

**COMPENSATORY PLANTATION BY DFCCIL**

In lieu of the 20525 trees on non forest land compensatory plantation will be taken up DFCCIL in compliance with the conditions of permission for felling of the trees. There are about 11600 trees in the States of Haryana and Punjab in lieu of which 20000 trees shall be planted in these states at suitable locations along the alignment. To compensate felling of 8884 trees, around 10,000 trees would be planted by DFCCIL through its contractor and 8500 trees by the Forest Department in UP. The total compensatory plantation of 30000 trees shall be taken up along the RoW and other facilities. Planatation in RoW shall be taken up immediately after physical completion of embankment construction as part of the civil works. Plantation activity can be also taken up at the stations, yards etc once the detailed plans for the same are finalised.

**SELECTION OF TREE SPECIES FOR COMPENSATORY PLANTATION**

The civil contractor in consulatation with DFCCIL decide on the type of species to be planted. The following points shall be considered while selecting the species.

- Trees to be selected for planting shall be site-specific taking into account the type of soil, features of the planting site e.g. for saline and alkaline soils and water logged area will require special attention.
- Browse hardiness, good growth rate, resistance to insects/pests disease and biotic interference etc shall be given appropriate weightage in selection of species.
- Evergreen / semi-evergreen species shall be preferred to deciduous species.
- In urban /semi-urban stretches of road, flowering trees shall be preferred to add to aesthetics of the surround.
- Trees having large tomentose leaves may be included in stretches where particulates are likely to be high.
- In the matter of selection of species for planting, stakeholders need be consulted and their views accommodated keeping view the site- specifics.
- Some trees species of economic importance suggested are

| S No. | Trees Name | Characteristics |
|---|---|---|
| 1 | Azardiracta indica (Neem) | The leaves, barks are used for medicinal purposes, and the seeds yield valuable oil. It can grow on alkaline usar soil |
| 2 | Madhuca indica (Mahua) | The fruit is edible and seeds yields oil. It is also ornamental |
| 3 | Tamarindus indica (Imli) | A beautiful tree, which stands the dust of roads very well. Its fruit and timber are also valuable; suitable for dry area. This species is most common along project road. |

| | | |
|---|---|---|
| 4 | Dalbergia sisoo (Shisham) | Yields excellent timber |
| 5 | Mangifera indica (Mango)<br>Tamil Name: Maa | Yield valuable fruit |
| 6 | Safed siris | A quick growing beautiful tree. Because of the light yellow colour of the trunk, it reflects even weak light. This is an excellent roadside tree. |

## PLANTING PATTERN FOR VACANT LAND IN DFFCIL RIGHT OF WAY/DFFCIL LAND

- Monoculture planting shall be avoided. Mixed culture of shade-giving, flowering and fruit-bearing species shall be preferred.
- Where sufficient land exists plantation shall be undertaken in three rows.
    - The first row may be composed of a mix of species of flowering trees; such mix may consist of trees coming into flowers in different seasons.
    - The second row may have representation of middle-sized evergreen and fruit-bearing species.
    - The third row wherever feasible should be of broad-leaved evergreen species; the species should be so chosen as to make sure that they grow taller than tress planted in the first and second rows.

## MANAGEMENT, MAINTENANCE AND MONITORING

- Strip plantations should be properly fenced to prevent damages by biotic interference.
- Wherever possible live-hedges may be provided; in such stretches live-hedges need be grown a year ahead of actual planting; such hedges may be reinforced by weaving with split bamboos.
- It may also be explored as to whether communities along the DFCCIL corridor can be involved in protection and maintenance of such plantations through a mechanism of sharing of fruits and products.
- Local voluntary organizations, sports/youth clubs may also be encouraged for protection of such plantations through provision of incentives.
- The maintenance of saplings within the DFFCIL land shall be done by DFCCIL once the civil contractor completes his period. The contractor should be handing over the project with a 95% survival percentage of the number of trees to be planted.

## SUGGESTED PLANTING MODEL

### A. Preparation of the Plantation Area

- Plantation site should be cleared from all wild vegetation. Suitable soil and water conservation measures will be adopted, if required. 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 below:

**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 |
| | **Shrubs & Grasses** | Akand |
| 1 | *Calotropis gigantea* | Harsighar |
| 2 | *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).