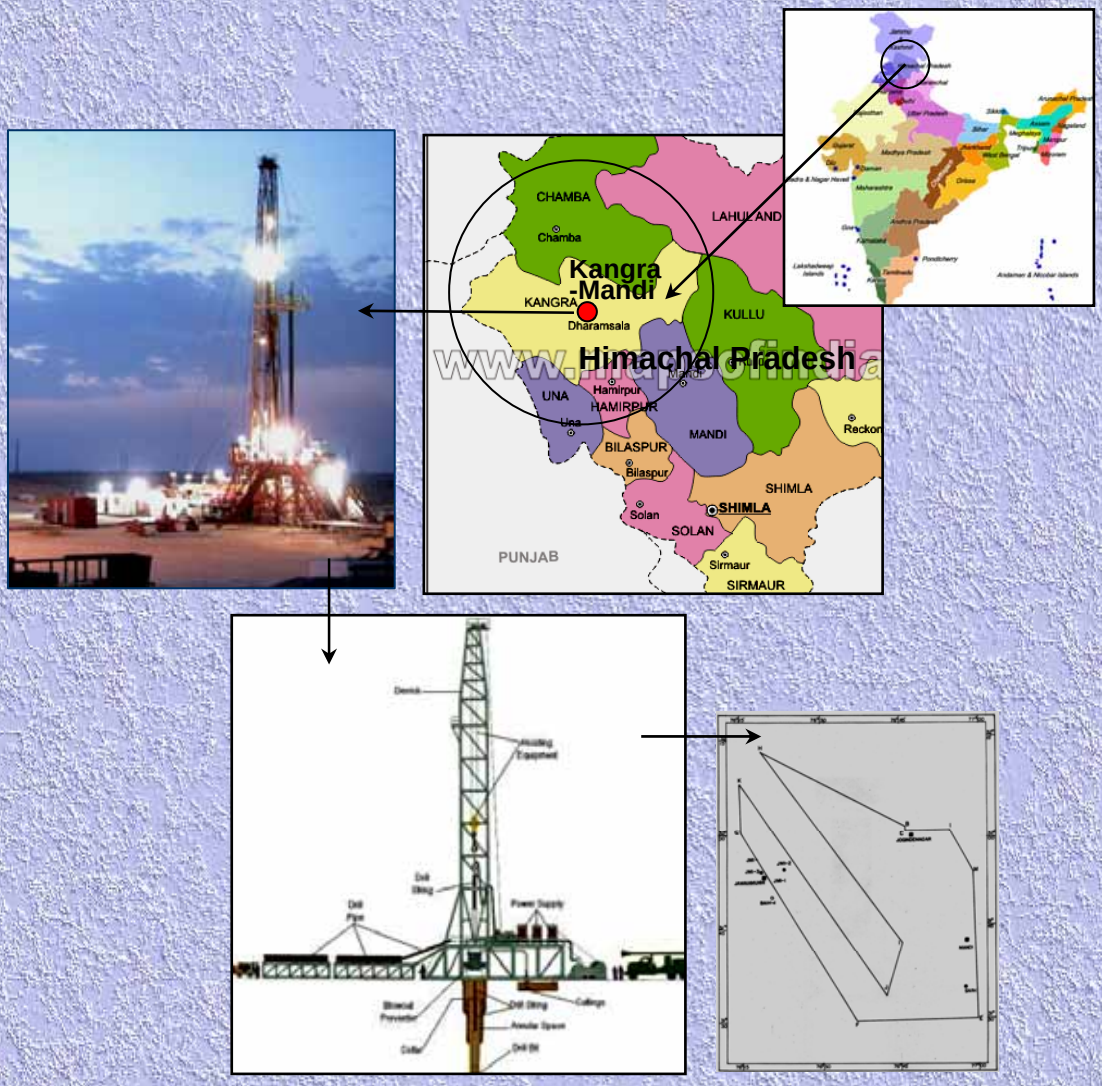
Environmental Impact Assessment (EIA) Study for Exploratory Drilling of Oil Exploration in the Block PEL of Kangra-Mandi, Himachal Pradesh

Sponsor:
M/s Oil & Natural Gas Corporation Limited



National Environmental Engineering Research Institute
Nehru Marg, Nagpur 440 020

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Executive Summary

1.0 Introduction

Oil and Natural Gas Corporation Limited (ONGC) is a public sector petroleum company in India. It is a company contributing 77% of India's crude oil and 81 % natural gas production. It is the highest profit-making corporation in India. In order to meet the increasing demand of petroleum product, ONGC has proposed to drill one exploratory well in the Kangra-Mandi block near village Tihari under Khundia Tehsil, Dist. Kangra (Himachal Madhya Pradesh) for exploration of hydrocarbon under PEL policy. The latitude and longitude of the identified drilling location is $31^{O}51'13.87''$ and $76^{O}21'57.77''$ respectively.

Article 14 of the contract signed with Govt. of India imposes on operator a condition to carry out a preliminary environmental impact study before commencement of exploratory drilling in the given contract area. Oil and Natural Gas Corporation limited (ONGC) being an operator in this block requires to carryout the Environmental Impact Assessment (EIA) study. The purpose of such study is to assess the environmental impacts arising due to the exploratory drilling proposed in the Kangra-Mandi block. To conduct this study, ONGC retained National Environmental Engineering Research Institute (NEERI), Nagpur to carry out EIA study for various environmental components including air, noise, water, land, biological and socio-economic which may be affected and to prepare Environmental Management Plan (EMP) for mitigating the adverse impacts.

2.0 Project Description

Exploratory drilling is undertaken to establish the presence of hydrocarbons indicated by seismic survey and interpretation of data. Exploratory drilling is temporary and short duration activity and includes site preparation, well foundation, rig building, drilling and restoration of the well site. This activity takes approximately 3-4 months under normal conditions. Drilling rig is used for drilling the well and involves rotation of drill bit, attached to a long string of a drill pipe down the well. Drilling mud is pumped through the drill string, through the drill bit, which returns up the annulus between the drill string and bore. Drill mud is used to cool the drill bit while drilling, remove cuttings from the well, control formation pressures, suspend and release cuttings, seal permeable formations,

maintain well-bore stability, minimize reservoir damage, cool and lubricate the bit etc. The drill cuttings are separated from the drilling mud in shale shaker and the fluid is re-circulated. If the presence of hydrocarbons is detected during drilling, production testing is normally conducted. The production testing is carried out to ascertain the reserves and economic viability.

3.0 Environment in the Block

The environmental baseline data was collected during the winter season 2008-2009 and primary data was collected along with the secondary data from various sources in public domain made available from published literature including discussion with various government departments and the project information is provided by ONGC.

The baseline status of ambient air quality was carried out in the block. While selecting ambient air quality monitoring stations due consideration was given to topography, terrain, human settlements, sensitive locations, general meteorological conditions, existing emission sources, industries, regional background and possible impact zones based on available information within the block area. The arithmetic mean and 98th percentile values of 24 hourly average samples for SPM varied between 108-188 µg/m^3 & 138-299 µg/m^3, RSPM in the range of 37-63 µg/m^3 & 46-88 µg/m^3, SO_2 in the range of 3-6 µg/m^3 & 3-7 µg/m^3 and NOx varied between 4-7 & 3-10 µg/m^3 respectively. Non-methane and methane hydrocarbons were monitored within the block area and varied between 0.3-0.4 ppm and 0.6-1.2 ppm respectively.

The background noise levels observed during daytime for residential and commercial areas were in the range of 43-54 dBA and 55-66 dBA during night time, in the range of 36-44 dBA and 45-54 dBA respectively. In the sensitive areas the noise levels were observed to be 38-47 and 33-39 during day and night time respectively.

The baseline data for surface and groundwater was collected based on its use especially for drinking purpose by the villages. In this area, river Byas is flowing near the block. There are deep wells, tube-wells, hand-pumps in villages. The monitored river showed pH values varied from 7.8 indicating water is in alkaline nature, TDS : 354 mg/l, total suspended solids : 12 mg/l and hardness : 212 µS/cm. Moderate minerals content was observed in the samples collected from river. Nutrient values in the form of nitrate and phosphate was found to be less with organic load BOD and COD in the range of 8 mg/l and 23 mg/l respectively. Similarly groundwater of the study area showed low to moderate mineral content. The variations in the levels of various parameters are: total dissolved solids : 342-1200 mg/l, hardness : 84-383 mg/l, whereas chlorides, sulphates in

the range of 12-270 and 62-268 mg/l respectively. Both surface and groundwater showed faecal contamination and need chlorination before used for drinking purpose.

The soil samples were collected for various types of land uses. The texture of the soil is clay, sandy loam and loamy sand to sand. The soils in the region are low to moderate and high adsorption capacity. The soils are normal with respect to exchangeable sodium percentage.

The study area is dominated by natural vegetation and avenue plantation. The forest lying in the study area range from northern dry mixed deciduous forest to deciduous scrub forest and tropical evergreen forest in the altitudes of 300 to 900 m. The drilling site in the Tihari village is surrounded by the agricultural field. Firewood, bamboos, Shisam, Deodar, Oak, Chil and Khair are the major species planted and observed in the forest. Mammals like Monkeys, Squirrels, Mongoose are common in the study area. Dominant birds observed in the study area are House Sparrow, House Crow, Myna, Parakeet and Dove. Common fishes found in the study area are Catla, Rohu, Mrigal, Mahabeez, Common carp, Silver Carp and Grass Carp etc. In this area, agriculture and cattle rearing is the occupation. The agriculture is mainly rain fed and mostly used farm yard manure. The main crops grown are wheat and paddy.

Demographic profile of this area consists of 17815 inhabitants in the area. The total number of household are 3531 and sex ratio is 1001 female/1000 male. Literacy rate is 68.93 %. Total main workers are 36.25 %. Primary middle and higher secondary schools and Primary Health Sub Centres are available in this area. Education facilities, medical and transportation and sanitary facilities are very poor in the area. Drinking water source is through handpumps, borewells and tanks.

4.0 Anticipated Environmental Impacts

The land requirement per well is about 150 m x 150 m and the environmental impacts during the construction stage to drilling phase is short term, temporary in nature and does not entail any displacement of people. The well head facilities will be located in such a manner avoiding settlements. The potential environmental impacts due to the proposed exploratory drilling activities can be exhaust gases from DG sets used for drilling; flaring of associated gas during production testing and the duration is for 3-4 days, disposal of drill cuttings and drilling mud, waste water treatment and disposal, noise from the drilling operations and power generation units. The electricity requirement for proposed activities will be generated using DG sets. No existing resources/water sources

(surface/groundwater) which are currently being used by the villagers for the purpose of obtaining drinking water, water for irrigation or other purposes will be tapped. Bore wells would be drilled to meet the water requirements or water will be supplied through tankers to the site.

5.0 Environmental Management Plan and Mitigation Measures

The land requirements for exploratory drilling is approximately 150 mx150 m and the land use pattern will not be affected as this is a short duration activity and of temporary nature. The land will be acquired from private/government lands. Crop and land compensation will be paid as determined by the revenue officials. The total water requirement will be met from tapping groundwater aquifer by drilling bore wells near the well site. If the local water quality does not meet the minimum quality requirement for use as make up water for drilling fluid/potable use, suitable arrangement for transportation of water will be made. Approximately 150 m^3 of spent drilling mud would be generated at each well site. Drilling mud is re-used as much as possible. At the end of drilling operations, the residual unusable mud is collected in lined pits and solar evaporated. The solids retained at the bottom of the pit will be disposed off in a lined landfill site. The domestic sewage will be treated in septic tanks followed by soak pit system. The solid waste generation is limited to spent drill bits, packaging wastes and used containers, drill cuttings, waste oil and any contaminated soil during the drill rig movements and operations. The only hazardous waste generated in exploratory drilling operations is spent lube oil. The spent oil will be collected, stored and disposed as per the MoEF guidelines and in compliance to the Hazardous Waste (Handling & Management) Rules. All DG sets and flaring will be installed with adequate stack heights to ensure wider dispersion. The mud chemical storage area will be paved. Emission standards stipulated by CPCB and SPCB would be complied with. The noise level will not exceed 85 dB (A) beyond the boundary of the drill site. Personal protective equipment will be provided and their proper usage will be ensured for eardrum protection of the workers. The ecological studies are carried out during the study period, rich and diverse vegetation in the study will be taken care and maintained. Special care must be taken to project endangered and localized animals. Wherever necessary, wildlife habitat will be re-established or restored.

6.0 Project Benefits

Though the exploratory drilling activity is temporary and of short duration it has many beneficial impacts.

- The proposed activities would generate indirect employment in the region during site preparation and drilling activities, supply of raw materials and auxiliary works.
- The commissioning of project would lead to improvement in transport facilities as loose or soft surface rural roads will be upgraded to facilitate movement of the drilling rig and supply vehicles.
- In case hydrocarbon reserves are found it will lead to all round prosperity of the region & nation

Chapter 1

Introduction

1.1 Purpose of Report

Oil and Natural Gas Corporation limited (ONGC) being an operator in the block PEL Kangra-Mandi (Himachal Pradesh) requires to carryout the Environmental Impact Assessment (EIA) study. The purpose of such study is to assess the environmental impacts arising due to the exploratory drilling proposed in the Kangra-Mandi block (HP). To conduct this study, ONGC retained National Environmental Engineering Research Institute (NEERI), Nagpur to carry out EIA study for various environmental components including air, noise, water, land, biological and socio-economic which may be affected and to prepare Environmental Management Plan (EMP) for mitigating the adverse impacts.

1.2 Identification of Project & Project Proponent

The exploration of oil and gas project has different stages as given below :

Stage	Activity	Purposes
1.	Seismic Survey	To search hydrocarbon bearing in the block
2.	Exploratory Drilling	To test firstly, the occurrence of hydrocarbons in the identified formations, secondly, its commercial viability
3.	Development Drilling	To delineate the hydrocarbon bearing reservoir and drill adequate number of wells for commercial hydrocarbon production
4.	Production	To produce oil and gas from the wells
5.	Decommissioning of installations	To remove abandoned onshore and offshore installation and restore the land environment to its original condition

All accumulations of oil or gas found within the sub-surface sedimentary basins do not contain hydrocarbons reserves that can be commercially exploited. The presence of hydrocarbons in commercial quantities depends upon the following:

- A source rock, rich in organic carbon
- Sufficient heat over millions of years to convert the organic carbon into hydrocarbons
- Migration pathways to enable the hydrocarbons to migrate upwards from the source rock
- Presence of a suitable reservoir rock, such as porous limestone or sandstone which must be sufficiently porous to store the hydrocarbons
- There should be an effective seal of impermeable rock, such as clay, shale or salt, above and against the reservoir, thereby forming a closed sub-surface structure and preventing further migration (and hence loss) of the hydrocarbons

Oil and Natural Gas Corporation Limited (ONGC) is a public sector petroleum company in India. It is a Fortune Global 500 company, and contributes 77% of India's crude oil production and 81 % of India's natural gas production. It is the highest profit-making corporation in India. It was set up as a commission on August 14, 1956.

Based on the encouraging results, ONGC wants to carryout exploratory drilling in the area to test firstly the occurrence of hydrocarbons in the identified formation, secondly its commercial viability.

1.3 Project Setting

One exploratory well is to be drilled at Kangra-Mandi in Himachal Pradesh. The site for proposed project has been identified near village Tihari, Kangra District (H.P.) lying between latitude $31^{O}51'13.87''$N and longitude $76^{O}21'57.77''$E. The area under context covers 2850 sq.km. and span from Kangra to Mandi towns. The one area of interest i.e. Baijnath falls between the Jogindernagar and Palampur towns and is bounded by the Jogindernagar thrust and Palampur thrusts on eastern and western sides. The sediments exposed belong to the tertiary age. Other area of interest is Jawalamukhi-Hamirpur founded by Jawalamukhi thrust. Accordingly two locations likely to be decided. The study area map is shown in **Fig. 1.1**.

1.4 Scope of EIA Study

The scope of study includes detailed characterization of existing status of environment around the proposed exploration drilling site in Kangra-Mandi block in Himachal Pradesh for various environmental components viz. air, noise, water, land, biological and socio-economic. Under the scope of EIA it is envisaged:

- To assess existing status of air, noise, water, land, biological and socio-economic components of environment
- To identify and quantify significant impacts of proposed drilling operations on various environmental components
- To evaluate proposed pollution prevention and control measures
- To prepare a pragmatic environmental management plan (EMP) outlining control technologies and or practices to be adopted for mitigation of adverse impacts
- To delineate post-project environmental quality monitoring programme to be pursued by ONGC.

1.4.1 Methodology for EIA

Keeping in view the nature of activities envisaged and environmental quality guidelines of Madhya Pradesh State and Government of India, the area around proposed exploration well site was studied for the purpose of environmental impact assessment studies. The work to be carried out for each of the environmental components is briefly reported below and described in details in subsequent sections.

1.4.1.1 Air Environment

- Collection of surface meteorological data like wind speed, wind direction, relative humidity, rainfall, ambient temperature etc.
- Design of ambient air quality monitoring network
- Measurement of 24 hourly average background concentrations of SPM, RSPM (size <10 μm), SO_2 and NO_X and hydrocarbon.

1.4.1.2 Noise Environment

- Establishing existing status of noise levels in residential, commercial, industrial areas and silence zones within the block area.

1.4.1.3 Land Environment

- Collection and assessment of representative soil samples within the study area
- Assessment of productivity and fertility of soil found within the study area.

1.4.1.4 Water Environment

- Collection of surface and ground water resources for determining quality of water in the study area
- Assessment of biotic environment for water in terms of phytoplankton/ zooplankton (enumeration, indices and distribution).

1.4.1.5 Biological Environment

- Collection of data on flora and fauna including rare and endangered species within the block area
- Collation of information on wildlife sanctuaries / reserve forest if any in the vicinity of the project area
- Assessment of species diversity, density, abundance etc., in the study region.

1.4.1.6 Socio-economic Environment

- Collection of baseline data including demographic details, such as households, population, literacy, employment pattern, general health, tribal, transport, communication & welfare facilities such as hospitals, educational institutions, project awareness amongst the public, infrastructure facilities, economic resources, cultural and aesthetic attributes etc. as per the requirements under MoEF.

1.4.2 Anticipated Environmental Impacts

- Identification of Environmental Impacts associated with exploratory drilling
- Prediction of adverse impacts due to activities related to proposed exploratory drilling
- Assessment of adverse impacts due to the proposed activity on air, land, water, biological and on human interests.

1.4.3 Mitigation Measures

- It is recommended that all equipment are operated within specified design parameters during construction, drilling and operational phases

- Use of ear muffs/plugs and other protective devices should be provided to the workforce in noise prone areas.

1.4.4 Environmental Management Plan

Environmental Management Plan (EMP) will be drawn after identifying, predicting and evaluating the significant impacts on each component of the environment with a view to maximizing the benefits from proposed project. The following measures will also be included in EMP:

- Recommend mitigation measures required to address environmental concerns such as wildlife and habitat protection, cultural and archaeological sites protection, terrain stabilization, maintaining fresh water horizons, debris disposal and conservation of natural drainage and water flow
- Assess additional infrastructures for treatment of produced water, proposed access cuttings, sewage, solid/hazardous waste with hydro-geo morphological details
- Provide a comprehensive and detailed plan covering environmental variables to be monitored, the location and timing of sampling and the use to be made of monitoring data to ensure compliance with the applicable environmental rules/regulations throughout the life of the project
- Delineate post-closure plan coexisting with natural surroundings for abandonment of wells, rig dismantling and site completion and reclamation for abandonment.

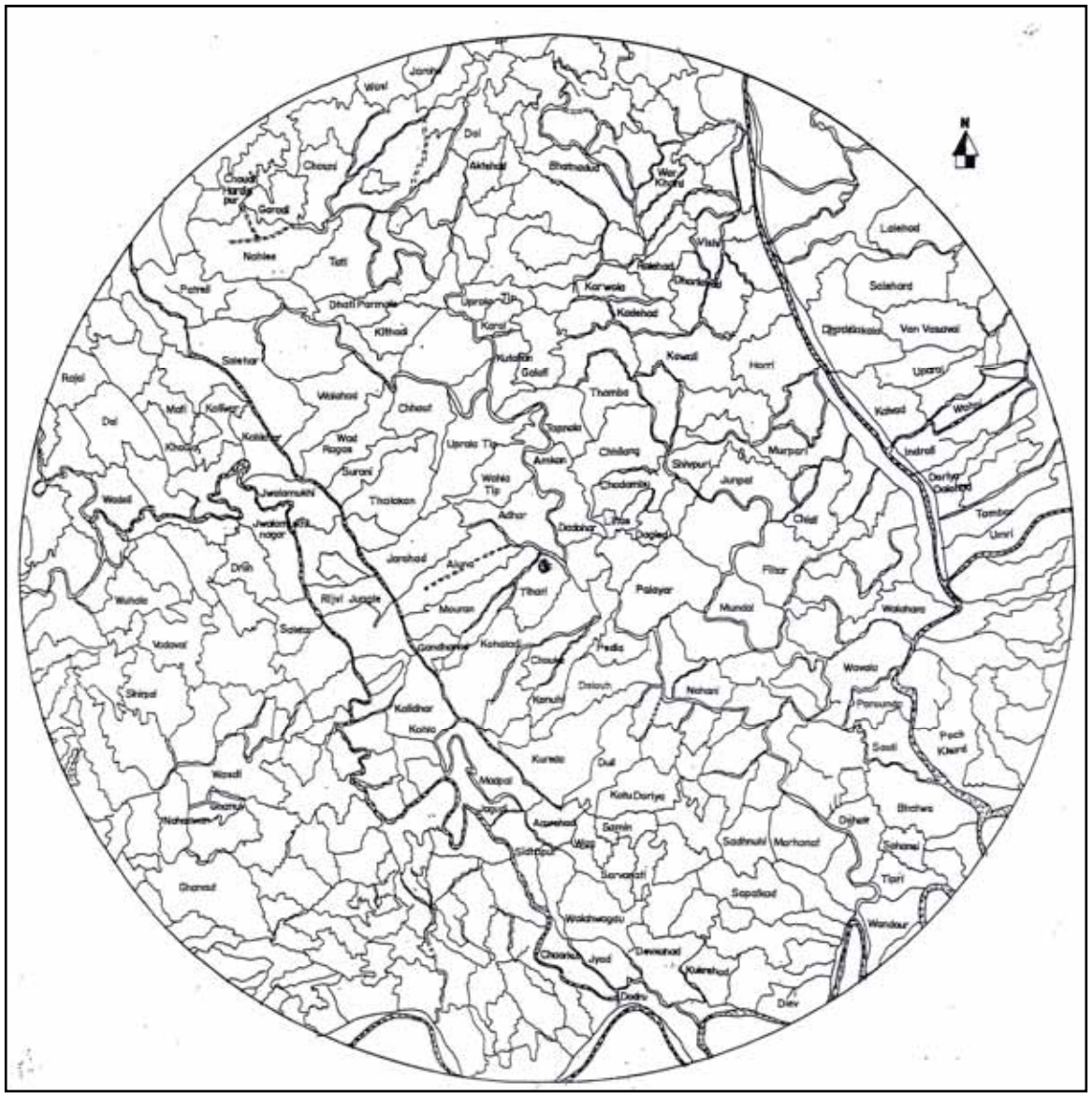

Fig. 1.1 : Study Area

Chapter 2

Project Description

2.1 Type of the Project

India's demand for petroleum products is growing at a rapid rate, having virtually doubled from 30 MMT in 1980-81 to almost 70 MMT in 1995-96. Current estimates indicate that it would reach a level of 155 MMT by 2006-07. With a view of meeting this growing demand, the new hydrocarbon policy aims at encouraging investment in oil exploration and production.

India is heavily dependent on imports to meet the rapidly growing demand for petroleum products. Current demand and supply projections indicate that the level of self-sufficiency is likely to decline to about 30% over the next few years. Substantial efforts are therefore, necessary to boost the level of exploration activity in the country, so that new finds can be made and the level of crude oil and gas production significantly increase in the years to come. Today India has the least explored regions. It is also evident that vast amount of capital investments are necessary if exploration efforts are to be substantially augmented. Therefore, there is need to attract both the National as well as private sector oil companies to invest in this critical area. In this block we have drilled many wells in Jawalamukhi area, Sundernagar and Hamirpur. However, no commercial oil and gas was found out. In Jawalamukhi wells, there were slight gas shows. Now, we have to explore further in this block for oil and gas find.

One exploratory well is to be drilled at Kangra-Mandi block in Himachal Pradesh for exploratory drilling. Depending upon the success of this well, we may take other wells in this block.

ONGC being the operator of this block has carried out the preliminary G & G studies undertaken and interpreted ONGC has decided to take up exploratory drilling to assess the hydrocarbon potential in the block. One exploratory location has been firmed based on G&G Studies and techno-economic evaluation of the prospect. Based on the results of this location and additional 3D seismic surveys and another location may be used for drilling.

2.2 Project Description

2.2.1 Description of Contract Area

Project Region	Block Title	Area (Sq. Km.)	Remarks
Kangra-Mandi (Himachal Pradesh)	PEL	2850	Lat. 31^{O}51′13.87″N Lon. 76^{O}21′57.77″E (**Table 2.1**)

2.2.2 Proposed Project

Having analyzed the subsurface data of the region, exploratory drilling is required to be carried out to test the occurrence of hydrocarbon in the targeted formation and assess its commercial viability. Accordingly exploratory well will be drilled upto the depth of 3500-4000 mts. If the successful results are obtained, other wells will be taken up in the same block.

2.2.2.1 Geological Setting

The area under context covers 2850 sq.km. and span from Kangra to Mandi towns. The one area of interest i.e. Baijnath falls between the Jogindernagar and Palampur towns and is bounded by the Jogindernagar thrust and Palampur thrusts on eastern and western sides. The sediments exposed belong to the tertiary age. Other area of interest is Jawalamukhi-Hamirpur founded by Jawalamukhi thrust. Accordingly two locations likely to be decided

2.2.3 Project Justification

ONGC has endeavored to meet the energy requirements of the country. The rising population and consequent increase in demands on petroleum has put lot of pressure on the government as in spite its best efforts, the country has to import oil from

the international market. It is expected that the proposed drilling activity in the new PEL block will meet the challenge partially. With a view to meeting this growing demand, the initiative for exploration in relatively less explored area is envisaged.

2.2.4 Drilling Operations

ONGC owned electrical type rig is proposed to be deployed for undertaking drilling in the block. The technical details of the proposed drilling activity are given below :

Well location/depth	Kangra-Mandi
Well Location/depth	PEL, Kangra-Mandi Block
No. of wells to be drilled	1
Quantity of drilling fluid	Water base mud
Quantity of cuttings Cu.m.	200-300 cu.m/day
Quantity of drilling waste cu.m.	1000 cu.m.
Locations details	Lat. $31^{O}51'13.87''N$ Lon. $76^{O}21'57.77''E$
Distance of Block boundary from the coast line	On land location
Development plan in case of strike	To be chalked after HC find
HC reserve (initial in place)	N/A as well is exploratory
Formation pressure	Hydrostatic
Test flaring, duration	2 to 3 days 3 flare details confined to the pit

Details of Drilling Rigs Proposed to be Deployed

Type of Rig	Electrical Rig
Drilling Mud composition	Water based drilling fluid
Power generator type and Nos.	AC-SCR type (06 Nos.)
Diesel consumption	6 m^3/day
Quantity of fresh water requirement and source	1000 m^3 transported from nearby source through contractor
Manpower of Rig	25 per shift of 12 hrs two shifts/day
Material requiredment and mobilization	From ONGC base
Details of solid handling system on rig	Shale Shakers : 1200 GPM Capacity Desander : 1200 GPM Capacity Desilter : 1200 GPM Capacity
Details of sewerage treatment facility if any	Not applicable
Waste pit availability and size	30′x33′x5′ : 2 Nos.

	38′x33′x5′	: 1 No.
	23′x20′x5′	: 1 No.
Oil Pit availability and size	3′x3′x4′	: 1 No.

Only water based drilling mud will be used. The quantity of drill cuttings generated will be around 200 m^3. The quantity of wastewater produced will be about 15 m^3/day. The rig will be provided with solids handling system comprising shale shakers (1200 GPM), Densader (1200 GPM) and Desilter (1200 GPM) and Desaster with vacuum pump.

Drilling operations will be carried out using the electrical type drilling unit (**Fig. 2.2**) for drilling of oil and gas wells consists of a derrick at the top of which is mounted a crown block and a hoisting block with a hook. From the swivel is suspended a Kelly stem passes through a square of hexagonal Kelly bush which fits into the rotary table. The rotary device receives the power to driver it from an electric motor. The electric motor rotates the rotary table which passes through the Kelly Bush and the rotations are transmitted to the bit as the drilling progresses, the drill pipes in singles are added to continue the drilling process. At the end of the bit life, the drill pipes are pulled out in stands and stacked on the derrick platform. A stand normally has 3 single drill pipes. After changing the bit, the drill string is run back into the hole and further drilling is continued. This process continues till the target depth is reached.

During the course of drilling, cuttings are generated due to crushing action of the bit. These cuttings are removed by flushing the well with duplex mud pumps. The mud from pump discharge through the rotary hose connected to stationary of the swivel, the drill string and bit nozzles. The mud coming out of the bit nozzles pushes the cuttings up hole and transports them to surface through annular space between the drill string and the hole. The not only carries away crushed rock from the bottom of the hole, but at also cools that bit as it get heated due to friction with formation while rotating. The mud also helps in balancing sub-surface formation pressures and by forming a cake on the walls of the well diminishes the possibility of crumbling or caving of the well bore.

At the surface, the mud coming out from well along with the cuttings falls in a trough, passes through the solids control equipments i.e. shale shaker, de-sander and de-silter. These equipments remove the solids of different sizes which get mixed with the mud during the course of drilling. The cleaned mud flows back to the suction tanks to re-again pumped into the well. The drilling mud/fluid circulation is thus a continuous cyclic operation. A sketch of the drilling mud circulatory system is shown in **Fig. 2.3**. The most suitable clay for mud preparation is Bentonite which is a capable of forming highly

dispersed colloidal solutions. Various other chemicals are also used in mud preparation as per requirements dictated by the temperature/pressure conditions of the wells. The mud is continuously tested for its density, viscosity, yield point, water loss, pH value etc. to ensure that the drilling operations can be sustained without any down hole complications.

2.2.5 Drilling Facilities

Drilling is a temporary activity which will continue for about 45 days for each well in the block. The rigs are self-contained for all routine jobs. Hence the drilling operations are completed, and if sufficient indications of hydrocarbons are noticed while drilling, the well is tested by perforation in the production casing. This normally takes 2-3 days. If the well is found to be a successful hydrocarbon bearing structure, it is sealed off for nature development, if any.

2.3 General Requirements of Drilling

2.3.1 Exploratory Drilling Programme Required the Following Common Facilities

2.3.1.1 Drilling Muds

Drilling of wells requires specially formulated muds which basically comprise inert earth materials like Bentonite, barite in water with several additives to give mud weight, fluidity and filter cake characteristics while drilling. The drilling muds have several functions like lubrication and cooling of the drilling bits balancing subsurface formation, bringing out the drill cuttings from the well bore, thixotrophic property to hold cuttings during non-operations, formation of thin cake to prevent liquid has along well bore etc. Several additives are mixed into the mud system to give the required properties. Water based mud will be used to the possible extent in exploratory drilling because of synthetic based mud may require due to complexities associated with the geological formations and associated hole stability problems. The constituents of water based mud (WBM) are given in **Table 2.2**. The special additives and their functions in WBM are shown in **Table 2.3**.

2.3.1.2 Power Generation

The drilling process requires movement of drill bit through the draw works which require power. The power requirement of the drilling rig will be met by using the six Diesel Generator sets with a diesel consumption of about 06 Kl/day. The exhaust stacks of the DG sets are likely to vent the emissions.

2.3.1.3 Water Requirement

The water requirement in a drilling rig mainly meant for preparation of drilling mud apart from washings and domestic use. While the former consumes the majority of water requirement, the water requirement for domestic and wash use is very less. The daily water consumption will be 25 m^3/d of which 15 m^3/d will be used for mud preparation and 10 m^3/d will be used for domestic purpose including drinking. The total quantity of water requirement is about 1200 m^3 which shall be transported from nearby source through the contractor after due approvals and recycling of water will be attempted to a maximum extent for resource case evaluation. The treatment of the wastewater is done on the onshore drill site before disposal.

2.3.1.4 Domestic Wastewater

The operating personnel in the drilling rigs will operate from drill site accommodation (DSA) in the vicinity of the location. Suitable soak pits will be available at the DSA.

2.3.1.5 Solids Removal

The rock cuttings and fragments of shell, sand and silt associated with the return drilling fluid during well drilling will be separated during shale shakers and other solids removal equipment like de-sanders and de-silters. The recovered mud will be reused while the rejected solids will be collected and discharged into the waste pit.

2.3.1.6 Drill Cuttings and Waste Residual Mud

During drilling operations, approximately 200 m^3 per well of wet drill cuttings are expected to be generated from each well depending on the type of formation and depth of drilling. In addition to the cuttings 15-20 m^3/day of wastewater is likely to be generated during well drilling. The waste residual muds and drill cuttings which contain clay, sand etc. will be disposed into the waste pit.

2.3.1.7 Testing

Testing facilities will be available at drilling rig for separation of liquid phase and burning of all hydrocarbons during testing. The test fire flare boom will be located at a distance from the drilling rig.

2.3.1.8 Chemical Storage

The drilling rig will have normal storage facilities for fuel oil, required chemicals and the necessary tubular and equipment. The storage places will be clearly marked with safe operating facilities and practices.

2.3.1.9 Manpower

The drilling rig will be operated by approximately 30 persons on the rig at any time. The manpower will operate in two shifts with continuous on the rig.

2.3.1.10 Logistics

Crew transfers to and from the drilling rig, materials, diesel and chemicals will be through light vehicles, trucks and trailers.

2.4 Project Investment

The project investment will be approximately 42 crores for drilling operations.

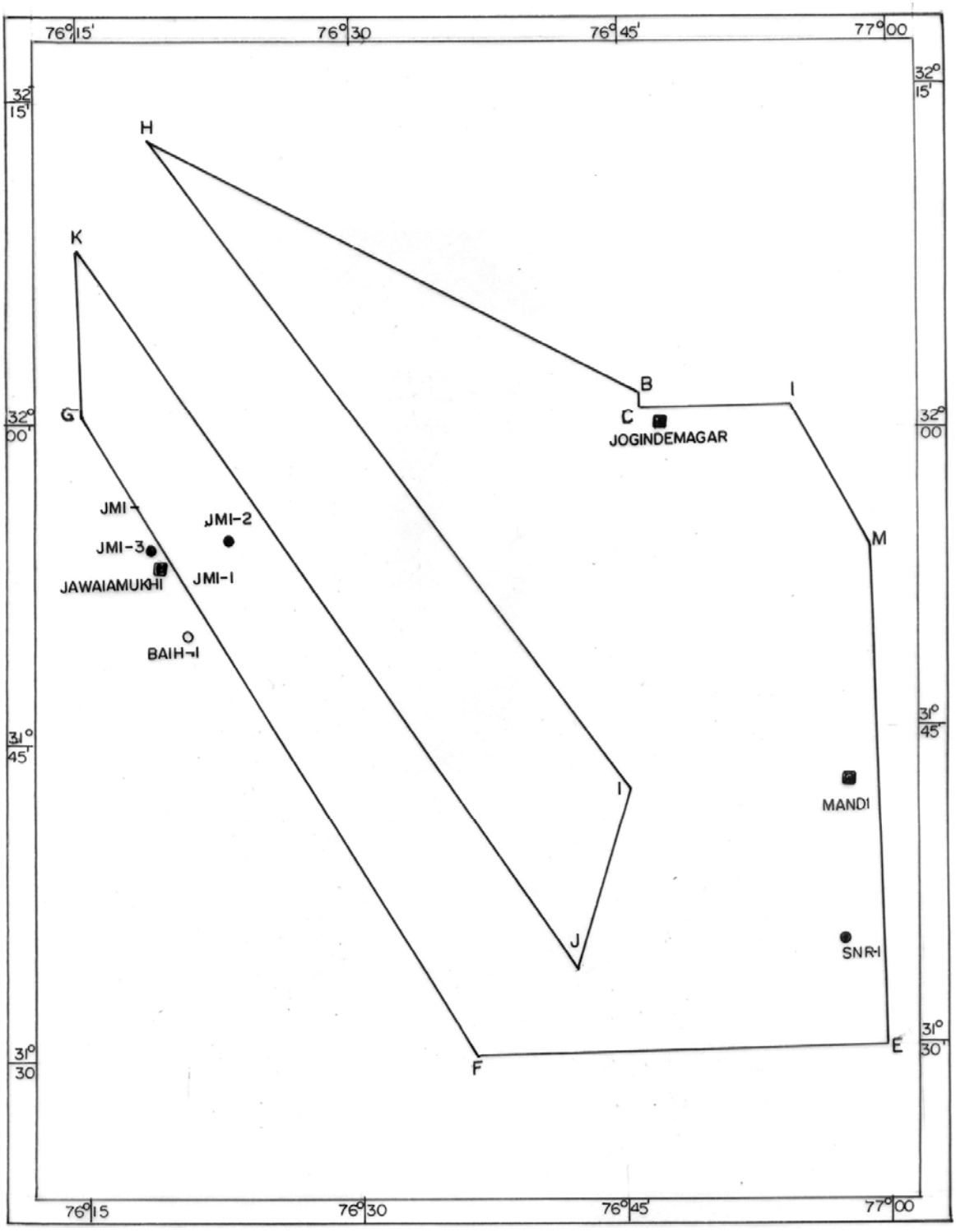

Fig. 2.1 : Location of the Block

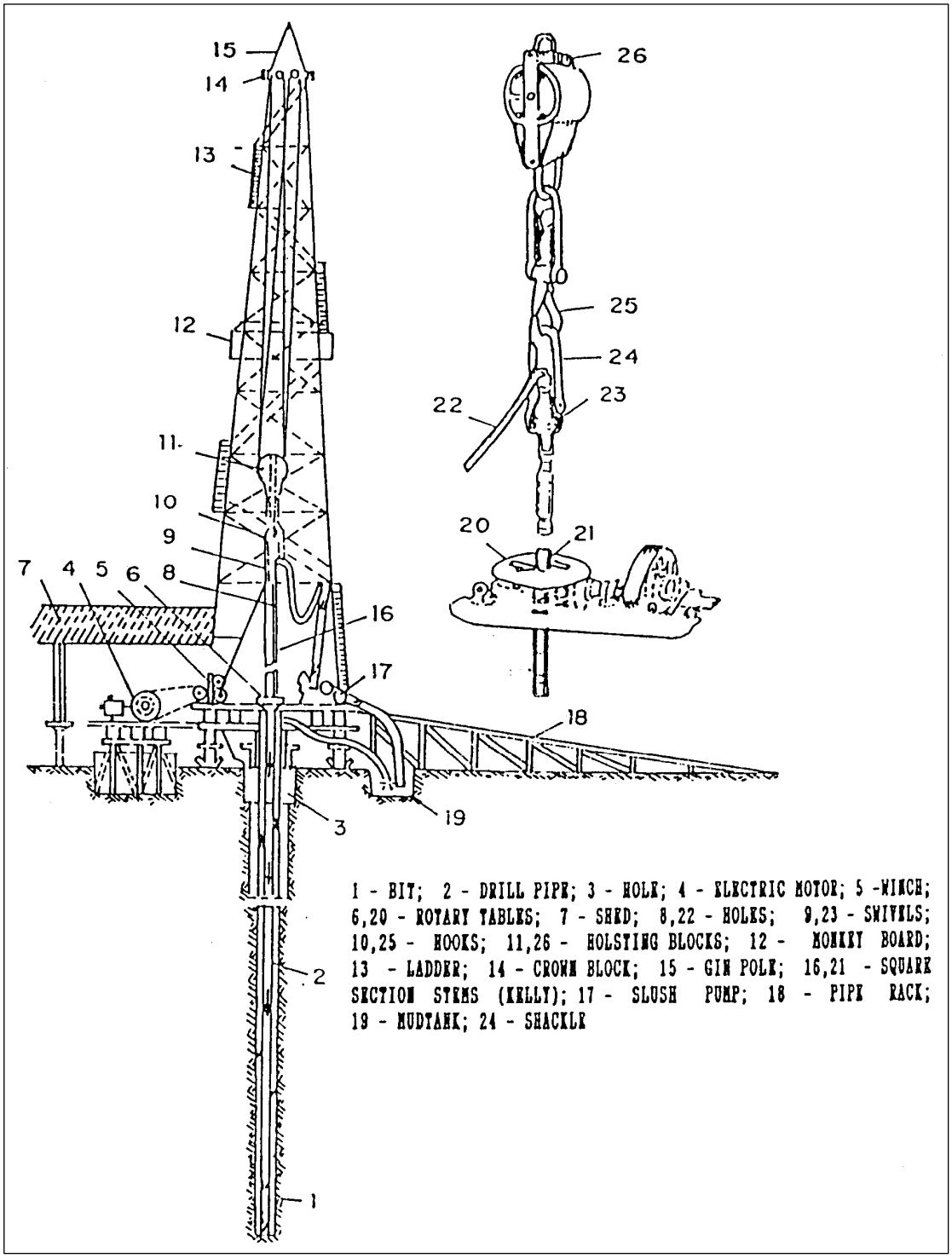

Fig. 2.2 : Stationary Drilling Outfit

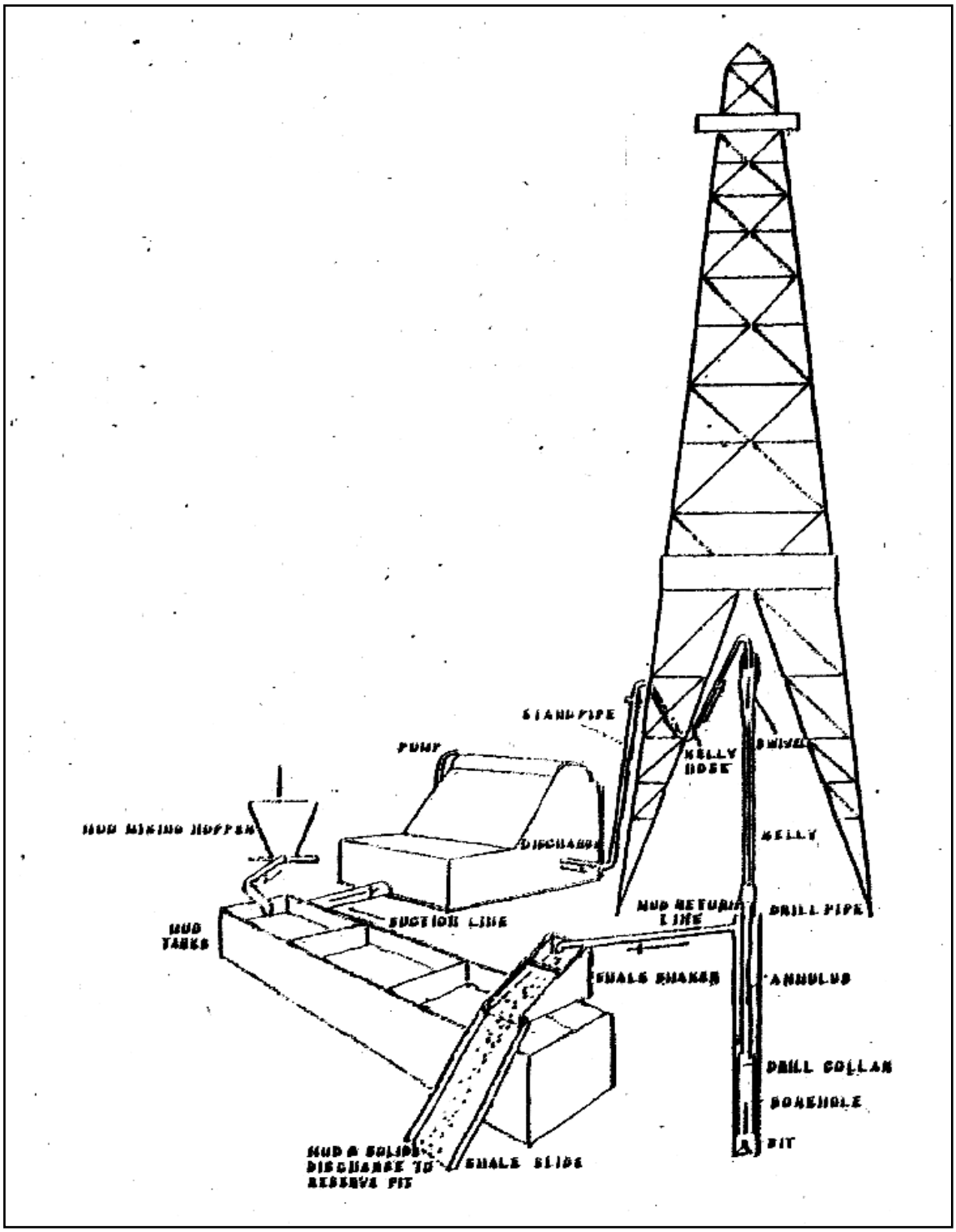

Fig. 2.3 : Drilling Fluid Circulation

Table 2.1

Coordinates of PEL Block

Point	Latitude	Longitude
B	$32^{O}00'$	$76^{O}50'$
C	$32^{O}00'$	$76^{O}45'$
D	$23^{O}21'36''$	$79^{O}37'36''$
E	$31^{O}30'$	$77^{O}00'00''$
F	$31^{O}30'$	$76^{O}35'$
G	$32^{O}00'00''$	$76^{O}15'$
K	$32^{O}8'$	$76^{O}15'$

Table 2.2

Ingredient of Water Based Drilling Fluid

Sr. No.	Chemicals
1.	Barite
2.	Bentonite
3.	Carboxy Methyl Cellulose
4.	Mud Thinner/Conditioner
5.	Resinated Lignite
6.	Non-Weighted Spotting Fluid
7.	Weighted Spotting Fluid
8.	EP Lube
9.	Drilling Detergent
10.	Caustic Soda
11.	Potassium Chloride
12.	Soda Ash

Table 2.3

Special Additives and their Function in Water Based Drilling Fluids

Sr. No.	Discharge Category	Exploration
1.	Sodium bicarbonate	Eliminate excess calcium ions due to cement contamination
2.	Sodium Chloride	Minimize horehole washout in salt zone
3.	Groundnut shells, mica of cellethane	Minimize loss of drilling mud to formation
4.	Cellulose polymers or starch	Counter thick, sticky filter cake, decrease filter loss to formation
5.	Aluminum stearate	Minimize foaming
6.	Vegetable Oil lubricant	Reduce torque and drag on drill string
7.	Pill of oil-based mud spotting fluid	Counter differential pressure sticking of drilling string. Pill is placed down hole opposite contact zone to free pipe

Chapter 3

Description of the Environment

3.1 Air Environment

A methodologically designed air quality surveillance programme (AQSP) was adopted as the basis to determine the impact assessment on air environment. This programme ultimately helps in formulating a sound Environment Management Plan (EMP). The basic considerations for designing such a programme include:

1. Representative selection of sampling locations primarily guided by the topography and micrometeorology of the region
2. Adequate sampling frequency and
3. Monitoring of the index pollutants

All these aspects were given due consideration for devising an optimal scheme for AQSP for Environmental Impact Assessment around the proposed exploratory drilling in Kangra-Mandi Block. The proposed exploratory drilling site is situated in Khundia tehsil of Kangra district, Himachal Pradesh.

The existing ambient air quality status (AAQS) within the impact zone is characterized through in-situ monitoring, whereas, predictions for differential emission

scenario are made through air pollution modeling for existing micro-meteorological and topographical features of the proposed location and its surrounding study zone.

3.1.1 Reconnaissance

A reconnaissance was conducted with a view to establish the baseline status with respect to air environment around the proposed exploratory drilling site, surrounding villages and other centers of human activities. A study area of 10km radius was marked to establish the existing regional background levels.

The proposed drilling site of ONGC in Kangra-Mandi Block is located on a hilly terrain near village Tihari which comes under Khundia Tehsil, Dist Kangra. The National Highway, NH-88, which links Kangra with Shimla, passes through Sapri, Jwalamukhi and Badoli in the study area. Jwalamukhi, which is famous pilgrimage, is approximately 5km (Aerially) and 15 km by road from the proposed site. There is as such no major industrial activity in the region. Forest dwelling, agricultural activity and some small business activity constitute the source of livelihood to the people. The prime objective of this AAQ survey within 10 km radial zone of proposed project site was to establish the existing regional background levels. The fluctuations of AAQ within the study zone of proposed project are expected to be governed by overall regional emissions and micrometeorology. Fourteen sampling locations were selected during survey depending upon the importance of site and/or sensitive receptors around the proposed project viz. residential area and also based on wind profiles available for the region from previous meteorological observation around the study area. At the same time wind direction and speed are recorded for the study period and windroses are plotted to demarcate the zone (direction) of probable maximum concentrations for study period. The monitoring sites were located keeping in view the prevailing wind patterns during the study period. The locations for different ambient air quality monitoring stations (AAQMS) are projected in **Fig. 3.1.1** and presented in Table **3.1.1**.

3.1.2 Ambient Air Quality Survey

Five major air pollutants viz., suspended particulate matter (SPM), respirable particulate matter (RPM), sulphur dioxide (SO_2), dioxide of nitrogen (NOx) and hydrocarbon (HCs) representing the basic air pollutants in the region were identified for AAQM.

The high volume samplers fabricated according to NEERI's design were used for air sampling. The significant air pollutants, viz. SPM, RPM, SO_2 & NOx were monitored on 24 hourly basis. SPM & RPM were analyzed by gravimetric method for

deriving concentrations at each site. The gaseous pollutants (SO_2 and NOx) were analysed using standard wet chemical methods. Grab samples of HCs were collected and analysed. A field laboratory was set up in the study area and representative air samples were analysed on the same day.

3.1.3 Micrometeorology

The study of micro-meteorological conditions of a particular region is of utmost importance to understand the variations in ambient air quality status in that region. The prevailing micrometeorology at project site plays a crucial role in transport and dispersion of air pollutants. The persistence of the predominant wind direction and wind speed at the project site will decide the direction and extent of the air pollution impact zone. The principal variables, which affect the micrometeorology, are horizontal transport and dispersion (average wind speed and directions), convective transport and vertical mixing (atmospheric stability) and also topography of the area towards local influences.

Climatological Tables of Observatories in India (1951-1980), published by India Meteorological Department, were used to obtain climatological normals for the region. Dharmsala is the nearest meteorological observatory to the project site (approx. 50 km distance). As per climatological normals in the project region, the ambient temperature varies from 1.7^{O}C to 21.7^{O}C in winter season. Rainfall during the winter season varies from 54-114.5mm with average of 89.7mm. Relative humidity varies from 53 to 60%. The average wind speed is between 1 and 19 km/h.

The micro-meteorological data recorded at the project site as well as surface meteorological data procured from IMD corresponding to nearest available observatory (Dharmsala) are appropriately used in this study. The hourly record of wind speed and wind direction during study period was used for computing the relative percentage frequencies of wind occurrences in various directions. The winter season windroses are presented in **Fig. 3.1.2**.

The windrose diagram (**Fig. 3.1.2**) for winter season indicates that the wind was blowing from all the sides but predominant winds were from SW & W directions. Accordingly, the impact zone will be spread in SE & E sector. The calm conditions were prevailing for 30.6% of time in winter season.

3.1.4 Baseline Status

The ambient air quality status observed is presented in **Table 3.1.2.** The average concentrations of SPM at each site varied from 108 $\mu g/m^3$ to 188 $\mu g/m^3$, while

the individual observations of 24 hrly SPM concentrations were recorded in the range of 66-325 μg/m^3 (**Table 3.1.2**). The 98th percentile values of SPM ranged between 138-299 μg/m^3 (**Table 3.1.3**).

The average RPM (<10 μm) concentrations at each site varied from 37-63 μg/m^3 (24 hrly sampling) while the individual observations of 24 hrly RPM concentrations were recorded in the range of 21-93 μg/m^3 (**Table 3.1.2**). The 98th percentile values (μg/m^3) of 24 hrly RPM ranged between 46-88 μg/m^3 were below the CPCB standard (100 μg/m^3) for residential and rural areas (**Table 3.1.4**).

The average concentrations of SO_2 at all stations were in the range of 3-6 μg/m^3, while the individual concentrations were recorded between 3-7 μg/m^3 (**Table 3.1.2**). The 98th percentile value of SO_2 varied in the range of 4-7 μg/m^3 (**Table 3.1.5**). The average concentrations of NOx were in the range of 4-7 μg/m^3, while individual concentration were observed in the range of 3-10 μg/m^3 (**Table 3.1.2**) and the 98th percentile values varied between 5-10 μg/m^3 (**Table 3.1.6**) The cumulative percentile levels of SO_2 and NO_x given in **Table 3.1.5** and **3.1.6** shows that the 98th percentile concentrations of SO_2 and NO_x were well within the stipulated standard (80 μg/m^3) of CPCB for residential, rural and other areas at all stations during study period. Non-methane hydrocarbon in the ambient air varied in the range of 0.3-0.4 ppm and methane hydrocarbon varied in the range of 0.6-1.2 ppm during winter season (**Table 3.1.7**).

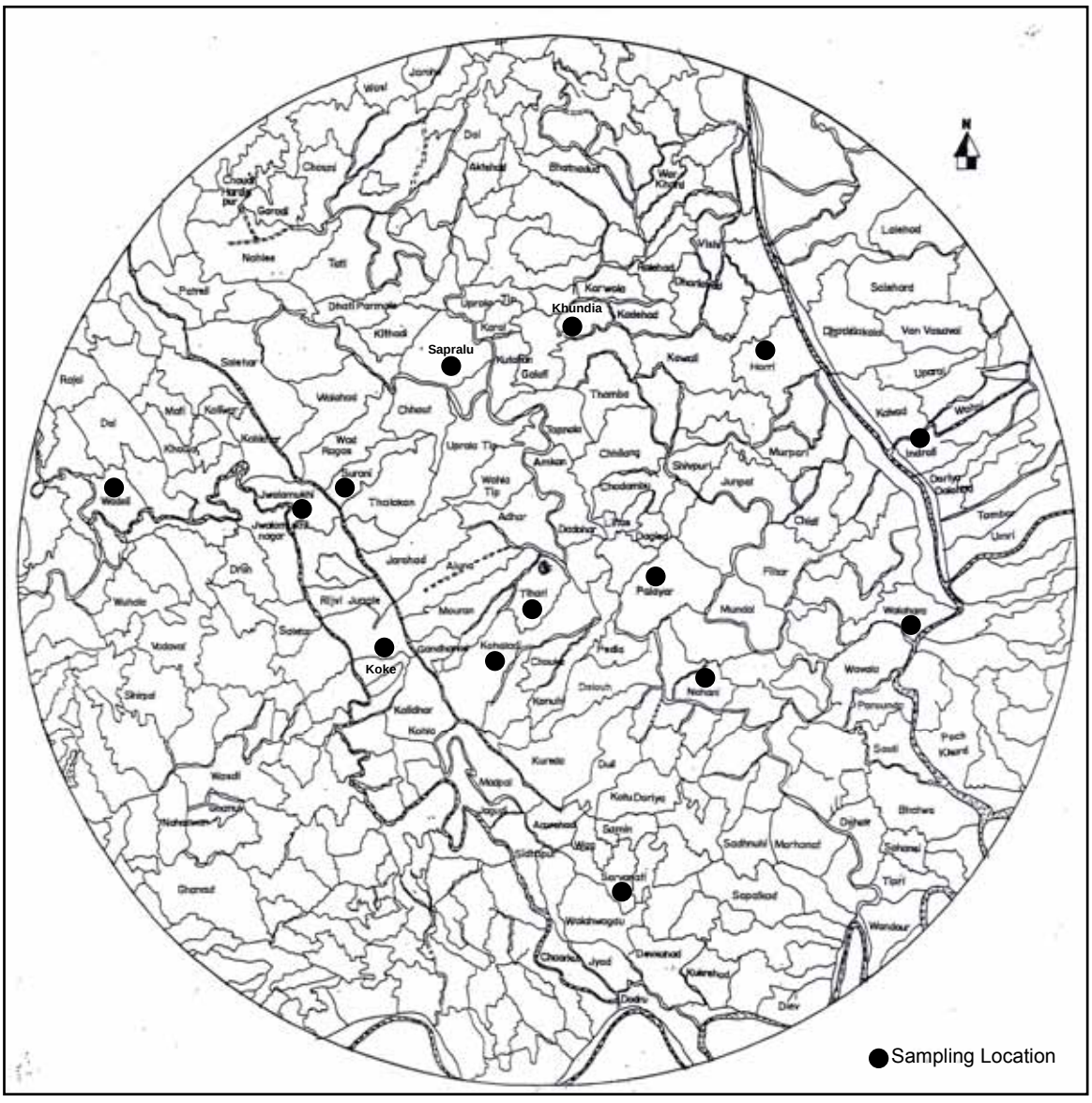

Fig. 3.1.1: Air Monitoring Locations - Kangra Mandi

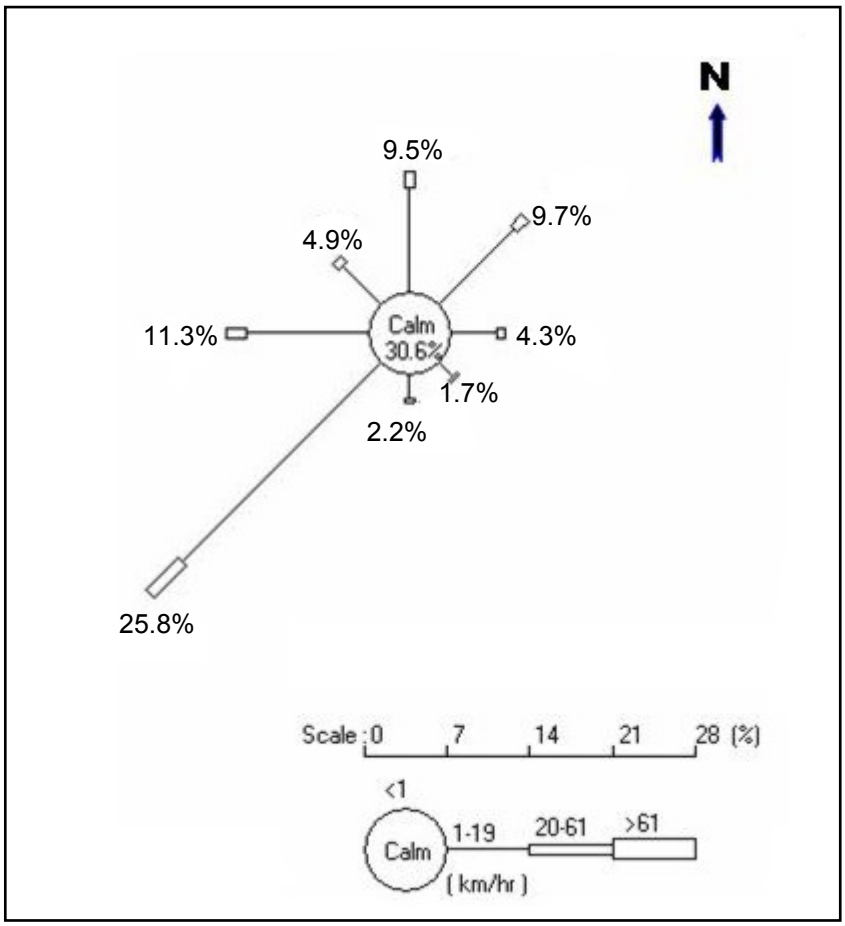

Fig. 3.1.2 : Windrose Diagram at Project Site (Winter Season)

Table 3.1.1

Ambient Air Quality Monitoring Locations (Winter Season)

Sr. No.	Sampling Location
1.	Kohladi
2.	Tihari
3.	Khundia
4.	Hari
5.	Indroli
6.	Walahara
7.	Palayar
8.	Nahania
9.	Sarvanti
10.	Koke
11.	Badoli
12.	Jwalamukhi
13.	Surani
14.	Sapralu

Table 3.1.2

Ambient Air Quality Status (Winter 2008-2009)

Units: μg/m^3 Avg.: 24 Hrs.

Sr. No.	Sampling Location	Avg. ± SD			
		SPM	RSPM	SO_2	NOx
1.	Kohladi	168 ± 30 (116-216)	57 ± 10 (41-71)	3 ± 1 (3-4)	4 ± 1 (3 - 5)
2.	Tihari	141 ± 28 (98-188)	47 ± 9 (34-62)	3 ± 1 (3-5)	4 ± 1 (3 - 5)
3.	Khundia	144 ± 55 (66-267)	49 ± 18 (21-88)	4 ± 1 (3-5)	6 ± 1 (4 - 8)
4.	Hari	108 ± 20 (72-141)	37 ± 7 (23-51)	4 ± 1 (3-5)	4 ± 1 (3 - 5)
5.	Indroli	176 ± 49 (109-302)	59 ± 14 (36-93)	4 ± 1 (3-5)	6 ± 1 (4 - 7)
6.	Walahara	144 ± 38 (106-226)	48 ± 13 (36-72)	3 ± 1 (3-4)	4 ± 1 (3 - 5)
7.	Palayar	116 ± 14 (97-142)	39 ± 5 (31-46)	3 ± 1 (3-4)	4 ± 1 (3 - 5)
8.	Nahania	141 ± 33 (92-199)	48 ± 11 (30-63)	3 ± 1 (3-5)	4 ± 1 (3 - 6)
9.	Sarvanti	118 ± 23 (94-156)	40 ± 8 (31-52)	4 ± 1 (3-5)	4 ± 1 (3 - 6)
10.	Koke	188 ± 34 (148-265)	63 ± 11 (49-87)	4 ± 1 (3-5)	4 ± 1 (3 - 6)
11.	Badoli	160 ± 67 (69-325)	52 ± 19 (22-88)	6 ± 1 (4-7)	7 ± 1 (5 - 10)
12.	Jwalamukhi	140 ± 62 (93-318)	46 ± 16 (31-87)	5 ± 1 (3-6)	6 ± 1 (4 - 8)
13.	Surani	120 ± 21 (92-156)	40 ± 6 (31-52)	4 ± 1 (3-5)	4 ± 1 (3 - 6)
14.	Sapralu	123 ± 23 (96-172)	41 ± 8 (32-60)	4 ± 1 (3-5)	4 ± 1 (3 - 6)

Table 3.1.3

Cumulative Percentile of SPM
(Winter 2008-2009)

Units: µg/m^3 Avg.: 24 Hrs

Sr. No.	Sampling Location	Min	Percentile				Max
			25th	50th	75th	98th	
1.	Kohladi	116	154	163	187	214	216
2.	Tihari	98	122	138	163	184	188
3.	Khundia	66	105	142	166	254	267
4.	Hari	72	95	108	122	138	141
5.	Indroli	109	148	163	186	284	302
6.	Walahara	106	111	136	164	219	226
7.	Palayar	97	107	117	122	141	142
8.	Nahania	92	116	142	165	194	199
9.	Sarvanti	94	101	109	136	154	156
10.	Koke	148	166	180	204	258	265
11.	Badoli	69	122	148	189	299	325
12.	Jwalamukhi	93	103	122	146	287	318
13.	Surani	92	106	113	133	156	156
14.	Sapralu	96	103	121	139	166	172

Table 3.1.4

Cumulative Percentile of RSPM
(Winter 2008-2009)

Units: µg/m^3 Avg.: 24 Hrs

Sr. No.	Sampling Location	Min	Percentile				Max
			25th	50th	75th	98th	
1.	Kohladi	41	51	55	64	71	71
2.	Tihari	34	43	46	54	61	62
3.	Khundia	21	35	49	57	84	88
4.	Hari	23	33	36	40	49	51
5.	Indroli	36	52	55	64	88	93
6.	Walahara	36	39	44	56	71	72
7.	Palayar	31	35	40	43	46	46
8.	Nahania	30	39	49	56	62	63
9.	Sarvanti	31	34	36	46	52	52
10.	Koke	49	58	61	66	85	87
11.	Badoli	22	40	50	63	85	88
12.	Jwalamukhi	31	35	41	52	81	87
13.	Surani	31	36	39	45	51	52
14.	Sapralu	32	35	40	45	58	60

Table 3.1.5

Cumulative Percentile of SO_2 (Winter 2008-2009)

Units :$\mu g/m^3$ Avg.: 24 Hrs

Sr. No.	Sampling Location	Min	Percentile				Max
			25th	50th	75th	98th	
1.	Kohladi	3	3	3	4	4	4
2.	Tihari	3	3	3	4	5	5
3.	Khundia	3	3	4	4	5	5
4.	Hari	3	3	3	4	5	5
5.	Indroli	3	3	4	4	5	5
6.	Walahara	3	3	3	4	4	4
7.	Palayar	3	3	3	4	4	4
8.	Nahania	3	3	3	4	5	5
9.	Sarvanti	3	3	3	4	5	5
10.	Koke	3	3	3	4	5	5
11.	Badoli	4	6	6	7	7	7
12.	Jwalamukhi	3	4	5	5	6	6
13.	Surani	3	3	4	4	5	5
14.	Sapralu	3	3	4	4	5	5

Table 3.1.6

Cumulative Percentile of NOx (Winter 2008-2009)

Units :µg/m^3 Avg.: 24 Hrs

Sr. No.	Sampling Location	Min	Percentile				Max
			25th	50th	75th	98th	
1.	Kohladi	3	3	4	4	5	5
2.	Tihari	3	3	4	4	5	5
3.	Khundia	4	6	6	7	8	8
4.	Hari	3	3	4	4	5	5
5.	Indroli	4	5	5	6	7	7
6.	Walahara	3	3	4	4	5	5
7.	Palayar	3	3	3	4	5	5
8.	Nahania	3	3	4	4	6	6
9.	Sarvanti	3	3	4	4	6	6
10.	Koke	3	4	4	4	6	6
11.	Badoli	5	7	7	8	10	10
12.	Jwalamukhi	4	5	6	6	8	8
13.	Surani	3	4	4	5	6	6
14.	Sapralu	3	4	4	5	6	6

Table 3.1.7

Levels of Hydrocarbon
(Winter 2008-2009)

Units: ppm Spot Concentration

Sr. No.	Sampling location	Methane	Non-methane	Total Hydrocarbon
1.	Kohladi	0.6	0.3	0.9
2.	Tihari	0.7	0.3	1.0
3.	Khundia	1.0	0.4	1.4
4.	Hari	0.7	0.3	1.0
5.	Indroli	0.9	0.4	1.3
6.	Walahara	0.8	0.3	1.1
7.	Palayar	0.7	0.3	1.0
8.	Nahania	0.8	0.3	1.1
9.	Sarvanti	1.1	0.4	1.5
10.	Koke	1.2	0.4	1.6
11.	Badoli	1.1	0.3	1.4
12.	Jwalamukhi	1.2	0.4	1.6
13.	Surani	0.7	0.4	1.1
14.	Sapralu	0.7	0.3	1.0

3.2 Noise Environment

Noise, often defined as unwanted sound, interfaces with speech communication, causes annoyance, distracts from work, and disturbs sleep, thus deteriorating quality of human environment.

The impact of noise on the health of an individual depends on physical dose of noise viz. noise level, frequency spectrum, annoyance etc. and human factors viz. sex, age, health status, type of activity, occupational exposure etc. The impact also depends on psychological and physiological state of individuals.

3.2.1 Methodology and Baseline Environmental Status

The objective of survey of noise pollution around the proposed exploratory drilling site in the Kangra-Mandi Block was to assess the existing levels of noise, being generated and their impact on the human settlements. Studies pertaining to noise environment were conducted as follows:

- Reconnaissance
- Identification and characterization of noise sources
- Measurement of baseline noise levels in the study area
- Measurement of prevailing noise levels due to vehicular movements

The impact due to noise does not undergo seasonal variations except some directional changes depending upon the predominant wind direction. The baseline studies for noise environment have been carried out through reconnaissance followed by field observations to identify the major activities contributing to noise levels within the study area.

3.2.1 Reconnaissance

A reconnaissance was conducted with a view to establish the baseline status of the environment with respect to noise levels around the proposed exploratory drilling site, surrounding villages and other centers of human activities.

The proposed drilling site of ONGC in Kangra-Mandi Block is located on a hilly terrain. The site is situated near the village Tihari which comes under Khundia Tehsil in Kangra District. Jwalamukhi, which is famous pilgrimage, is approximately 5km (Aerially) and 15 km by road from the proposed site. The National Highway NH-88, which links Kangra with Shimla, passes through the study area. A study area of 10km radius was taken to measure the baseline noise levels around the proposed exploratory site, surrounding villages and other centers of human activity.

3.2.2 Identification and characterization of noise sources

There is no major industrial activity in the study area. Agricultural activity, forest dwelling and small business constitute the major source of livelihood to the people. The potential noise sources in the study area around the project site are mainly traffic density on the National Highway NH-88, Village roads and Agricultural activity in the region. Trucks, buses, jeeps, matadors and two wheelers are the mobile sources of noise.

3.2.3 Measurement of baseline noise levels in the study area

Noise standards have been designated for different types of landuse, i.e. residential, commercial, silence zones, as per 'The Noise Pollution (Regulation and Control) Rules, 2000, Notified by Ministry of Environment and Forests, New Delhi, February 14, 2000'. Different standards have been stipulated during daytime (6 am to 10 pm) and nighttime (10 pm to 6 am). Equivalent noise levels (Leq) for a period of about 20 minutes have been measured at each monitoring location during daytime and nighttime.

The background noise levels were measured using the Quest 1200/2200 Sound Level Meter. The sampling locations are shown in **Fig. 3.2.1** and noise levels during daytime and nighttime are presented in **Table 3.2.1, 3.2.2 and 3.2.3**

The noise levels in the residential zone have been monitored. The Noise levels ranged between 43.1-54.7 dBA during daytime and 36.2-44.4 dBA during night time(**Table 3.2.1**). At the commercial zone the noise level ranged between 55.5-66.5 dBA during daytime and 45.8-54.5 dBA at night time (**Table 3.2.2**).

Noise levels were also monitored in Schools, Primary Health Centres, hospitals and temples in the study area i.e. silence zone. The noise levels varied from 38.0-47.4 dBA during daytime and 33.6-39.8 dBA during night time shown in **Table 3.2.3**. At some locations during the daytime the noise levels are above the prescribed limit as some of schools are located near the roadside. Vehicular movement on roads may be attributed as the potential cause of the same.

The vehicular traffic was monitored on National Highway NH-88, which links Kangra to Shimla near village Sapri and on Palampur road near village Ghatta during morning peak hours. During survey period the traffic density on NH-88 was observed as 520 vehicles/hour, out of which heavy, medium, and light vehicles were 114, 176 and 230 respectively. On Palampur road the traffic density was observed as 346 vehicles/hour, out of which heavy, medium and light vehicles were 58, 104 and 184 respectively. The equivalent noise levels on the road side were observed in the range of 62.6.1-75.3 dBA.

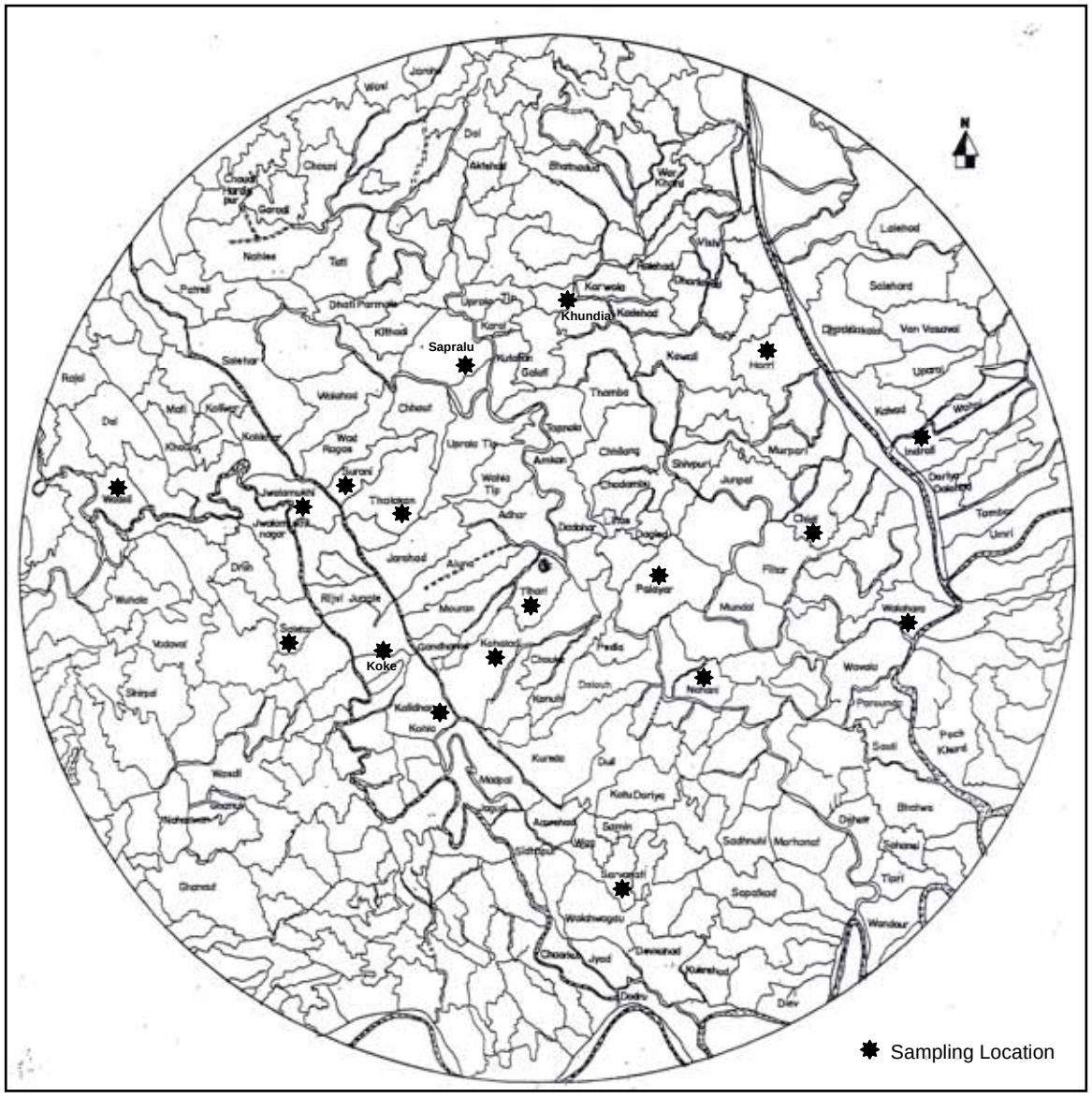

Fig. 3.2.1 : Noise Monitoring Locations

Table 3.2.1

Noise Monitoring Locations

Sr. No.	Sampling Location
1.	Kohladi
2.	Tihari
3.	Khundia
4.	Palayar
5.	Nahania
6.	Indroli
7.	Walahara
8.	Sarvanti
9.	Kalidhar
10.	Koke
11.	Salehar
12.	Surani
13.	Thalakan
14.	Jwalamukhi
15.	Badoli
16.	Sapralu
17.	Chidi
18.	Harri

Table 3.2.2

Noise Level in the Residential Area

Sr. No.	Sampling Location	Day Time Leq. (dBA)	Night Time Leq. (dBA)
1.	Kohladi	43.9	36.5
2.	Tihari	44.7	36.6
3.	Khundia	53.6	43.0
4.	Palayar	45.7	36.7
5.	Nahania	48.7	41.1
6.	Indroli	46.1	39.0
7.	Walahara	46.0	38.5
8.	Sarvanti	47.2	40.5
9.	Kalidhar	46.2	39.2
10.	Koke	47.3	40.8
11.	Salehar	49.0	41.6
12.	Surani	51.4	42.0
13.	Thalakan	43.1	36.2
14.	Jwalamukhi	54.7	44.4
15.	Badoli	52.6	42.5
16.	Sapralu	52.4	42.7
17.	Chidi	44.1	38.6
18.	Harri	46.7	39.2

Table 3.2.3

Noise Level in Commercial Area

Sr. No.	Sampling Location	Day Time dB(A)	Night Time dB(A)
1.	Jwlamukhi	66.5	54.5
2.	Surani	63.5	48.5
3.	Khundia	64.1	52.0
4.	Badoli	63.8	52.1
5.	Nahania Small Market	58.7	46.4
6.	Ghatta	58.3	46.0
7.	Sapralu Small Market	55.5	45.8

Table 3.2.4

Noise Level in Sensitive Zone

Sr. No.	Sampling Location	Day Time dB(A)	Night Time dB(A)
1.	Govt. Senior Sec.School, Tihari	38.6	33.8
2.	Govt. Primary.School, Alooha	38.0	33.6
3.	Govt. Senior Sec.School, Khundia	40.2	34.0
4.	Primary Health Centre, Khundia	40.9	34.8
5.	Govt. Senior Sec.School, Nahania	42.4	37.0
6.	Govt. Primary.School, Palayar/Jamuli	40.3	34.2
7.	Govt. Middle School, Walahara	41.9	35.0
8.	Govt. Primary.School, Salihar	42.0	36.6
9.	Sub Health Centre, Surani	39.0	34.1
10.	Govt. Senior Sec.School, Jwalamukhi	46.5	39.7
11.	Community Health Centre, Jwalamukhi	47.4	39.8
12.	Temple, Jwalamukhi	47.2	39.5
13.	Govt. Higher Sec.School, Badoli	44.3	36.4

3.3 Water Environment

3.3.1 Reconnaissance

In order to generate the baseline water quality (physico-chemical and biological) of the region, a study was undertaken and 10 sampling locations were identified. Samples collected include various sources viz. 1 surface water sample from River Byas and 9 Hand Pump samples from the study area. The sampling locations are listed in **Table 3.3.1** and depicted in **Fig. 3.3.1**.

3.3.2 Physico-chemical Characteristics

Analysis was carried out as per Standard Methods (APHA) for Examination of Water and wastewater 21st Edition 2005 and data obtained on water quality for various parameters are presented in **Tables 3.3.2-3.3.10**. The results of water quality in Winter 2008 are summarized as follows:

3.3.2.1 Surface Water

The physico-chemical characteristics of River Byas for Winter 2008 were, pH: 7.8, TDS: 354 mg/l and TSS: 12 mg/l respectively. Temperature was $9^{O}C$. The alkalinity was 64 mg/l, whereas total hardness was found to be 212 mg/l as $CaCO_3$. The chloride and sulphate were observed 59 mg/l and 128 mg/l respectively. Whereas sodium and potassium concentrations were found to be 26 and 6 mg/l respectively (**Tables 3.3.3-3.3.6**).

The organic load in terms of COD and BOD was found to be 23 mg/l and 8 mg/l respectively. Nutrients with respect to Nitrates were 0.2 mg/l and Phosphates were found to be 0.8 mg/l. Heavy metals were found to be within the permissible limits of drinking water.

3.3.2.2 Groundwater

The physico-chemical characteristics of groundwater indicate pH in the range of 8.2-8.4; temperature 10-$17^{O}C$; turbidity 4-26 NTU, and TDS: 342-1200 mg/l. The highest conductivity in groundwater was found in village Jwalamukhi followed by Gummer, Dull and Khundia. Total suspended solids (TSS) concentration was in the range of 4-14 mg/l.

The inorganic parameters viz. alkalinity was in the range of 106-256mg/l; total hardness 84-383 mg/l; chlorides 12-270 mg/l; sulphates 62-268 mg/l.

Dissolved Oxygen was in the range of 3.5-6.4. Nitrates and phosphates were 0.1-6.1 mg/l and 0.3-1.3 mg/l respectively. Concentrations of heavy metals viz. nickel, cadmium, chromium, copper, lead, iron, manganese, zinc and cobalt were found in the

range of ND-0.03, ND-0.01, ND-0.01, ND-0.04, ND-0.05, 0.46-2.94, 0.01-0.59, 0.08-3.94 and ND mg/l respectively (**Tables 3.3.2-3.3.10**).

3.3.2.3 Bacteriological Characteristics

Coliform group of organisms are indicators of faecal contamination. Surface and groundwater samples were analysed during Winter 2008 and is presented in **Tables 3.3.6**.

The surface water was found to be faecally contaminated and hence need chlorination before consumption. Most of the groundwater samples do not show any faecal contamination except village Kalidhar-Kohla and it needs chlorination before consumption.

3.3.2.4 Biological Characteristics

Biological species viz. phytoplankton and zooplankton specific for a particular environmental condition are the best indicators of environmental quality. Studies on biological aspects of ecosystem are important in environmental impact assessment in view of the conservation of environmental quality and safety of natural flora and fauna including human beings. Information about the impact (environmental stress) on the community structure serves as inexpensive and efficient "early warning and control system" to check the effectiveness of control measures to prevent damage to a particular ecosystem (e.g. adjustments of emission norms, management of installations and sanitation etc.) Planktons (phytoplankton and zooplankton) being good indicators of environmental stress have been included in the study.

The nature and quality of biological species in a water body is dependent on various physico-chemical characteristics of water such as pH, conductivity, nutrients, BOD, alkalinity etc. and also on the type of water body such as flowing waters (canals), stagnant water (lakes) and saline water (sea). Thus the quality and quantity of plankton obtained in any water body is an indicator of the physico-chemical quality of water as well as the type of water body. The estimation of plankton community structure in water bodies is thus helpful to assess the baseline status. Details are as follows:

(a) Total biomass

The total biomass (expressed as count or by weight) increases with the increase in levels of nutrient and BOD in water and vice versa, and serves as a good indicator of trophic status of water body.

(b) Quality

Presence of different organisms has been listed in standard publications according to increasing trophic levels in aquatic environment. Similarly, many organisms have been listed to favor certain physico-chemical conditions, viz. silicates for diatoms etc. Hence presence of certain groups is also indicative of trophic conditions.

Desmids and Diatoms indicate highly eutrophic conditions. Planktonic rotifers are usually abundant in fresh water. It is believed that when crustacean (copepoda, cirripedia, ostracoda etc.) and insects outnumber other groups, the situation reflects the enriched organic condition of water. Thus presence of certain organisms helps in classifying water body in trophic levels in knowing its physico-chemical characteristics.

(c) Diversity

Diversity of planktons depends on physico-chemical characteristics of water especially on trophic levels. In oligotrophic water diversity of plankton is high. While with increasing levels of pollution such as mesotrophic and eutrophic condition diversity of planktons decreases. Shannon Weaver Index is a measure of diversity of planktons, which takes into account the total count, and individual species count in a water sample.

$$d = - \Sigma (ni/n) \log_2 (ni/n)$$

where,

d = Shannon Weaver Diversity Index
ni = number of individual of each individual species in a sample
n = total number of individual and of all species in the sample

It should also be noted that the diversity is also susceptible to other parameters such as turbidity, colour and flow rate particularly in hilly rivers. Thus the results should be interpreted with caution. A widely accepted ecological concept is that communities with large number of species (i.e. with high diversity) will have high stability that can resist adverse environmental factors. The maximum value of Shannon Weaver Index of Phytoplankton for clean waters has been reported to be around 6, though it may differ slightly in different locations. Decrease in the value of index may thus be taken as indicator of pollution.

In the present study River water sample was collected from River Byas to enumerate phyto and zooplankton species and establish diversity index to assess the biological quality.

(d) Phytoplankton

The phytoplankton species/groups, its count and community composition at each sampling locations are presented in **Table 3.3.7**.

The count as number of organisms per ml of water sample was found to be 224. Bascillariophyceae was found to be the dominant group followed by Chlorophyceae. SWD Index was 2.0 indicating moderate water body. The phytoplankton species identified are presented in **Table 3.3.8**.

(e) Zooplankton

The zooplankton species/groups, its population dynamics and community composition at each sampling location are given in **Table 3.3.9**. The count as number of organisms per m^3 of water sample was found to be 11,000. Copepoda was found to be the dominant group followed by Cladocera and Rotifera. (**Table 3.3.10**). The SWD index 1.9, which indicates moderate productivity.

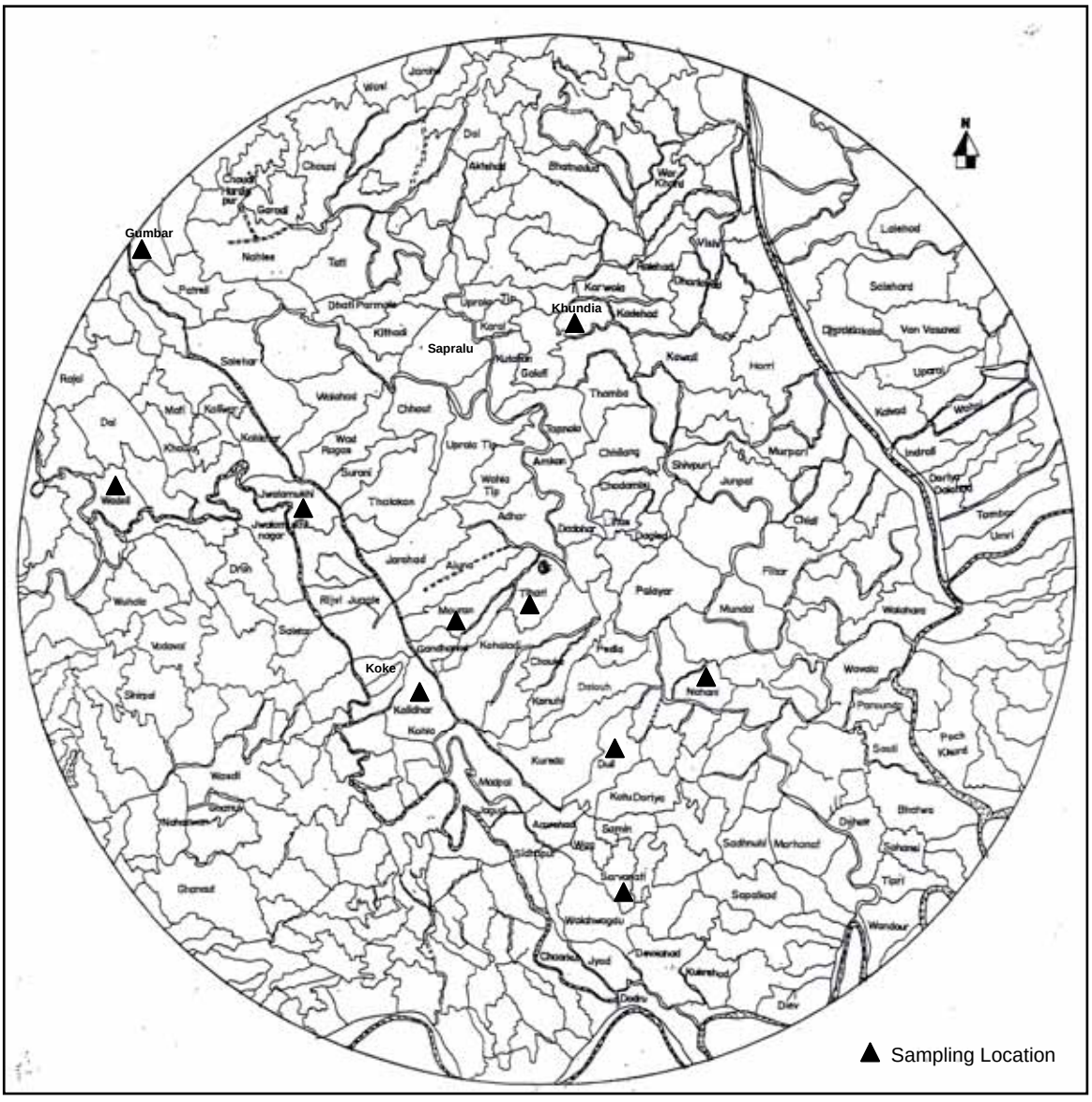

Fig. 3.3.1 : Water Quality Sampling Locations

Table 3.3.1

Water Quality – Sampling Locations
(Winter 2008)

Sr. No.	Sampling Location
Surface Water (River Water)	
1.	Village Wadoli
Ground Water (Handpump)	
2.	Tihri
3.	Khundia
4.	Jwalamukhi
5.	Gummer
6.	Moohal
7.	Kalidhar- Kohla
8.	Nahania
9.	Dull
10.	Sarvanati

Table 3.3.2

Water Quality - Physical Parameters (Winter 2008)

Sr. No.	Sampling location	pH	Temp (^{0}C)	Turbidity (NTU)	Total suspended solids (mg/l)	Total Dissolved Solids (mg/l)	Conductivity (μS/cm)
Surface Water (River Water)							
1.	Village Wadoli	7.8	9	6	12	354	580
Ground Water (Hand Pump)							
2.	Tihri	8.3	15	8	4	490	800
3.	Khundia	8.2	15	4	4	538	880
4.	Jwalamukhi	8.2	14	26	14	1200	2040
5.	Gummer	8.2	13	9	4	600	930
6.	Moohal	8.2	17	16	4	412	690
7.	Kalidhar- Kohla	8.2	15	8	20	368	650
8.	Nahania	8.3	10	8	12	398	630
9.	Dull	8.4	13	6	8	478	901
10.	Sarvanati	8.3	16	8	12	342	660

Table 3.3.3

Water Quality- Inorganic Parameters
(Winter 2008)

Sr. No.	Sampling locations	Total Alkalinity	Total Hardness	Calcium Hardness	Chloride	Sulphate	Sodium	Potassium	Total Nitrogen
		(as $CaCO_3$)			(Mg/l)				
Surface Water (River Water)									
1.	Village Wadoli	64	212	81	59	128	26	6	16
Ground Water (Hand Pump)									
2.	Tihri	244	358	185	30	115	20	6	-
3.	Khundia	148	345	144	70	124	32	7	-
4.	Jwalamukhi	256	170	78	270	268	325	34	-
5.	Gummer	196	383	199	63	165	43	6	-
6.	Moohal	106	173	93	63	122	67	6	-
7.	Kalidhar-Kohla	157	221	113	27	94	33	6	-
8.	Nahania	228	239	120	56	92	40	7	-
9.	Dull	220	84	57	68	130	110	5	-
10.	Sarvanati	222	249	168	12	62	23	5	-

Table 3.3.4

Water Quality - Nutrient and Demand Parameters (Winter 2008)

Sr. No.	Sampling location	Nitrate as N	Total Phosphates	Dissolved oxygen	Chemical Oxygen Demand	Biochemical Oxygen Demand	Oil & Grease	Sulphide	Hydro-carbons
		(mg/l)							(µg/l)
Surface Water (River Water)									
1.	Village Wadoli	0.2	0.8	8.0	23	8	ND	3	ND
Ground Water (Hand Pump)									
2.	Tihri	2.1	0.6	5.0	-	-	ND	4	ND
3.	Khundia	2.5	0.7	6.4	-	-	ND	3	ND
4.	Jwalamukhi	0.1	1.3	6.2	-	-	ND	9	ND
5.	Gummer	6.1	1.1	4.5	-	-	ND	4	ND
6.	Moohal	0.1	0.8	6.0	-	-	ND	2	ND
7.	Kalidhar- Kohla	1.4	0.7	5.4	-	-	ND	6	ND
8.	Nahania	0.1	0.8	6.0	-	-	ND	4	ND
9.	Dull	0.1	1.1	3.5	-	-	ND	2	ND
10.	Sarvanati	0.1	0.3	4.0	-	-	ND	3	ND

Table 3.3.5

Water Quality-Heavy Metals (Winter 2008)

Sr. No.	Sampling Stations	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	Co
		(mg/l)								
Surface Water (River Water)										
1.	Village Wadoli	0.01	0.01	0.01	0.02	0.01	0.14	0.01	0.02	ND
Ground Water (Hand Pump)										
2.	Tihri	0.02	ND	ND	ND	0.04	0.82	0.59	1.54	ND
3.	Khundia	0.02	0.01	0.01	0.03	0.03	0.79	0.02	1.79	ND
4.	Jwalamukhi	0.02	0.01	0.01	0.02	ND	1.50	0.12	0.62	ND
5.	Gummer	0.02	0.01	ND	0.02	ND	1.54	0.02	2.09	ND
6.	Moohal	ND	ND	0.01	ND	ND	2.94	0.02	0.90	ND
7.	Kalidhar- Kohla	0.03	0.01	0.01	0.02	0.03	1.84	0.01	0.08	ND
8.	Nahania	0.01	ND	0.01	ND	ND	2.58	0.03	3.76	ND
9.	Dull	0.02	0.01	0.01	0.04	0.05	2.11	0.07	3.94	ND
10.	Sarvanati	ND	ND	0.01	0.01	0.02	0.46	0.04	1.47	ND

ND : Not Detectable

Table 3.3.6

Water Quality – Bacteriological Parameters
(Winter 2008)

Sr. No.	Sampling Location	Total Coliform	Faecal Coliform
		CFU/100ml	
Surface Water (River Water)			
1.	Village Wadoli	100	10
Ground Water (Hand Pump)			
2.	Tihri	ND	ND
3.	Khundia	ND	ND
4.	Jwalamukhi	ND	ND
5.	Gummer	ND	ND
6.	Moohal	ND	ND
7.	Kalidhar- Kohla	90	10
8.	Nahania	ND	ND
9.	Dull	ND	ND
10.	Sarvanati	ND	ND

ND : Not Detectable
CFU : Colony Forming Unit

Table 3.3.7

Biological Parameters – Phytoplankton (Winter 2008)

Sr. No.	Sampling Locations	Phyto-plankton No/ml	% Composition			Shannon Wiener Diversity Index
			Bascill-ariophyceae	Chlor-ophyceae	Myxophy-ceae	
Surface Water (River Water)						
1.	Village Wadoli	224	56.25	43.75	-	2.0
Ground Water (Hand Pump)						
2.	Tihri	Nil	-	-	-	-
3.	Khundia	Nil	-	-	-	-
4.	Jwalamukhi	Nil	-	-	-	-
5.	Gummer	Nil	-	-	-	-
6.	Moohal	Nil	-	-	-	-
7.	Kalidhar- Kohla	Nil	-	-	-	-
8.	Nahania	Nil	-	-	-	-
9.	Dull	Nil	-	-	-	-
10.	Sarvanati	Nil	-	-	-	-

Ranges of Shannon Wiener Diversity Index

1: Indicate maximum impact of pollution or adverse factor
1-2: Indicate medium impact of pollution or adverse factor
>2: Indicate lowest or no impact of pollution or adverse factor

Table 3.3.8

Phytoplankton Species Observed in Water Sample (Winter 2008)

Bacillariophyceae	Chlorophyceae	Myxophyceae
Navicula sp.	*Chlorella sp.*	*Merismopedia sp.*
Nitzschia sp.	*Cosmarium sp.*	*Spirulina sp.*
Synedra sp.	*Ankistrodesmus sp.*	
Melosira sp.	*Closterium sp.*	
	Botryococcus sp.	

Table 3.3.9

Biological Parameters – Zooplankton (Winter 2008)

Sr. No.	Sampling Locations	Zooplankton No/m^3	% Composition of Groups			Shannon Wiener Diversity Index
			Copepoda	Cladocera	Rotifera	
Surface Water (River Water)						
1.	Village Wadoli	11,000	63.63	18.19	18.18	1.9
Ground Water (Hand Pump)						
2.	Tihri	Nil	-	-	-	-
3.	Khundia	Nil	-	-	-	-
4.	Jwalamukhi	Nil	-	-	-	-
5.	Gummer	Nil	-	-	-	-
6.	Moohal	Nil	-	-	-	-
7.	Kalidhar- Kohla	Nil	-	-	-	-
8.	Nahania	Nil	-	-	-	-
9.	Dull	Nil	-	-	-	-
10.	Sarvanati	Nil	-	-	-	-

Ranges of Shannon Wiener Diversity Index
1: Indicate maximum impact of pollution or adverse factor
1-2: Indicate medium impact of pollution or adverse factor
>2: Indicate lowest or no impact of pollution or adverse factor

Table 3.3.10

Zooplankton Species Identified in Water Samples (Winter 2008)

Copepoda	Cladocera	Rotifera
Nauplius sp.	*Daphnia sp.*	*Brachionus sp.*
Diaptomus sp.	*Ceriodephnia sp.*	*Keratella sp.*
Cyclopus sp.		*Mytilina sp.*
Labidocera sp.		
Eucyclops sp.		

3.4 Land Environment

The impact of any major developmental project on land environment generally depends on the type/category of proposed development. For example, the grass root/green field development requires land acquisition/procurement, site grading/ construction and operation. In such cases the impacts on land environment would be in the form of temporary or permanent change in landuse pattern as well as direct and indirect impacts on surrounding landuse due to pollution discharge in the form of flue gases, fugitive emission, liquid effluents etc. apart from the above, the importance of impacts on land environment also depend on several factors like the project location, landuse/land cover in surrounding area, ecological or otherwise sensitivity of the surrounding region.

The project under study is related to exploratory drilling (ONGC) for oil and gas, accordingly for assessment of impact on land environment is carried out pertinent to study, the current land use/land cover of identified project site as well as surrounding area and the resulting changes in land use pattern and the corresponding impacts and also the pollution impact during normal operation of the proposed project depending on requirement. The baseline (pre-project) status of land environment has been assessed through reconnaissance in project area, characteristics of soils through field studies, study of land use pattern through census records to project region.

3.4.2 Reconnaissance

The study area is covered with clay and sandy loam in texture. These soils are of the study area is covered with wheat, pea and vegetable crops like tomato, potato etc. The site of the selected area for drilling purpose is an agricultural field. The study area have most complicated geological region of the Himalyas. This system comprises of great thickness of the detrital rocks sand stone clay and conglomerates. It also lies between the main boundary thrust and the central Himalayan Thrust. Most of the part of this zone is composed of granites and other crystalline rocks. The study of area has a diversified and rich flora due to climatic and altitudinal zonation. The study area also covered with coniferous and mixed coniferous forest.

3.4.1.1 Relief

It is a hilly and a mountainous tract with altitude ranging from about 350 to 4975 m above the mean sea level. The study area presents an intricate mosaic of mountain ranges, hills and valleys.

3.4.1.2 Agro ecological zone

The study area comes under the warm, pre humid lesser Himalayas with length of growth period (LGP 270-300 day) and humid/pre-humid, lesser Himalays with length of growth period 300-300 days

3.4.1.3 Soil type

The soils are medium deep to excessively drained, loamy skeletal with severe to very sever erosion. They are slightly acidic to slightly alkaline. Soils with poor to moderate organic carbon and low to moderate available water content.

3.4.1.4 Land Forms

Moderately steep to steep low hills and the intervening valleys of the siwaliks.

3.4.2 Natural Vegetation

Study area has diversified and rich flora due to climate and altitudinal zonation. The following types of trees are observed in the study area.

Coniferous forest: Chir, deodar, spruce, silver fir and chilgoza pine.

Board-Leaved forest : Sal, ban mohru, oak kharsa, walnut, maple, bird cherry, horse chest nut poplar aldar and shisham. The distribution of different species follows fairly regular altitudinal stratification except where the micro-climate changes due to the aspect and exposure and local changes in rock and soils bring vegetation inversion is the vegetation which otherwise occur at higher altitudes are found projected in the lower zone and vice-versa. Generally the sequence of important timber species growing in the region is Sal Chir deodar, kail spruce and silver fir.

3.4.3 Geology of the Study Area

The study is covered with rock of the shivalaks system occupy a thick belt are seen around. These formation occupy the major portion of the division and are composed of grey soft friable, coarse grained sand stone with bands of grayish green and purple clay bands. These are inter bedded with boulder beds. Boulders are poorly cemented and quartzitic in nature. The another pinjor boulder bed are also absorbed in the study area, these pinjor boulder bed is a mixture with conglomerates are met in the study area. The composition of these boulders is loose sand and prone to weathering. The lower shivalik consists of red and purple sand stone and shale. Middle shivalik gray sand stone and orange colour clay whereas upper shivalik is made of soft sand stone. Arkosh brownish clay purely sorted and cross bedded conglomerate and boulder bed. The major structure in the area is Dehra Goplpur auticline.

The shivalik system of rocks yield soil of the sandy to loamy structure and support low quality chil and scrub forests. These soils are generally dry and deficient in organic matter. Development of soil profiles over the most of the tract is not clearly discernible. The north west slopes have clays which alternate with sand stones. Alluvial deposits along streams have depend fertile sandy loam to clays loam soils where pioneer species like Khair, Dalbergia and Salmalia flourish.

3.4.4 Climate

The climate is subtropical type. The seasons area well defined mid of February to March end and October are pleasant. May to mid June is very hot months and June mid to mid of September, this area experience large rain. The entire belt is almost rained. The minimum temperature is generally observed in the study area is 6.5^0C and maximum temperature is 37.5^0C. The relative humidity minimum 31 percent and maximum 98 percent. The annual rainfall ranges from 350 mm to 3800 mm. The mean annual rainfall of the area is 1412 mm. The maximum rainfall in the area is 3400 mm. About 70 percent of the annual rainfall is received during July to September, about 20 percent from October to March and 10 percent from April to June.

3.4.5 Cropping Pattern

The major crops of the study area is paddy, maize, pulses (masur) are cultivated in the kharif season and similarly wheat are grown in the Rebi season. The majority of the area is covered with the wheat crops the crop like barly, gram, black gram seamum, mustered, linseed, berseem chery are also cultivated around the study area. The sugar cane is also cultivated.

3.4.6 Land Use Pattern

So far 23 villages of the study area were studies and it is found that 20 percent land is covered with forest, 39.78 percent land is covered with agriculture, 23 percent unirrigated land is available and only 5.96 percent land is covered with irrigation. Area not available for cultivation is 21.10 percent and 28.12 percent area is culturable waste land. The land use pattern is presented in **Table 3.4.1** and **Fig. 3.4.2**. The land use pattern of the study area is presented in **Table 3.4.2** and described in **Fig 3.4.2**.

3.4.7 Baseline Data

Ten (10) villages were identified for existing soil quality assessment. The location and names of sites/villages of the study areas are given in **Table 3.4.1**. The sampling locations are shown in **Fig. 3.4.1**.

Representative soil samples from depth (0-15 cm) were collected from these sites/villages area for estimation of the physicochemical characteristics of soil. Air-dried and Sieved samples have been used for determination of physical properties of soil. Standard methods were followed for the analysis of soil samples.

The International Pipette Method (Black, 1964) was adopted for determination of particle size analysis. The textural diagram was generated using "SEE soil Class 2.0 version based on United States Department of Agriculture (USDA) classification of soils. Physical parameters such as bulk density, porosity and water holding capacity were determined by following KR Box Method (Keen and Raczkowski, 1921).

3.4.8 Physical Characteristics

Physical characteristics of soil are delineated through specific parameters, viz., particle size distribution, texture, bulk density, porosity and water holding capacity. The particle size distribution in terms of percentage of sand, silt and clay is depicted in **Fig. 3.4.2** given in **Table 3.4.2**. The texture of the soil is clay, sandy loam, loamy sand and sand. The clay contain in the soils of the study area varies from 3.2 to 42.2 percent.

Regular cultivation practices increase the bulk density of soils thus inducing compaction. This results in reduction in water percolation rate and penetration of root through soils. The bulk density of soil in the region is found to be 1.22-1.38 g/cm^3 and considered as moderately good.

Soil porosity is a measure of air filled pore spaces and gives information about movement of gases, inherent moisture, development of root system and strength of soil. Variations in soil porosity are depicted in **Table 3.4.3**. The porosity and water holding capacity of soil is in the range of 22.8-46.2 % and 20.2-49.6 % respectively.

3.4.9 Chemical Characteristics

The chemical characteristics of soil were determined by preparing soil extract in distilled water in ratio 1:1 (as per Jackson procedure, 1967). Organic carbon was determined by Walkley and Black method (1972). Fertility status of soil in terms of available nitrogen was determined by nitrogen Kjeldhal method, available phosphorus was determined by chlorostannous reduced molybdo phosphorus blue colour. Olsen's method (1954) and available potassium was determined by flame photometer method (Jackson M. L. 1967). Heavy metals in soil were determined by extracting soil with concentration HNO_3 and $HClO_4$ followed by analysis on ICP or AAS (APHA, 1995).

The soil samples were analysed for various chemical properties. The parameters selected were pH, electrical conductivity, soluble cations, cation exchange

capacity (CEC), exchangeable cations, exchangeable sodium percentage, nutrients status, organic carbon content and heavy metals are presented in **Tables 3.4.4-3.4.9**.

pH is an important parameter indicative of the alkaline or acidic nature of the soil. It greatly affects the microbial population as well as the solubility of metal ions and regulates nutrient availability. pH of soil in the study area is found to be acidic, neutral and slightly to moderately alkaline in reaction as pH is in the range of 4.2-8.2.

The soluble salts were determined from soil extract (1:1), the soluble salt are expressed in terms of electrical conductivity (EC), the EC electrical conductivity of the soil samples are in the range of 0.20-1.02 dS/m and presented in **Table 3.4.4**. The important cations present in soil are calcium and magnesium. It is observed that both calcium and magnesium concentrations are in the range of 5.8-13.4 meq/l and 1.16-6.2 meq/l respectively whereas sodium and potassium are in the range of 0.36-2.02 meq/l and 0.12-0.20 meq/l respectively.

The soils have low to moderate and very high cation exchange capacity (CEC) and the cation exchange capacity of the soils of the study area are presented in **Table 3.4.5**. Amongst the exchangeable cations, Ca^{+2} and Mg^{+2} are found in the range of 1.1-21.66 cmol(p^+) kg^{-1} and 0.88-10.5 cmol(p^+) kg^{-1} of soil while Na^+ and K^+ are in the range of 0.03-2.98 cmol(p^+) kg^{-1} and 0.12-2.03 cmol(p^+) kg^{-1} of soil respectively. Exchangeable sodium percentage range from 1.03-8.63 Soils from all the sites/villages are normal with respective to alkalinity as exchangeable sodium percentage of soil is below 15. The soils have very low to moderate and very high cation exchange capacity & productivity of the soil based on cation exchange capacity is low to moderate. The soils have limited to, moderate and high adsorbtivity with respects to cation exchange capacity. The classification of soil on the basis of their relationship with productivity and adsorptivity based on cation exchange capacity is presented in **Tables 3.4.6-3.4.7**.

3.4.10 Nutrient Status

Organic matter present in soil influences its physical and chemical properties of soil. It commonly accounts as one third or more of the cation exchange capacity of the surface soils and is responsible for stability of soil aggregates. Organic carbon, available nitrogen and available phosphorous are found to be in the range of 0.54-0.84 %, 131.71-260.2 and 4.38-15.20 kg/ha respectively. Available potassium is found in the range of 114.9-170.3 kg/ha **Table 3.4.8**. These soils are medium to moderate in organic carbon content but poor in available nitrogen content in the soil. Similarly soils are poor fertility

level with respect to available phosphorus content. Available potassium present in the soil show low fertility level. The fertility status of the soil is presented in **Table 3.4.8**.

3.4.11 Heavy Metals Content in the Soil

Plants require some of the heavy metals at microgram levels for their metabolic activities. These some heavy metals are also called as micronutrients. Their deficiency becomes a limiting factor in plant growth, but at the same time their higher concentrations in soils may lead to toxicity. Levels of heavy metals in soils are presented in **Table 3.4.9**.

3.4.12 Soil Microbiology

Soil organisms play key role in nutrient transformation, organic forms are transformed into their respective inorganic forms and plants are able to absorb them for their growth, physicochemical characteristics of soil and its nutrient status influence the microbial population.

Various ecological cycles in the Rhizosphere of the plant depend upon microbiological population. The population of bacteria, fungi and actinomycetes are vital components of soils and they help in maintaining their stability. Characteristics of soil micro-organisms are presented in **Table 3.4.10**.

Rhizobium and Azotobactor are symbiotic and non-symbiotic nitrogen fixing micro organisms respectively and improve soil fertility by fixing nitrogen in soil. Fungi also constitute an important part of the microflora of normal soil. They are active in initial stages of decomposition of plant residues and actively participate in the process of soil aggregation. Total viable microbial population per gram of soil varied from 20-83x10^6 CFU. Different microflora observed per gram of soil were fungi (2-9x10^4 CFU), actinomycetes (1-5x10^4 CFU), rhizobium (1-7x10^4 CFU) and azotobacter (1-8x10^4 CFU).

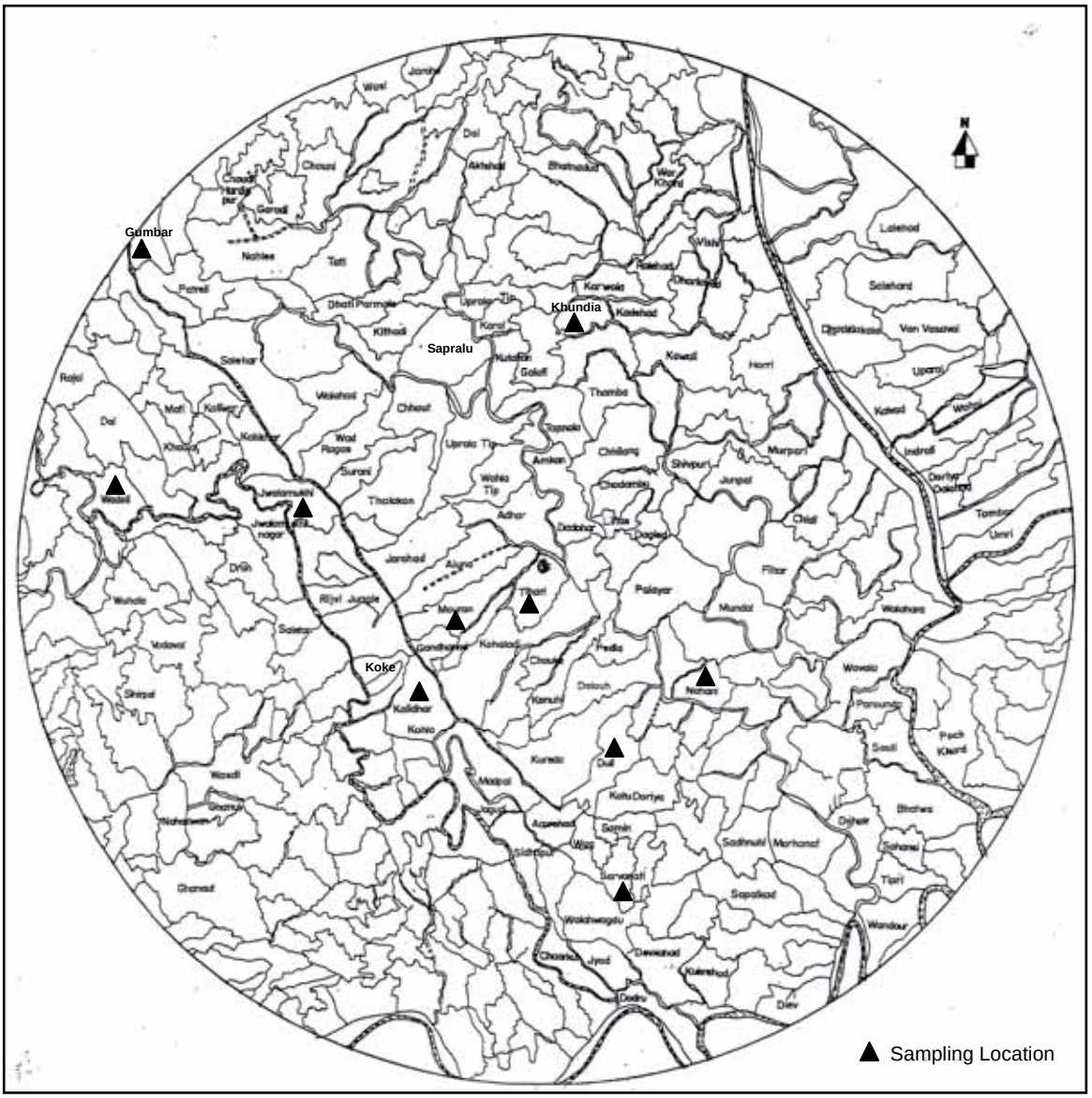

Fig. 3.4.1 : Sampling Location for Land Environment

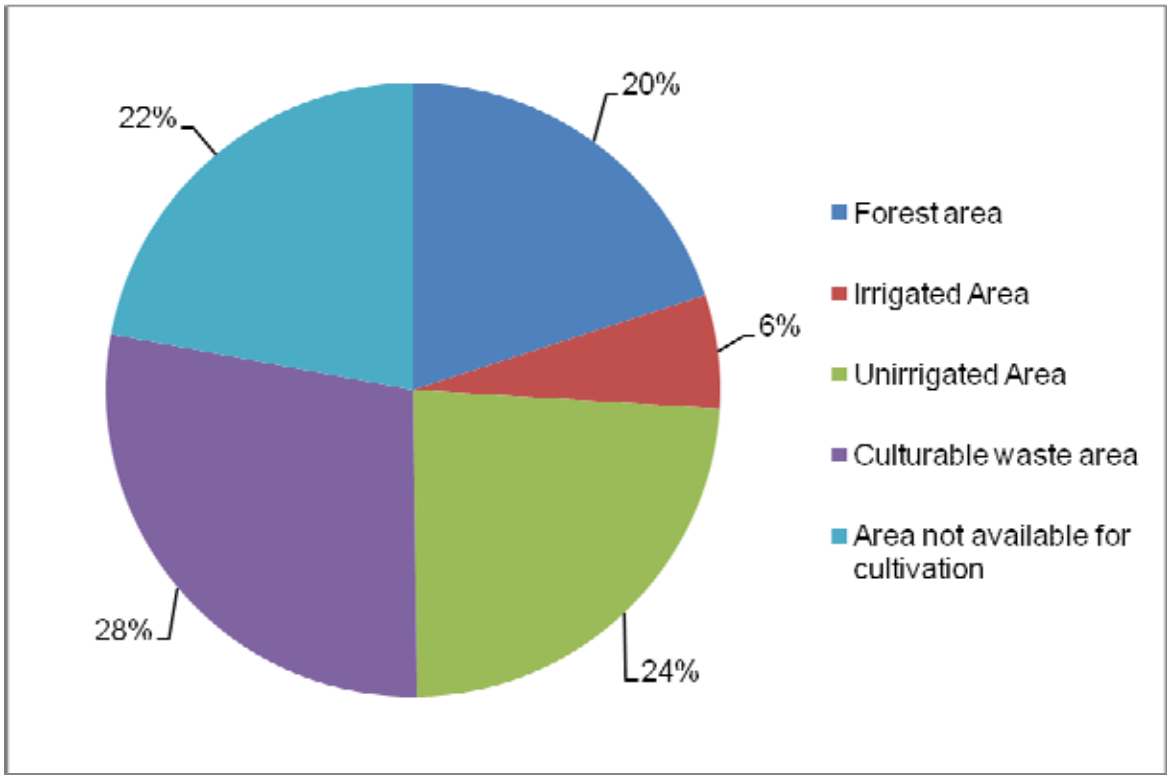

Fig. 3.4.2. Landuse Pattern

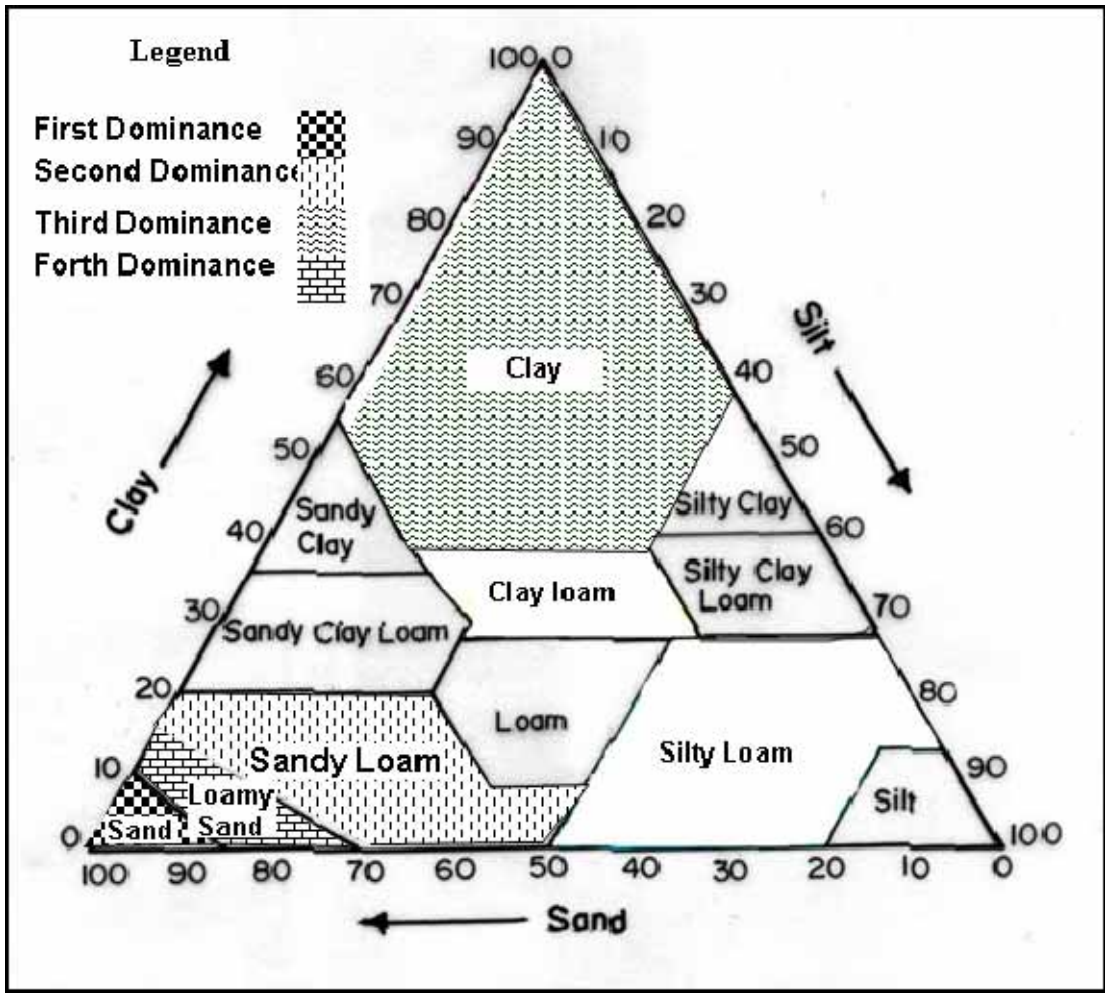

Fig. 3.4.3 : Soil Textural Diagram

Table 3.4.1

Name of the villages surveyed

Sr. No	Sampling Location
1.	Wadoli
2.	Tihari
3.	Khundia
4.	Jwalamukhi
5.	Gumbar
6.	Mouran
7.	Kalidhar
8.	Nahania
9.	Dul
10.	Sarvanati

Table 3.4.2

Land Use Pattern (Kangra)

Sr. No.	Village	Area of the village	Forest area	Irrigated Area	Unirrigated Area	Culturable waste area	Area not available for cultivation
1.	Tihari	83	26.00	0.00	27.00	22.00	8.00
2.	Dhati Parmala	90	0.00	0.00	57.00	26.00	7.00
3.	Surani	64	0.00	0.00	23.00	3.00	38.00
4.	Thalakan	183	14.00	0.00	46.00	38.00	85.00
5.	Chhont	127	16.00	4.00	30.00	6.00	71.00
6.	Tip Uparla	240	0.00	0.00	92.00	126.00	22.00
7.	Tip Buhla	123	0.00	0.00	47.00	62.00	14.00
8.	Bhaluna	74.00	31.00	0.00	5.00	34.00	4.00
9.	Shivpuri	183	0.00	0.00	53.00	5.00	125.00
10.	Laharri	186	120.00	17.00	27.00	9.00	13.00
11.	Kurera	205	32.00	0.00	66.00	85.00	22.00
12.	Abdullapur	132	0.00	100.00	0.00	24.00	8.00
13.	BHATWAL	52	33.00	0.00	10.00	7.00	2.00
14.	Hari	172	32.00	0.00	28.00	104.00	8.00
15.	THAMBA	114	4.00	0.00	47.00	57.00	6.00
16.	Galoti	128	18.00	0.00	30.00	79.00	1.00
17.	Amkan	37	18.00	0.00	4.00	4.00	11.00
18.	Gibar	63	3.00	0.00	30.00	22.00	8.00
19.	Dul	75	49.00	0.00	12.00	11.00	3.00
20.	Khundian	36	0.00	0.00	12.00	19.00	5.00
21.	Mouran	329	191.00	0.00	50.00	71.00	17.00
22.	Nahalan	68	0.00	54.00	1.00	3.00	10.00
23.	Kalidhar Kuhla	170	0.00	0.00	2.00	8.00	160.00s

Table 3.4.3

Texture Class of Soils

Sr. No	Sampling Location	Particle Size Distribution (%)				Textural Class
		Core sand	Fine Sand	Silt	Clay	
1.	Wadoli	10.2	29.6	19.0	41.2	Clay
2.	Tihari	20.2	38.5	28.5	12.8	Sandy Loam
3.	Khundia	12.2	69.4	14.0	4.4	Loamy sand
4.	Jwalamukhi	11.8	68.2	16.8	3.2	Loamy sand
5.	Gumbar	18.4	46.8	24.6	10.2	Sandy Loam
6.	Mouran	19.8	40.2	23.8	16.2	Sandy loam
7.	Kalidhar	10.8	28.8	18.2	42.2	Clay
8.	Nahania	12.8	78.4	5.6	3.2	Sand
9.	Dul	8.6	30.2	20.0	41.2	Clay
10.	Sarvanati	10.2	54.2	19.4	16.2	Sandy loam

Table 3.4.4

Physical Characteristics of Soil

Sr. No.	Sampling location	Bulk density (gm/cm^3)	Porosity (%)	Water Holding Capacity (%)
1.	Wadoli	1.28	42.6	48.6
2.	Tihari	1.32	28.6	30.2
3.	Khundia	1.38	22.8	20.2
4.	Jwalamukhi	1.36	23.6	20.6
5.	Gumbar	1.32	28.6	30.8
6.	Mouran	1.30	38.8	40.2
7.	Kalidhar	1.22	46.2	48.8
8.	Nahania	1.32	30.2	28.6
9.	Dul	1.24	44.8	49.6
10.	Sarvanati	1.26	38.6	40.8

Table 3.4.5

Chemical Characteristics of Soil Extract

Sr. No.	Sampling Location	pH 1:1	EC mS/cm	Calcium	Magnesium	Sodium	potassium
				me/l			
1.	Wadoli	8.1	0.30	10.2	2.16	1.72	0.13
2.	Tihari	7.0	0.20	5.6	1.8	0.79	0.13
3.	Khundia	8.1	0.60	11.0	4.2	1.63	0.14
4.	Jwalamukhi	4.2	1.02	13.4	4.0	0.36	0.12
5.	Gumbar	7.4	0.35	6.3	5.3	1.86	0.13
6.	Mouran	7.5	0.40	7.6	1.16	1.52	0.12
7.	Kalidhar	7.8	0.70	9.5	1.83	1.47	0.12
8.	Nahania	8.0	0.20	5.8	2.8	2.02	0.14
9.	Dul	8.2	0.45	9.3	6.2	1.80	0.20
10.	Sarvanati	7.9	0.40	7.3	3.16	1.66	0.13

pH 1:1 soil: Distilled Water

Table 3.4.6

Cation Exchange Capacity of Soil

Sr. No.	Sampling Location	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CEC	ESP (%)
		cmol (p^{+}) kg^{-1}					
1.	Wadoli	21.66	6.55	2.8	2.03	35.21	7.9
2.	Tihari	6.80	3.2	0.32	0.58	11.2	2.86
3.	Khundia	2.10	0.98	0.28	0.32	3.92	7.14
4.	Jwalamukhi	1.2	0.88	0.03	0.46	2.89	1.03
5.	Gumbar	2.5	1.1	0.24	0.56	4.62	5.12
6.	Mouran	4.6	3.2	0.60	0.98	10.2	5.88
7.	Kalidhar	18.42	10.50	2.21	1.1	33.72	6.55
8.	Nahania	1.1	0.42	0.16	0.12	2.32	6.89
9.	Dul	20.68	8.53	2.98	1.64	34.53	8.63
10.	Sarvanati	5.54	3.02	0.82	1.62	10.46	7.80

CEC-Cation Exchange Capacity
ESP- Exchangeable Sodium Percentage

Table 3.4.7

Relationship of CEC with Productivity

CEC	Range in (cmol (p^+) kg^{-1})	Productivity	Location (Sr. No.)
Very low	<10	Very low	1,3,4,5,8
Low	10-20	Low	2,6,10
Moderate	20-50	Moderate	1,7,9
High	>50	High	-

Table 3.4.8

Relationship of CEC with Adsorptivity

CEC	Range in (cmol (p^+) kg^{-1})	Adsorptivity	Location (Sr. No.)
Limited or low	<10	Limited or low	2,3,4,5,8
Moderate	10-20	Moderate	6,10,
High	20-30	High	-
Very High	>30	Very High	1,7,9

Table 3.4.9

Fertility Status of Soils in study area

Sr. No.	Sampling Location	Organic Carbon (%)	Available (kg/ha)		
			N	P_2O_5	K_2O
1.	Wadoli	0.78	131.71	14.28	116.2
2.	Tihari	0.54	228.30	7.62	118.6
3.	Khundia	0.84	274.71	4.38	170.3
4.	Jwalamukhi	0.72	215.75	5.43	118.9
5.	Gumbar	0.84	149.27	18.01	114.9
6.	Mouran	0.78	186.90	15.20	116.2
7.	Kalidhar	0.78	220.77	8.10	115.5
8.	Nahania	0.66	181.88	4.88	119.5
9.	Dul	0.72	165.58	5.65	115.2
10.	Sarvanati	0.66	174.00	5.32	118.6
	Level in poor soil	<0.5	<280	<23	<133
	Level in medium soil	0.5-0.75	280-560	23-57	133-337
	Level in high fertile soil	>0.75	>560.0	>57.0	>337.0

Table 3.4.10

Heavy Metals Content in Soil

Sr. No.	Sampling Location	Cd	Cr	Co	Cu	Fe	Mn	Ni	Pb	Zn
		(mg/kg)								
1.	Wadoli	ND	1.0	10.7	16.3	2691.4	303.3	26.0	12.0	60.7
2.	Tihari	0.1	ND	8.2	12.7	2644.4	178.9	19.5	13.5	103.2
3.	Khundia	0.2	ND	8.9	12.5	2106.4	430.8	23.8	9.6	74.5
4.	Jwalamukhi	ND	ND	6.0	8.4	2507.4	309.8	11.7	2.8	36.9
5.	Gumbar	0.2	2.1	11.7	16.9	2723.4	447.3	28.5	15.8	70.5
6.	Mouran	0.5	4.8	10.4	14.9	2671.4	365.1	25.4	23.7	60.6
7.	Kalidhar	0.7	ND	12.3	17.2	2718.4	358.4	26.4	8.6	72.3
8.	Nahania	0.7	ND	8.7	8.9	2656.4	376.7	19.0	34.5	47.0
9.	Dul	0.6	2.9	12.3	14.6	2737.4	416.8	27.7	9.5	64.6
10.	Sarvanati	1.1	ND	11.9	15.6	2725.4	358.3	28.2	11.8	70.1

ND-Not detected

Table 3.4.11

Microbiological Characteristics of Soil

Sr. No.	Sampling location	TVC	Fungi	Actinomycetes	Rhizobium	Azotobacter
		CFU/g of soil				
1.	Wadoli	$83x10^6$	$3x10^4$	$1x10^4$	$7x10^4$	$8x10^4$
2.	Tihari	$37x10^6$	$9x10^4$	$2x10^4$	$2x10^4$	$3x10^4$
3.	Khundia	$28x10^6$	$5x10^4$	$5x10^4$	$1x10^4$	$1x10^4$
4.	Jwalamukhi	$31x10^6$	$4x10^4$	$1x10^4$	$1x10^4$	$1x10^4$
5.	Gumbar	$20x10^6$	$4x10^4$	$4x10^4$	$1x10^4$	$3x10^4$
6.	Mouran	$31x10^6$	$3x10^4$	$3x10^4$	$2x10^4$	$3x10^4$
7.	Kalidhar	$26x10^6$	$2x10^4$	$3x10^4$	$5x10^4$	$2x10^4$
8.	Nahania	$29x10^6$	$4x10^4$	$6x10^4$	$1x10^4$	$1x10^4$
9.	Dul	$31x10^6$	$1x10^4$	$2x10^4$	$3x10^4$	$1x10^4$
10.	Sarvanati	$62x10^6$	$9x10^4$	$7x10^4$	$2x10^4$	$4x10^4$

TVC : Total Viable Count
CFU : Colony Forming Unit

3.5 Biological Environment

3.5.1 Introduction

Study of biological environment is one of the most important components for Environmental Impact Assessment, in view of the need for conservation of environmental quality and biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities which interact not only within and between themselves but also with the abiotic components viz. Physical and chemical components of the environment.

Generally, biological communities are good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important in Environmental Impact Assessment for safety of natural flora and fauna. Information on the impact of environmental stress on the community structure serves as an inexpensive and efficient early warning system to check the damage to a particular ecosystem. The biological environment includes mainly terrestrial ecosystem and aquatic ecosystem.

Biological communities are dependent on environmental conditions and location of its resources. They show various responses and sensitivities to anthropogenic activities. The changes in biotic community are studied by the pattern in the distribution, abundance and diversity. These changes over a span of time can be quantified and related to the existing environmental conditions. The sensitivity of plants and animal species to changes occurring in their ecosystem can therefore be used for monitoring the biological environment for environmental impact assessment.

3.5.2 Study Area

Total 10 sampling locations were selected for study on biological survey based on topography, land use, vegetation pattern etc. The observations were made on forest area, village forest and community forest and non-forest area comprising agriculture fields, hills, plain area, and village wasteland. The list of sampling location is given in **Table 3.5.1** and map for Biological Environment is shown in **Fig. 3.5.1**.

The altitude of the tract varies from 340 m to 950 m above msl. The proposed project site is a barren hilly area having very few plant species (**Plate 3.5.1**). The configuration in the study area varies form steep slopes to gentle hill slopes with network of small rivers and big river like Beas River which meet the water requirement of the study area. Small River usually remains dry except in rainy season and cause lots of soil erosion. The climate in the study area is subtropical type.

3.5.3 Survey Methodology

The land use / land covers image prepared by remote sensing technology was used for vegetation survey. Study area is dominated by the terrestrial vegetation, which includes dense or sparse evergreen forests, deciduous forest and degraded forest. On the basis of these the sampling stations are decided, while the density and diversity was calculated by using quadrate method. The quadrate method includes lying down of a square sample plot of suitable size for detailed analysis of vegetation. It may be a single sample plot or may be divided into several subplots. Quadrates of 10m x10m, 5m x5m and 1m x1m were used for tree, shrubs and herbaceous community respectively (John G. Rao and David C. Wooten, Environmental Impact Analysis handbook, 1980, pp1-44).

Co-existence and competition amongst various species are affected directly by the number of individuals in the community. Therefore, knowing the quantitative structure of the community becomes essential. Various diversity indices including Simpson's Diversity Index give a comparative and quantitative picture of the community existing in the study area.

To characterize vegetation in the study area, the primary data was collected and analyzed for describing the characteristics of vegetation with reference to species composition and structural attributes. The diversity measurement reflect as to how many diverse species are present, the density measurement indicate number of individuals of a species in the study area. Species diversity is the best measure of community structure and it is sensitive to various environmental stresses. Smaller value of Simpson's Diversity Index shows healthy ecosystem and the higher value shows that an ecosystem is under environmental stress.

The assessment of wild life fauna was carried out by field observation, enquiring with local people and on the basis of secondary data collected from different government offices like District Forest office, Fishery Department, Agriculture Department.

3.5.4 Floristic Composition and distribution of forests in the study area:

The forests of the tract dealt with are well scattered on the both bank of the river Beas, it can be broadly classified into following groups on the basis of various factors a) Scrub forests, b) Bamboo forests, c) Chill forests.

The forests of this division can be further grouped into various forest types as identified by Champion and Seth.

Group: 5 Dry Tropical forests includes

1. 5B/C2 Northern dry mixed deciduous forests

2. 5B/DS1/dry deciduous scrub forests
3. 5B/E9 dry bamboo

Group: 9 sub tropical pine forests includes

i) 9/cla-Lower or shivalik chir pine forests
ii) 9/clb upper Himalayan chir pine forests

Type-5B/C2

Northern Dry mixed Deciduous Forests

This type of forests (**Plate 3.5.2**) occur between altitude of 340 meter to 900 meter msL. most part of the tract has been occupied by small trees and shrubs such as *Acacia catechu* (Khair) *Diospyras Montana*, *Mallotus phillipinensis, Myctanthes arbortristis, Carissa spinarium* and *Mimosa rubicaulis* and a very little amount of *Shores robusta*. The main dominant species is among them *Acacia catechu*.

The dominant tree species observed during survey area *Acacia catechu, Anogeissus latifolia, Aegle marmelos, Zizphus manritiana, Butea monosperma, Dispyres Montana, Cassia fistula, Albizzia lebbek, Acacia nolotica, Bombox ceiba*.

The undergrowth vegetation found in this forest type is *Mimosa himalayana, Nyctanthes Arboritristis, Adhatoda vasica, Zizyphus mauritiana, Vitex nigondo, Hetropogon contortus* etc.

Deciduous scrub forests

This type occurs between the altitudes of 330 to 900 meter. Mainly the shrubs from the part of this type which usually do not grow beyond 4 meter in height. The main cause of such type is due to maltreatment of forest over grazing, continuous fire and felling and lopping *lantana camera* shrub is the main species of this type. The dominant plant species mainly observed in this type are *Dononaea viscose, wood fordier floribunda, Flacourtia indica, Nyetanttnes arbortrists, Lannea coromandilica, Aegle marmelos, Acacia catechu* etc.

Dry Bamboo Brakes

Forest of such types are usually met an attitudes of 340 meters to 850 meters. Only one species *Dandrolamus strictus* occurs in the entire tract which forms relatively low and dense brakes. Which form a major part of the entire tract. The floristics characteristics are almost the same as that of previous type but the main associated are as follows:

Diospros chloromylon, Erythrina glebiseens, Anogeissus latifolia, Aegle mermelos, Adhatoda vasicosa and grasses are very common in the entire area.

Lower or Shiwalik Chir Pine Forest

Such type of forest occurs between attitudes of 500-800 meters. *Pinus roxburghil* form, the top canopy mixed with other broad leaved species. Such type of forests usually is having competition with khair and various shrubs like *lantana, Carissa* species.

The vegetation found in the tract is as follows:

Pinus roxburghii, Terminalia chebula, Mallotus philippinesis, Acacia catechu, Zizyphus manritiana, Anogeissus latifolia, Cassia fistula, Shorea robusta, Cassia tora.

Upper or Himalayan Chir Pine Forest

This type of forest occurs mainly between 800-1200 meter attitudes. Majority of good chill forest of this type is characterized by more or less pure crop of chill. At certain places it is found in a mixture with *Pyrus pashia, Terminalia chebula, Terminalia Balerica, Bauhinia, Barberis species, Dalbegi sisoo* such type of forest are found in Jawalamukhi Range on the lower side the chil if found mixed with *Dalbergia sisoo*.

Biodiversity in Study Area

The altitude of the tract varies from 340 m to 950 m above msl. The configuration varies form steep slopes to gentle hill slopes with network of small rivers and big river like Beas River. Out of total area studied, 199 plant species were recoded, comprising trees, shrubs, herbs, climber and grasses.

During the survey some Bryophytic and Fern species were observed. Bryophytes are small thalloid structure plants which are commonly seen on moist places. Riccia and Marchenia (**Plate 3.5.3**) were commonly observed in these locations. Some Fern species (**Plate 3.5.4**) were also observed during the survey. On higher altitudes of the study area dominant species observed is *Pinus roxburghii*. Other associates are *Terminalia chebula, Mallotus philippinesis, Acacia catechu, zizyphus manritiana, anogeissus latifolia, cassia fistula shorea robusta, cassia tora.* On the hill slopes Acacia catechu a dominant species observed. Lantana species is widely distributed on the hill slopes from Jwalamukhi to Tihri. In Kangra District forest department planted some native species like Shisam, Deodar, Oak, Chil and Khair etc. The list of common plant species found in this area is given in **Table 3.5.2** and tree plantation by forest division for the last three years is given in **Table 3.5.3**.

3.5.5 Threatened Plant Species

National threatened species are those found only in small numbers or those very to extinction in the country. India has a list of threatened species at the all India level, published by the Botanical survey of India entitled Red Data Book. **Not a single species were observed to be threatened in the study area**.

3.5.6 Fauna

The animal life of an area is dependant upon the vegetation and there are countless relationships between the species composing an animal community. Faunal assessment provides a basis for determining relative abundance and rarity of each species which is important for assessing the diversity of fauna of a particular area.

Assessment of wildlife fauna has been done on the basis of secondary data collected from different government offices (including Forest and Wildlife Departments) and by the visual observations during the field survey. Among the reptiles house lizard, common Indian monitor, rock lizard etc encountered in the study area. Among snakes rat snake, common Indian crait, Indian cobra etc were common in the study area as narrated by local people. Rhesus Macaque (**Plate 3.5.5**) and Common Langoor were observed in most of the sampling locations.

The list of common faunal species found in this area is given in **Table 3.5.4**.

Avifauna

During Birds survey actual counts of birds were made following the standard survey technique (Clarke 1986, Richter and Sondgerath 1990) by traversing a known distance in which designated sampling areas occur. Observations were made during a walk through in the chosen transect for sighting birds. The number of birds observed in one-milometer stretch of the site was directly counted and listing was made. The milometer of the car/jeep was used to measure the stretch of the study transect. Birds were noted, counted and identified with the help of 7X-15x35 “Optima Zenith” binocular and standard field identification guides (Ali 1988, Ali & Ripley 1983, 1987, Woodcock 1988).

A total of 177 birds were found to be available in the study area. The common birds observed during the survey are Indian robin, Magpai robin, Babblers, Bulbul, & Blue rock pigeon. The birds which are found near human settlement are House sparrow, House crow, Common myna, Parakeet and Dove etc. The list of common bird species found in this area is given in **Table 3.5.5**.

Fishery

The fisheries activity in kangra district are mainly to promote agriculture in rural areas , conservation of natural fisheries, resources of the district, such as rivers and public water bodies and to implement various schemes such as riverine license, river fish production etc. one small fish farm at Kangra producing about 2-3 lakhs fries of common carp and producing Gold Fish. According to the information collected from the fisheries department large number of ponds and lakes are present in the study area. In District Kangra, more than 200 ha ponds, lakes and other small water bodies present including the ponds of FFDA. The vast scope of carp culture especially in Jwalaji area exist and fish production of these area at present is about 5-6 tons/ ha. The common fish species which are found on lower altitudes (i.e. below 900 msl) are Common carp, Silver carp, Grass carp, Rohu, Katla Mrigal and Mahaseer etc. and on higher altitudes (i.e. above 900 msl) Rainbow trout and Brown trout are mainly found.

In the district major source of fish production are private and village ponds. The total Riverine and Pond fish production for the year 2007-08 is 1470 and 742 tons respectively.

Details of seed and fish production in the district are given in **Table 3.5.6**.

Endangered & Vulnerable Animals

A comprehensive central legislation namely Wild Life (Protection) act was enforced in 1972. This law provides protection to wild animals and for matters related to their ancillary or incidental death. Not a single species were observed to be threatened in the study area.

3.5.7 Agriculture

The majority people of the area have agriculture (**Plate 3.5.6**) and cattle rearing as a main occupation. The agriculture is mainly rainfed and mostly used farmyard manure. A very few farmers produce surplus which they send into various adjoining areas otherwise almost all produce to meet their own requirement. A main agricultural crop grown in study area is paddy (*Oriza sativa*) and wheat (*Triticum vulgare*). Grains pulses are generally imported from the adjoining Punjab State. Agro- climatic condition of the area provides a range of potentialities for growing vegetable crop i.e. onion, chilly, brinjal, bhindi etc.

The main horticulture crops found in the study area are Apple, dry fruits, Citrus fruits (**Plate 3.5.7**), other tropical fruits etc. fruit production in last three years in kangra district is given in **Table 3.5.7**.

Plate 3.5.1 : Project site

Plate 3.5.2 : Vegetation Pattern in the Study Area

Plate 3.5.3 : *Marchantia* – a Bryophyte Species found in the Study Area

Plate 3.5.4 : Fern Species Found in the Study Area

Plate 3.5.5 : *Macaca mullata* –Generally found on the Roadside Area

Plate 3.5.6 : Agriculture Field near Study Area

Plate 3.5.7 : Banana Species found in Agriculture Fields

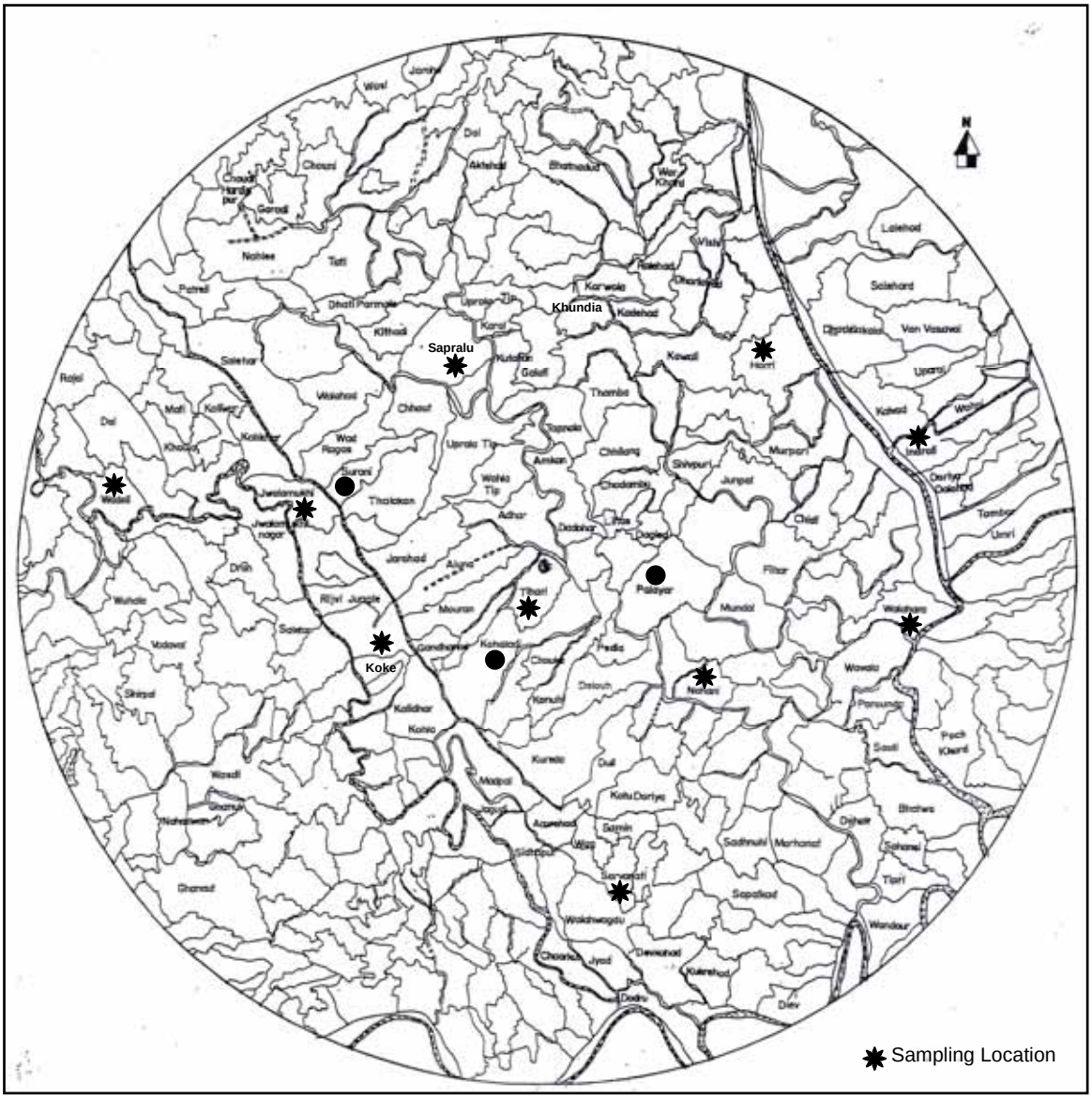

Fig. 3.5.1 : Sampling Locations for Biological Environment

Table 3.5.1

Biological Environment Sampling Locations

Sr. No.	Sampling Locations
1.	Tihri
2.	Jwalamukhi
3.	Shivpuri
4.	Wadoli
5.	Saruapani
6.	Sapralu
7.	Nahani
8.	Harri
9.	Walahara
10.	Indrali

Table 3.5.2

List of Plants Species found in the Study Area

Sr. No.	Botanical Name	Local Name	Family
1.	Adhatoda vasica	Basuti	Acanthaceae
2.	Strobilanthis auriculatus	Kapur minngar	
3.	Agave Americana	Ram ban	Amaryllidacea
4.	Deeringia celosioides	Bhirang	Amarantaceae
5.	Lannea doromandelica	Kehmal	Anacardiceae
6.	Mangifera indica	Am	
7.	Pistacia integerrima	Kakrain	
8.	Miliusa	Chopar chilla	Anonaceae
9.	Carissa opaca	Garuna	Apocyanceae
10.	Holarrhena antidysenterica	Keor	
11.	Ichnocarpus frutescens	Bakkarbel	
12.	Nerium odorum	Ghanira Gandheela	
13.	Vallaris heynel	Dudh bcl	
14.	Wrightia tomentosa	Khalawa	
15.	Calotropis pracera	Ak	Asclepiadaceae
16.	Cryptolepis buchanani	Jaman khumb	
17.	Wattakaka Volubilis	Mund bel	
18.	Periploca calophyila	Sarpri	
19.	Tyropnora hirsute	Terni	
20.	Strereospermum	Padal	Bignonoaceae
21.	Oroxylum indicum	Tatplanga	
22.	Flacaurtia romaantchi	Kangu	Bixaceae
23.	Xylosmalongifolium	Chirandi	
24.	Cordial myxa	Lasura	Boraginaceae
25.	Cordial vestita	Kumbhi	
26.	Ehretia laevis	Chamorar	
27.	Ehretia aspera	Sakar	
28.	Capparis sepiaria	Hiun garna	Capparidaceae
29.	Crataeva religiosa	Barna	
30.	Opuntia	Chhittar Chhun	Cactaceae
31.	Cassine glauca	Mirgu	Celastraceae
32.	Euonymus pendulus	Bharmela	
33.	Celastrus paniculata	Sankhiran	
34.	Gymnosporia royleana	Bhadrun	
35.	Anogeissus latifolia	Dhao. Chhal	Combretaceae
36.	Terminalia arjuna	Arjan	
37.	Terminalia belarica	Bahera	
38.	Terminalia Chebula	Harar	

Table 3.5.2 Contd…

Sr. No.	Botanical Name	Local Name	Family
39.	Terminalia tomentosa	Asian Sain	
40.	Pinus roxburghill	Chil	Conferee
41.	Cuscutta reflexa	Agas bel	Convolvulaceae
42.	Ipomea turpethum		
43.	Lettosmia thomsoni		
44.	Porana paniculata	Faindal	
45.	Dioscorea belophyla		Diocoreaceae
46.	Dioscorea bulbifera		
47.	Dioscorea deltoids	Jung kinch	
48.	Shorea robusta	Sal	Dipterocarpaceae
49.	Diospyros cardiolia	Kala dhao	Ebenacea
50.	Diospyros Montana	Kendu	
51.	Diospyros chloroxylon	Kinnu	
52.	Antidesma acidium	Amla	Euphorbiaceae
53.	Bischoffia javanica	Marak	
54.	Bridelia squamosa	Gaddi kuri	
55.	Euphorbia royleana	Thor, Chhun	
56.	Glochidion velutinum	Chamar-saman	
57.	Jatropha curcas	Jamnota	
58.	Mallotus philippinensis	Kamal	
59.	Emblica officinalis	Amla	
60.	Aqeratum conyzoides	Ghabufi	Compositae
61.	Artistida depressa	Lambi	Gramineae
62.	Bambusa arudinacea	Magar (Cultivated)	
63.	Chrysopogan Montana	Dholu	
64.	Cymbopogan maitini	Makora gha	
65.	Dendrocalamus hamiltonil	Mohar (Cultivated)	
66.	Dendrocalamus strictus	Bans Bainj	
67.	Eulaliopsis binata	Bhabar, Bagar	
68.	Hetropogan contortus	Lambu	
69.	Saccharum, spontaneum	Kahi	
70.	Sorghum nitidum	Lunji	
71.	Colebrockia oppositifolia	Dusen	Labiatae
72.	Pogostemon plectranthoides	Kali basuti	
73.	Roylea cinearea	Karoroi Tila Pati	
74.	Persea gamblei	Badrol	Oauraceae
75.	Acacia nilotica spp. Indica	Kikar	Leguminosae
76.	Acacia catechu	Khair	
77.	Acacia leucophloea	Reru, Riur	
78.	Acacia modesta	Phalai	
79.	Abrus precatorius	Rattak	
80.	Albizzia labbak	Siris, Sarin	

Table 3.5.2 Contd…

Sr. No.	Botanical Name	Local Name	Family
81.	Dryptes roxburghii	Putajen	
82.	Albizzia odoratissima	Karmaru	
83.	Albizzia chinensis	Ohi	
84.	Atylosia crassa	Bantapur	
85.	Bauthinia malabarica	Kacnnar, Karal	
86.	Bauhinia purpurea		
87.	Bauhinia vahlii	Taur	
88.	Bauhinia variegate	Kacnnar, Karal	
89.	Butea monosperma	Dhak, Plah	
90.	Caesalpinia decapetala	Ralan, Arlu	
91.	Cassia fistula	Kaniar Amltas, Alis	
92.	Cassia occidentalis	Chakunda	
93.	Cassia tora	Panwar	
94.	Dalbergia sissoo	Shisham tali	
95.	Desmodium motorium	Dudli	
96.	Desmodium velutinum	Jagru	
97.	Erythrina glabrescens	Pariara Paliaro	
98.	Flemingia semialata	Bara Solpan	
99.	Indigofera dosua	Kathi	
100.	Millotta extensa	Salangan	
101.	Mjmosa himalayana	Dargarhi	
102.	Mucuna pruriens	Gajal bel	
103.	Ougeinia ougeinensia	Sandan, Sanan	
104.	Derris indica	Sukhchain	
105.	Pueraria tuberose	Salod	
106.	Asp-aragus racemosus	Satmnli, Musli	Lillaceae
107.	Reinwardtia indica	Basant	Linacea
108.	Dendrophthoe falcate	Parand	Loranthaceae
109.	Punica granatum	Anar, Doran	Lythaceae
110.	Woodfordia floribunda	Dhawin, Dhawi	
111.	Bombax cieba	Sjmal	Malvaceae
112.	Urena lobata	Unga	
113.	Aspidopterys. Wallichii	Jugter Dhur bel	Malpighiaceae
114.	Hiptage madablota	Malti wan	
115.	Azaeirachta indica	Nim	Meliaceae
116.	Toona ciliata	Tun	
117.	Melira azedorach	Drek, Dek, Bakain	
118.	Cocculus laurifarius	Paror	
119.	Stephania elegans	Batindu	Menispermaceae
120.	Moringa oleifera	Sanan Suhanjua	Moringaceae
121.	Myrsline Africana	Chhota mendhru	Myrsinaceae
122.	Ardisia solanacea		

Table 3.5.2 Contd…

Sr. No.	Botanical Name	Local Name	Family
123.	Maesa indica	Burkani	
124.	Careya arborea	Handabhera	Myrtaceae
125.	Syzygium cuminl	Jaman	
126.	Eugenia jambolana var.	Kathaman	
127.	Caryophyllifolia		
128.	Jusminum arborscens	Dhur-malti	Oleaceae
129.	Jusminum dispermum	Sarain	
130.	Jusminum grandi-florum	Malti	
131.	Jasminum multiflorum	Banmalti	
132.	Linociera intermedia	Masandaru	
133.	Nyctanthus arbortristis	Kuri, Hurshjnagar	
134.	Olea ferruginea	Kao	
135.	Phoenix sylvestris	Khajoor	Palmeae
136.	Clematis gouriana	Jhol	Raunnanculaceae
137.	Clematis grata	Charki	
138.	Clematis nutans	Coibru, Machrum	
139.	Zizyphus mauritiana	Ber	Rhamnaceae
140.	Zizyphus oenoplia	Kokal-ber	
141.	Rhamnus trigaeter	Gulodan	
142.	Sugeretia parviflora	Giigithan	
143.	Pyrus Pashia	Kainth	Rosaceae
144.	Rubus paniculutus	Akha	
145.	Rubus lasiocarpus	Kala akha	
146.	Hamiltonia suaveolens	Gullhain	Rubiaceae
147.	Hymenodictyon excelsum	Barthua	
148.	Xeromphis spinosa	Rara	
149.	Randia tetrasperma	Jindru	
150.	Mitragyne parvifolia	Kalan	
151.	Wendiandia heynei	Panseraa	
152.	Aegle marmelos	Bil	Rutaceae
153.	Limonia acidissima	Barnahi Billan	
154.	Murraya paniculate	Nargan	
155.	Murraya koenigii	Gandhla	
156.	Casearia elliptica	Chilia	Samydaceae
157.	Osyris wightiana	Sason	Santalaceae
158.	Dodonaea viscose	Maindhor	Sapindaceae
159.	Sapindus mukorossi	Ritha	
160.	Madhuca indica	Mohun (introducted)	Sapotaceae
161.	Engelhardtia spicata vor. Colebrokeana	Samma	Juglandaceae
162.	Salix tetrasperma	Badhla	Salicaceae
163.	Helicteres lsora	Maror phalli	Sterculiaceae
164.	Saurauja napaulensis	Bhakara	Ternstroemilaceae

Table 3.5.2 Contd…

Sr. No.	Botanical Name	Local Name	Family
165.	Grewia elastica	Phalsa	Tiliaceae
166.	Grewia laevigata	Dhamriana Damani	
167.	Grewia oppositifolia	Biul, Dhaman	
168.	Boehmeria platyphylla	Padara	Urticaceae
169.	Boehmeria regulosa	Ligga	
170.	Cannabis sativa	Bhang	
171.	Ficus clavata	Barh, Bohar	
172.	Ficus semicordata	Karanda	
173.	Ficus sarmentosa	Kandroi	
174.	Ficus racemosa	Rudhar	
175.	Ficus hispinda	Rumbal	
176.	Ficus Virens	Dagur	
177.	Ficus nemoralis	Padari	
178.	Ficus palmate	Dudia	
179.	Ficus relgiosa	Dura, Dogla	
180.	Ficus relgiosa	Papal	
181.	Ficus rumphii	Palakh	
182.	Holoptelea integrifolia	Rajain, Pardesi	
183.	Morus alba	Tut	
184.	Morus australis	Sia-tut	
185.	Morus laevigata	Shah-tut	
186.	Morus serrata	Karun (cultivated)	
187.	Trema politora	Kasa Kuri	
188.	Caryopteris odorata	Ban-basuti	Verbenaceae
189.	Clerodendron phlomidis	Dhakkari	
190.	Callicarpa macrophylla		
191.	Gmelina arborea	Ban	
192.	Lantana camara	Lantana, Ukkal Buti	
193.	Premna barbata	Ginani	
194.	Premna mucronate	Bhankahar, gin	
195.	Tectona grandis (introducted)	Sagwan	
196.	Vitex negundo	Bana	
197.	Ampelocissus latifolia	Giddar Dakh	Vitaceae
198.	Vitis parvifolia		
199.	Cayratia trifolia	Chamber bel	

Source : Forest Department, Dharamshala

Table 3.5.3

Plantation for Last Three Years in Kangra District

Name of trees	Years		
	2004-05	2005-06	2006-07
Area	2953	2422	2288
Deodar	38955	27952	158667
Kail	17550	20677	30687
Chil	156525	176784	113060
Khair	775808	650382	341431
Shisam	466949	370768	263170
Oak	44520	19187	82990
Rovinia	1480	9280	13045
Other plants	986753	1031682	593876
Total	**2488540**	**231682**	**1599214**

Source : Forest Department, Dharamshala

Table 3.5.4

List of Fauna in Study Area

Sr. No	Common Name	Zoological Name
Reptiles		
1.	Pyton	*Pyton moturus*
2.	Russell's viper	*Vipera russelli*
3.	Common Krait	*Bungarus caerulens*
4.	Chameleon	*Calotes versicolor*
5.	Monitor lizard	*Varanus monitor*
6.	House lizard	*Hemidactylus domesticus*
7.	Non-poisonous snake	*Dendrophis pictus*
8.	Non-poisonous snake	*Gongylophis conicus*
9.	Non-poisonous snake	*Lycoden Aulicus*
10.	Non-poisonous snake	*Zamenis mucosus*
Mammals		
11.	Common Indian squirrel	*Lepus ruficaudatus*
12.	Spotted Deer	Axis axis
13.	Field Rat	Bandicota bengalensis
14.	Indian Bush rat	Colunnda ellioti
15.	Indian Field Mouse	Gus booduga
16.	Common House Rat	Rattus rattus
17.	Jungle Cat	Felis chaus
18.	Indian Wildboar	Sus scrofa
19.	Common Mongoose*	Herpestes edwardsi
20.	Rhesus Macaque*	Macaca mulata
21.	Walf	Canis lupus
22.	Common langur*	Presbytis antellus

Source : Forest Department, Dharamshala

Table 3.5.5

List of Bird Species found in the Study Area

Sr. No.	Scientific Name	Local Name	Family
1.	Podiceps euficollis	Little grebe	Prodicipedidae
2.	Podiceos criseigena	Red necked grebe	
3.	Pelecanus philippensis crispus	Grey pelican	Pelecanidae
4.	Phalacrocorax niger	Little cormorant	Phalacrocoracidae
5.	Anhinca rufa	Darter	
6.	Ardea Cimerea	Grey heron	Ardeidae
7.	Ardea purpurea	Purple heron	
8.	Ardaola grayii	Pond heron	
9.	Bubulcus ibis	Cattle egret	
10.	Ardea alba	Large egret	
11.	Eqretta garzetta	Little egret	
12.	Mycteria Leucocephala	Painted stork	Ciconiidae
13.	Anser indicus	Barheaded Goose	Anatidae
14.	Anas Crecca	Common Toal	
15.	Anas poecilorhyach	Spotbill or grey duck	
16.	Anas clypeata	Shoveller	
17.	Anas querquedula	Gargeny or Bluewinged Teal	
18.	Anas platyrhynchos	Mallard	
19.	Anas strepera	Gadwall	
20.	Anas Penelope	Wigeon	
21.	Tardorna Ferrucinea	Ruddy Bhelduc or Braminy Duck	
22.	Elanus caeruleus	Black winged kite	Accipitridae
23.	Milvus migrans covinda	Pariar rite	
24.	Haliastur Indus	Braminy kite	
25.	Accipiter badius	Shirka	
26.	Aquila rapax	Tawany eagle	
27.	Sarcogyps calvds	Black or king vulture	
28.	Gyps benegalansis	Whitebacled or Bengal Vulture	
29.	Neophron percnopterus	Whiter scavenger vulture of Pharaoh's chicken	
30.	Spilornis cheela	Crested serpent eagle	
31.	Pandion haliaetus	Osprey	
32.	Circus aeruginosus	Margh harrier	
33.	Falco tinnunculus	Kestrel	Falognidae
34.	Prancolinus francolinus	Black partridge	Phasianidae

Table 3.5.5 Contd…

Sr. No.	Scientific Name	Local Name	Family
35.	Prancolinus pondicerianus	Grey partridge	
36.	Coturnix coturnix	Grey quall	
37.	Perdicula asiatica	Jungle bush quall	
38.	Gallus qallus	Red jungle fowl	
39.	Pavo cristatus	Common peafowl	
40.	Amaurornis phoenicurus	White breasted waterhen	Rallidae
41.	Gallinule choropus	Moorhen	
42.	Fulica atra	Coot	
43.	Porphyrio porphyrio	Furple moorhen	
44.	Himantopus himantopus	Blackwinged stilt	Recurvirstridae
45.	Burhinus oedicnamus	Stone curlew	Burhinidae
46.	Esaus magnirostris	Great stone plover	
47.	Glareola lactase	Small Indian pratimcole	Glareolidae
48.	Vanallus indicus	Red wattled lapwing	Charadriidae
49.	Vanellus vanellus	Lapwing or peewit or green plover	
50.	Charadrius dubius	Little ringed plover	
51.	Tringa hypoleucos	Common sandpiper	
52.	Tringa tetanus	Common redshank	
53.	Tringa ochropus	Greenshank	
54.	Tringa ochropus	Green sandpiper	
55.	Calidris temminckii	Remminck's stint	
56.	Gallinago spp	Snipe	
57.	Vanellus spinosus	Spjrwinged lapwing	
58.	Sterna aurantia	Indian river tern	Laridae
59.	Sterns acuticaula	Black bellied tern	
60.	Larus ridibundus	Black headed gull	
61.	Larus idhthyaetus	Great black headed gull	
62.	Columba livia	Blue rock pigeon	Pterclididae
63.	Streptopelia decapcto	Indian ring dove	
64.	Streptopelia chinensis	Spotted dove	
65.	Streptopelia tranguebarica	Red turtle dove	
66.	Streptopelia senagalensis	Little brown dove	
67.	Psittacula supatria	Alakndrine parakeet	Psittacidae
68.	Psittacula krameri	Rose ringed parakeet	
69.	Psittacula Himalayana	Slatyheaded parakeet	
70.	Psittacula cyanocephala	Blossom headed parakket	
71.	Clamator jacobinus	Pied crested cuckoo	Cuckoos

Table 3.5.5 Contd…

Sr. No.	Scientific Name	Local Name	Family
72.	Ccuculus varius	Common hawk cuckoo or Eraiafever bird	
73.	Cuclus micropterus	Indian cuckoo	
74.	Cuclus canorus	The cuckoo	
75.	Eudynamya scolopacea	Koel	
76.	Taccocua leschanaultii	Sirkeer cuckoo	
77.	Centropus sinensis	Crow pheasant or coucal	
78.	Athena brama	Spotted owlet	Strigidae
79.	Glaucidium radiatum	Jungle owlet	
80.	Bubo	Great horned owl	
81.	Caprimulgus asiaticus	Common Indian nightjar	Caprimulgidal
82.	Apus affinis	House swift	Apodidae
83.	Collocalia brevirostris	Himalayan swiftlet	
84.	Cryle rudis	Lsseer pied kingfisher	Alcedinidae
85.	Alcedo atthis	Common kingfisher	
86.	Halcyon smyrnensis	White breasted kingfisher	
87.	Merops leschenaultia	Chestnut headed bee-eater	Meropidae
88.	Merops orientalis	Green bee-eater	
89.	Coracias carrulus	Indian rooller	Coraciidae
90.	Upupa spops	Hoopoe	Upupidae
91.	Tockus birostris	Common grey hornbill	Bucerotidae
92.	Megalaima zevlenica	Large green barest	Capitonidae
93.	Megalaima haemacep	Crimson breasted barget, coppersmith	
94.	Dinopium benghalens	Lesser goldenebacked wood pecker	Picidae
95.	Picus canus	Black naped green mood pscher	
96.	Dandro-copos mahrattensis	Mahratta woodpecker	
97.	Picus squamatus	Himalayan scaly bellied green woodpecker	
98.	Jynx torginallla	Wryneck	
99.	Pitta brachyuran	Indian pitta	Pittidae
100.	Mirafra Javanica	Singing bush lark	Alaudidae
101.	Eremoptarix grlsea	Ashycrowned finch-lark	
102.	Galerida cristats	Crested Lark	
103.	Alauda gulgule	Skylark	
104.	Mirafra erythroptara	Red winged bush lark	
105.	Melanocorypha spp	Calandra lark	
106.	Calendrella revtal	India sand lark	

Table 3.5.5 Contd…

Sr. No.	Scientific Name	Local Name	Family
107.	Riparia paludicola	Plain sand martin	Hirundinidae
108.	Hirundo rustica	Swallow	
109.	Hirundo smithii	Wirs tailed swallow	
110.	Hirundo fluvicola	Indian cliff swallow	
111.	Hirundo duriea	Striated or redrumped swallow	
112.	Lanius schech	Rufous backed shriks	Laniidae
113.	Oriolus	Golden oriole	Oriolidae
114.	Oriolus traillii	Black headed oriole	
115.	Oriolus xanthornus	Maroon oriole	
116.	Dicrurus adsimilis	Black drongo or aing-crow	Dicrjridae
117.	Dicrurus caarulescens	White bellied drongd	
118.	Sturnus pagodarum	Black headed or brahminy myan	Sturnidae
119.	Sturnus contra	Pied myna	
120.	Acridotherss tristis	Common myna	
121.	Acridotherss fuscus	Jungle myna	
122.	Dendrocitta vagabunda	Indian tree pie	Corvidae
123.	Corvus splendens	Hojee crow	
124.	Corvus macrorhynchos	Jongle crow	
125.	Tephrodornis pondicerianus	Common wood shriks	Campephagtdae
126.	Pericrocotus flamueus	Scarlet minivet	
127.	Pericrocotus cinnsmomaus	Small minivet	
128.	Aegithins tiphia	Common uora	irenidae
129.	Pycnonotus leucoganys	Whitecheeked bulbul	Pycnonotidae
130.	Pycnonotus cafer	Redvented bulbul	
131.	Hypsipates madacascariensis	Black bulbul	
132.	Pematorhinus schisticaps	Slaty-heafed gcimitar-e abler	Muscicapidae
133.	Turdoides striatus	Jungle blbbler	
134.	Turdoides caudatus	Common babbler	
135.	Turdeides cariei	Striatsd babbler	
136.	Chrvsomma sinenss	Ysllow syed babbler	
137.	Pellorneum ruficeps	Spotted babbler	
138.	Muscicapa thalassina	Verditer flycatcher	Musctcapinae
139.	Culicicapa cevlonensis	Grey headed flycatcmer	
140.	Terpsiphone paredisi	Paradise flycatcher	
141.	Rhipidura albicollis	White throated fantall flycatcher	
142.	Rhipidura hypexantha	Yellow ballied fantall plycatcher	

Table 3.5.5 Contd…

Sr. No.	Scientific Name	Local Name	Family
143.	Orhotomus sutorius	Tallor bird	Syviinae
144.	Acrocophalus stantoreus	Indian great reed warbler	
145.	Prinia spp.	Northern ashy-grey-hren warblsr	
146.	Phylioscopus collybits	Brown leaf warbler or chiffchape	
147.	Phyiloscopus neglectus	Plain leaf warbler	
148.	Phyioscopus affinis	Tickell's leaf warbler	
149.	Phyioscopus proregulus	Pallas's leaf warbler	
150.	Phyiloscopus reguloides	Blyth's leaf warbler	
151.	Primia rufeecens	Rufous wheh-warbler	
152.	Brithacus svecicus	Blue throat	Turdinae
153.	Copsychus saularis	Magpie-robin or dhyal	
154.	Phognicurus ochrures	Black red stard	
155.	Phyacornis fuliginosus	Plumbeous redstart	
156.	Chaimarrornis leucocephalus	Whits capped redstart or river chat	
157.	Saxicoloides fulicsts	Indian robin	
158.	Saxicola forrea	Pied bush chat	
159.	Saxicola-forr	Dark grey bush chat	
160.	Monitocola soclitarius	Blue rock thrush	
161.	Mviophonus caeruleus	Blue whistline thrush	
162.	Saxicola torguata	Stone chat or collared bush chat	
163.	Oenanthe oenanthe	Wheatear	
164.	Cercomela fusca	Brown rock chat	
165.	Cinclus dallasii	West Himalayan brown dipper	Cinclidae
166.	Perus major	Grsy tit	Paridas
167.	Parus monticolus	Green hacked tit	
168.	Sitta castansa	Chestnutdsllied nuthatch	Sittidae
169.	Tichodroma muraria	Wall creeper	
170.	Certhis himelevana	Himalayan tres creeper	Certhiidae
171.	Anthus trivialis	Tree pipit	Motacillidae
172.	Anthus similes	Brown rock pipit	
173.	Anthus novueseolandiee	Padoyfield pipit	
174.	Matacilla albs	White wagtail	
175.	Motacilla maderaspatensis	Large pied wagtail	
176.	Motacilla flava	Yellow wagtall	
177.	Anthus hodosoni	Indian tree pipip	

Source : Forest Department, Dharmashala

Table 3.5.6

Target Achieved by Fisheries Department in Kangra District in 2007-08

Sr. No.	Name of Scheme	Kangra
1.	Carp Seed Production (no. lakh)	19.20
2.	Fry Production	2.10
3.	Riverine Fish Production (ton)	1470
4.	Pond Fish Production (ton)	742
5.	Carp Farm Production (kg)	28

Source : Fisheries department Palampur.

Table 3.5.7

Fruit Production in Last Three Year in Kangra District

Fruit Name	2004-05	2005-06	2006-07
Apple	710	650	443
Other tropical fruits	3909	4057	3417
Dry fruits	184	596	342
Citrus fruits	24906	23638	8001
Other fruits	85587	57367	28305
Total	**115296**	**86308**	**40508**

Source : Horticulture department , Dharmashala

3.6 Socio-economic Environment

3.6.1 Reconnaissance

The study of socio-economic component incorporating various facets related to socio-economic conditions in the area is an integral part of EIA. Demographic structure, population dynamics, infrastructure resources, health status of the community, and economic attributes such as employment, industrial development and sustainability of the project in financial terms have been incorporated in socio-economic environment study. The aesthetic environment refers to scenic value of the area, tourist attraction, forest and wild life, historic and cultural monuments. The study of these parameters forms the basis for identifying, predicting and evaluating the potential impacts due to project activities.

The study areas of 10 km redial distance has proposed from exploratory drilling operations. The site for proposed project has been identified near Tihri village in Kundian Tahsil, Kangra District in Himachal Pradesh as shown in **Plate 3.6.1**. This includes 48 villages from Khundian Taluka, 11 villages from Dera Gopipur Taluka and 02 villages from Jai Singhpur Taluka in Kangra district.

Ten villages identified for socio economic survey as listed in **Table 3.6.1** were surveyed within 10 Km radial distance from the project site for the collection of socio-economic data. The villages identified for socio economic environment are shown in **Fig 3.6.1**.

3.6.2 Baseline Status

The survey has been carried out with the help of a pre-designed set of questionnaires. Adult male and female representing various communities were interviewed on judgmental or purposive basis data on following parameters has been collected for the study region.

- Demographic structure
- Infrastructure resource base
- Economic attributes
- Health status
- Aesthetic attributes
- Socio economic status with reference to quality of life (QoL) indices
- Awareness and opinion of the people about the project

The data is generated using secondary sources viz. Census records, District Statistical Abstract, Official Document and Primary Sources viz. field survey and field observation.

3.6.2.1 Demographic Structure

Summary of demographic structure with reference to population, household, literacy, community structure and employment is presented in **Table 3.6.2**. Demographic data at a glance is presented in **Table 3.6.3**.

The salient features of the study area are as follows:

- Total number of residential houses in the study area is 3531
- Total population of the region is 17815
- Sex ratio i.e. no. of female per thousand male is 1001
- Percentage of Scheduled Caste is (4390) 24.62%
- Percentage of literate people in the study area is (12281) 68.93%
- Percentage of employed people in the study area is (6458) 36.25% while the Non worker population is (7782) 43.69 %

3.6.2.2 Infrastructure Resource Base

Infrastructure resource base in the study area with reference to education, medical, power supply, water resources, communication and transport is presented in **Table 3.6.4**. The infrastructure resources details have been abstracted from Houses, household amenities 2001 CD of Himachal Pradesh State, obtained from Office of Registrar General India, New Delhi.

3.6.2.3 Economy

Agriculture

Agriculture is the main occupation of the people in the study area. 54.16% of the total main workers are engaged as cultivators and agriculture labours. The variant climatic conditions provide a range of potentialities for growing cash crops like off season vegetables; Wheat is the main large scale cultivation in study area as shown in **Plate 3.6.2**. Rice, Makka, Til, Arbi, Masur, and Sarso are produced and consumed but in a small measures. So economy of the study area is dependent on forest. The holdings are small and cultivation is done on orthodox techniques of farming. The production is very

low. Cultivation is not possible by tractors because the fields are small and terraced. The employment pattern are shown in **Fig 3.6.2**.

The significant observations about employment pattern in study area.

- Total main workers in the villages of study area are 36.25%
- Majority of main workers are engaged as cultivator 53.20%
- There are 0.96% agriculture laborers
- Non-worker population in the study area is 43.69%

3.6.2.4 Health Status

Health is a very important socio-economic parameter; it has a direct linkage with environment. As per the National Health Policy (1983), Primary Health Care has been accepted as main instrument for achieving this goal for the development and strengthening of rural health care through three tier health infrastructure system i.e. primary health sub-centre (PHS) primary health centre (PHC) and community health centre (CHC) have been established.

The standards set by the national health policy are given below

Population	Infrastructure	Personnel
3000 – 5000	1 Sub Centre	1 ANM (Auxiliary Nurse Midwives)
25,000-30,000	1 PHC, 6 Beds	2 medical Officer
1,00,000	Rural Hospital	Medical Superintendent

Data regarding health status has been collected from Block Medical Officer PHC, Tihri. Viral fever, Malaria, Gastro, tuberculosis and skin diseases are the common diseases prevalent in the study area.

Primary Health Center organizes Blood Donation, Pulse Polio and Eye chek up camp in study area. Panchayat wise no. of Birth and Death in study area is given in **Table 3.6.5**. Primary Health centers and Govt Ayurvedic Health Centers are available in study area as shown in **Plates 3.6.3-3.6.4**.

3.6.2.5 Cultural and Aesthetic Attributes

The ancient temples of Jwaladevi temple are situated in Jwalamukhi. 6-7 km away from Project site. The temple is famous for its stone carvings decorations.

3.6.3 Socio-economic Survey

3.6.3.1 Sampling Method

A socio-economic survey was carried out by using judgmental or purposive sampling method for collecting detailed information about prevailing socio-economic condition in the study area and also to assess awareness, opinion and reaction of the inhabitants about the project. Occupational stratification is a prime parameter for sampling because each strata of the sample unit possess specific characteristics and their views and attributes would reflect on various parameters of Quality of Life. Assessment of existing economic activities vis-à-vis correlating it with the developmental activities would form the basis for predicting and evaluating the likely impacts due to the project on existing social and economic status

3.6.3.2 Socio-economic Survey

Villages for the socio-economic survey were selected along project sides. In all, there are 10 villages located in all directions with reference to project site. Care was taken to have interview of Sarpanch/Mukhia of each village. In addition to individual interviews with the adult male/female common meetings were conducted in which heads of the villages, panchayat representatives, and other stakeholders like, school teacher, anganwadi sevika, PHC incharge, gramsewak etc were present.

Salient Observation Recorded During the Survey

- About 70% respondents are having agricultural land. The fields are terraced hence irrigation facilities are limited resulting in low crop yield
- Twenty-four hours Power supply facility is available in almost villages in the study area
- Unsatisfied transportation facility has been observed in the study area. Maximum portation of the study area is covered by the kaccha roads and the condition of the roads is very poor.
- 90% of the respondents are not satisfied with the available medical facilities
- Majority of the respondents were concerned about communication facilities
- Sanitation facilities in the villages seem to be very poor/non-existent

- Primary, middle and High schools are available in study area as shown in **Plate 3.6.5**
- Hand pump are main source of drinking water in study area. Drinking water storage tank are available in hill area as shown in **Plate 3.6.6**
- People reported water scarcity problem in the summer season. It is mainly due to hill area and ground water level is low
- A large number of respondents reported their income between Rs. 2000-3500/- per month

3.6.3.3 Project Awareness and Opinion

During survey, queries were made regarding awareness about the project in general and apprehensions about safety and socio-economic impacts of proposed exploratory drilling operations project in particular. During the discussion, following observations were recorded.

- Awareness about the proposed exploratory drilling project amongst the respondents is 70% but the villagers do not have any clear idea regarding proposed project
- On an average, number of respondents who expressed favourable opinion about the project is 80%,
- Most of the respondents opined that there would be increased job opportunities and availability of oil in the region
- Similarly, most of the respondents are expected for improvement in medical and water facilities, as these facilities are not enough presently

3.6.4 Quality of Life (QoL)

An exercise has been carried out to assess the Quality of Life (QoL). The particulars of the concept are:

Quality of life (QoL) is defined as a function between “objective conditions” and “subjective attitudes” involving a defined “area” of concern.

The “objective conditions” are defined as numerically measurable artifacts of a physical event, sociological event or economic event. Objective conditions may be

defined as any number that stands for a given quantity of a variable of interest so long as it is independent of subjective opinion.

Subjective attitude" is primarily concerned with affective and cognitive dimensions. It is specifically concerned with 'how aspects of cognition vary as objective conditions vary'.

Once objective measures are obtained for each factor they are transformed to a normal scale varying from 0 to 1 (value function curve) in which 0 corresponds to the lowest or least satisfactory measure, and 1 corresponds to the highest. The weights are assigned to each factor by ranked-pairwise technique, by the expert group based on the secondary data and general observations.

For each objective measure, a corresponding subjective measure is developed for each individual of the sample population by asking him to rate his satisfaction scale (value function curve) is used such that 0 corresponds to the lowest level of attitudinal satisfaction and 1 corresponds to the highest level of satisfaction. Weights are assigned to each factor using ranked - pairwise comparison techniques.

The Socio-economic Indicators for QoL Assessment are:

1. Income, Employment and Working Condition
2. Housing
3. Food
4. Clothing
5. Water Supply and Sanitation
6. Health
7. Energy
8. Transportation and Communication
9. Education
10. Environment and Pollution
11. Recreation
12. Social Security
13. Human Rights

I. Subjective quality of life

$$QoL_s = 1/p \sum_{i=1}^{m} \sum_{j=1}^{p} QI_{ij} \times W_i$$

Where,

QoL_s = Subjective quality of life index

P = No. of respondents, j = 1, ..., p

m = No. of factors, i = 1, ..., m

QI_{ij} = Subjective quality index for i^{th} factor assigned by j^{th} respondent

$\sum Qi_{ij}$ = Subjective quality index for i^{th} factor assigned by all respondents in an area

W_i = Relative weightage of the i^{th} factor

II. Objective quality of life

$$QoL_o = \sum_{I=1}^{i=n} QI_i \times W_i$$

Where,

QoL_o = Objective quality of life index

n = No. of QoL Factors

i = 1, ..., n

QI_i = Satisfaction level (assigned by the expert group) for the i^{th} objective indicator

W_i = Normalized weight for i^{th} factor

III. Cumulative Quality of Life

$$QoL_c = \frac{QoL_o + QoL_s}{2}$$

The subjective and objective QoL indices prior to commissioning of the project is presented in **Table 3.6.5**.

The QoL index values are estimated as:

$QoL_{(S)}$ = 0.48

$QoL_{(O)}$ = 0.50

$QoL_{(C)}$ = 0.49

Plate 3.6.1 : Proposed Project Site near Village Tihri

Plate 3.6.2 : Wheat is the Main Large Scale Cultivation in Study Area

Plate 3.6.3 : Primary Health Center in Study Area

Plate 3.6.4 : Govt Aurvedic Health Center in Study Area

Plate 3.6.5 Educational Facility Available in Study Area

Plate 3.6.6 Drinking Water Storage Tank are Available in Study Area

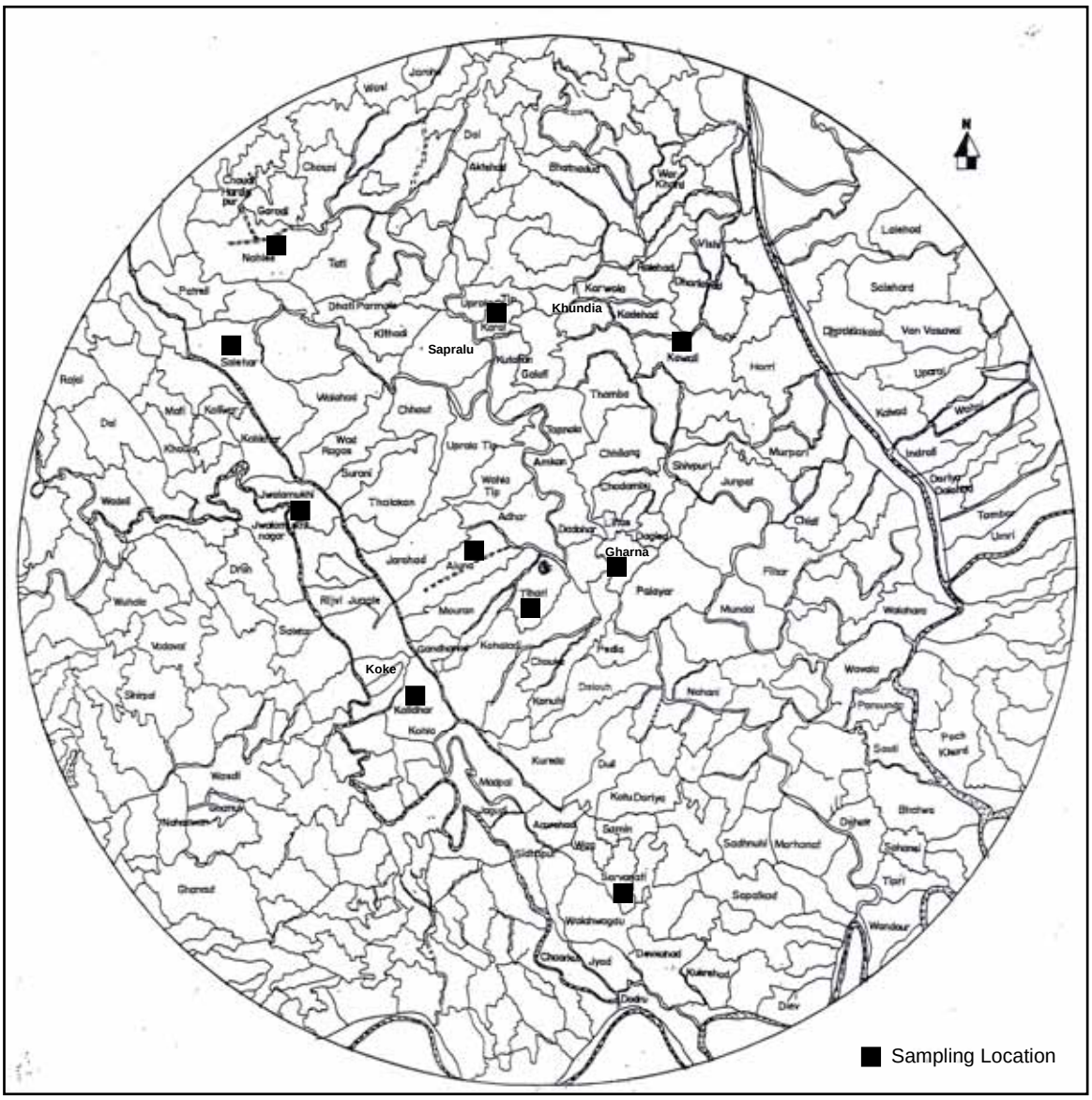

Fig. 3.6.1: Sampling Location Identified for Socio-economic Environment

Fig: 3.6.2 Employment pattern in Study area

Table 3.6.1

Distance and Direction of the Villages Surveyed

S. No.	Villages	Aerial Distance (km)	Direction
		with respect to proposed site	
1.	Sarab Nati	6.0	SSE
2.	Karal	4.6	NNW
3.	Aluha	1.7	W
4.	Tihri	0.5	-
5.	Gharna	2.6	E
6.	Kuwali	4.9	NE
7.	Nahli	8.0	NW
8.	Kali Dhar	3.7	SW
9.	Salehr	4.7	WSW
10.	Jawalamukhi	5.0	WNW

Table 3.6.2

Demographic structure of the Study Area

Name	No House Hold	TOT Pop	TOT Male	TOT Female	Pop SC	Pop ST	Pop LIT	Main Worker Pop	Marginal Worker Pop	Non Worker Pop
District – Kangra Tehsil - Khundian										
Hari	31	132	67	65	0	0	77	74	0	58
Dabkehri	36	192	105	87	1	0	120	45	114	33
Sarab Nati	56	338	165	173	17	0	222	166	71	101
Kukrehr	16	106	50	56	0	0	51	17	59	30
Dodru	31	161	71	90	0	0	103	28	84	49
Jiod	9	44	23	21	0	0	30	10	23	11
Lihas	30	141	59	82	82	0	81	67	22	52
Paliar	38	195	93	102	0	0	121	116	36	43
Mundhal	30	177	77	100	59	0	119	75	70	32
Galoti	100	484	247	237	82	0	349	247	6	231
Kutahn	8	60	27	33	0	0	39	33	0	27
Karal	10	65	36	29	0	0	45	26	16	23
Thamba	74	413	196	217	259	0	260	222	95	96
Aluha	99	511	260	251	178	0	317	235	97	179
Aghar	50	253	123	130	20	0	158	61	102	90
Tihri	65	271	138	133	85	0	202	74	103	94
Sidhpur	23	135	65	70	0	0	93	65	39	31
Dal	44	216	95	121	57	0	153	96	71	49
Kurera	89	460	234	226	305	0	305	203	84	173
Dol	39	170	94	76	59	0	107	84	10	76
Rohal	11	64	32	32	39	0	39	27	7	30
Tapnala	11	61	33	28	0	0	43	31	21	9
Amkan	10	70	29	41	0	0	49	14	37	19
Chhilag	43	262	119	143	25	0	167	49	145	68
Kotu Dhorian	40	183	86	97	68	0	119	39	88	56
Amred	15	92	43	49	46	0	59	8	61	23
Jamuli	15	69	31	38	2	0	37	14	34	21
Gharna	59	307	151	156	0	0	198	164	76	67
Daglehr	31	153	73	80	41	0	100	60	47	46
Charambu	58	269	137	132	268	0	156	142	67	60
Kuwali	40	221	102	119	0	0	147	88	11	122

Table 3.6.2 Contd…

Name	No House Hold	TOT Pop	TOT Male	TOT Female	Pop SC	Pop ST	Pop LIT	Main Worker Pop	Marginal Worker Pop	Non Worker Pop
Mariari	20	109	52	57	14	0	77	51	16	42
Shiv Pur	16	79	44	35	0	0	53	43	4	32
Jujhpul	39	181	82	99	27	0	100	92	19	70
Tipri	29	136	62	74	89	0	98	21	9	106
Duhk	31	158	73	85	18	0	107	26	19	113
Saoli	39	157	73	84	0	0	109	15	72	70
Bhatawan	50	265	121	144	41	0	173	60	16	189
Chaunki	77	385	171	214	152	0	256	181	111	93
Kadehr	12	63	29	34	7	0	38	10	22	31
Surani	51	274	142	132	130	0	177	113	85	76
Thalakan	72	357	169	188	64	0	250	164	70	123
Nahli	74	387	199	188	222	0	268	154	72	161
Patreli	33	180	94	86	14	0	123	27	97	56
Chhont	59	332	164	168	0	0	215	100	102	130
Hardip Pur	94	445	231	214	352	0	287	198	152	95
Chori	31	159	75	84	86	0	103	66	61	32
Parauntha	10	45	21	24	0	0	23	8	16	21
Tehsil - Dera Gopipur										
Rajol	93	511	255	256	0	0	342	243	162	106
Saletar	93	517	262	255	251	0	338	201	6	310
Kohla	20	122	71	51	23	0	65	69	23	30
Kali Dhar	9	51	28	23	0	0	31	22	13	16
Dol	36	167	78	89	0	0	125	102	0	65
Mat	11	57	31	26	4	0	40	17	2	38
Sihor Pai	87	450	231	219	164	0	324	152	100	198
Salehr	42	227	107	120	7	0	154	93	61	73
Gangot	22	63	31	32	1	0	55	21	20	22
Drihn	48	233	112	121	60	0	160	37	143	53
Reserve Jangal	11	56	28	28	4	0	33	27	18	11
Tehsil - Jai Singhpur										
Umri	58	258	129	129	100	0	183	76	84	98
Tambar	41	185	80	105	55	0	131	11	36	138
Jawalamukhi	1012	4931	2587	2344	812	0	3777	1478	268	3185
Total	**3531**	**17815**	**8893**	**8922**	**4390**	**0**	**12281**	**6458**	**3575**	**7782**

Source: Primary Census Abstract (CD) 2001, Himachal Predesh State

Table 3.6.3

Summary of Demographic Structure at a Glance

S. No.	Demographic Parameters	Details
1.	No. of Villages	62
2	No. of Urban areas	01
3.	Total No. of Residential houses	3531
4.	Total population	17815
5.	Sex Ratio (male : thousand female)	1001
6	Scheduled caste	4390(24.62)
7.	Literates	12281 (68.93%)
8.	Main workers	6458 (36.25%)
9.	Marginal workers	3575 (20.06%)
10.	Non Worker	7782(43.69%)

Source: Primary Census Abstract (CD) 2001, Himachal Predesh State

Table 3.6.4

Village wise Information of Infrastructure Facility in Study Area

Sr. No.	Village	Educational Institutions	Medical Facilities	Drinking Water Supply	Commu-nication	Transpor-tation	Approach Road	Power Supply
District Tahsil - Khundian								
1.	HARI	P(2)	2	T(1) W(1),HP(1),R(1)	PH(02)			
2.	DABKEHRI	P(2)	2	T(1)	PH(1)	BS		
3.	SARAB NATI	P(2)	2	T(1)	PH(1)	BS	AP	
4.	KUKREHR	P(2)	2	T(1)	PH(2)			
5.	DODRU	P(1)	2	T(1))	PH(2)			
6.	JIOD	P(2)	2	T(1)	PH(1)	BS		
7.	LIHAS	P(1)	1	T(1)	PH(1)	BS		ED
8.	PALIAR	P(1)	2	T(1)	PH(1)	BS		ED
9.	MUNDHAL	P(2)	2	T(1)), W(1)),HP(1)	PH(2)			ED
10.	GALOTI	P(1),M(1),H(1),C(1)	1	T(1)	PH(1)	BS	AP	
11.	KUTAHN	P(2)	2	T(1)	PH(1)	BS	AP	
12.	KARAL	P(2)	2	T(1)	PH(1)	BS	AP	ED
13.	THAMBA	P(1)	1	T(1)	PH(1)	BS	AP	
14.	ALUHA	P(1)	1	T(1)), W(1)),HP(1)	PH(1)	BS		ED
15.	AGHAR	P(2)	2	T(1),HP(1)	PH(1)	BS		ED
16.	TIHRI	P(2)	1	T(1),HP(1)	PO(1),PH(1)	BS		ED
17.	SIDHPUR	P(2)	2	T(1),HP(1)	PH(2)			ED
18.	DAL	P(2)	1	T(1)	PH(2)			ED
19.	KURERA	P(2)	2	T(1)	PH(2)			ED
20.	DOL	P(1),M(1)	1	T(1),S(1)	PO(1),PH(1)	BS		ED
21.	ROHAL	P(2)	2	T(1)	PH(2)	BS		ED
22.	TAPNALA	P(2)	2	T(1)	PH(2)			ED
23.	AMKAN	P(1)	2	T(1),HP(1),TW(1)	PH(2)		AP	ED
24.	CHHILAG	P(1)	2	T(1)	PH(1)	BS	AP	ED
25.	KOTU DHORIAN	P(2)	2	T(1)	PH(1)	BS		
26.	AMRED	P(2)	2	T(1)	PH(1)	BS		
27.	JAMULI	P(2)	2	T(1)	PH(1)	BS		
28.	GHARNA	P(1)	2	T(1)	PO(1),PH(1)	BS		ED
29.	DAGLEHR	P(2)	2	T(1)	PH(2)			ED
30.	CHARAMBU	P(2)	2	T(1),HP(1)	PH(1)	BS		ED
31.	KUWALI	P(1)	2	T(1)	PH(2)			
32.	MARIARI	P(2)	2	T(1)	PH(2)			
33.	SHIV PUR	P(2)	2	T(1)	PH(2)			

Table 3.6.4 Contd…

Sr. No.	Village	Educational Institutions	Medical Facilities	Drinking Water Supply	Commu-nication	Transpor-tation	Approach Road	Power Supply
34.	JUJHPUL	P(1)	2	T(1)	PH(2)			
35.	TIPRI	P(2)	2	T(1)	PH(2)			ED
36.	DUHK	P(2)	2	T(1), S(1)	PH(2)			ED
37.	SAOLI	P(1)	2	T(1), S(1)	PH(2)			ED
38.	BHATAWAN	P(1),M(1),H(1)	2	T(1), S(1)	PO(1),PH(1)			ED
39.	CHAUNKI	P(1)	2	T(1) S(1),	PH(2)			ED
40.	KADEHR	P(2)	2	T(1)	PH(2)			
41.	SURANI	P(1)	1	T(1)	PO(1),PH(1)	BS	AP	ED
42.	THALAKAN	P(2)	2	T(1),W(1),HP(1)	PH(1)	BS	AP	ED
43.	NAHLI	P(2)	2	T(1),W(1),R(1),S(1)	PH(1)			ED
44.	PATRELI	P(1)	1	T(1),W(1),HP(1)	PH(2)	BS	AP	ED
45.	CHHONT	P(2)	2	T(1)	PH(1)			ED
46.	HARDIP PUR	P(1),M(1),H(1)	1	T(1)HP(1))	PO(1),PH(2)			
47.	CHORI	P(2)	2	T(1)	PH(2)			
48.	PARAUNTHA	P(2)	2	T(1) ,(1)	PH(2)			ED
49.	RAJOL	P(1)	2	T(1),W(1),HP(1)	PH(2)			
50.	SALETAR	P(1),M(1),H(1)	1	T(1), HP(1)	PO(1),PH(1)	BS	AP	
51.	KOHLA	P(1)	2	T(1), HP(1)	PO(1),PH(1)	BS	AP	
52.	KALI DHAR	P(2)	2	T(1)	PH(2)			
53.	DOL	P(1)	1	T(1),W(1),HP(1)	PH(2)		AP	
54.	MAT	P(2)	2	T(1),W(1)	PH(1)	BS	AP	
55.	SIHOR PAI	P(1),M(1),H(1)	2	T(1)	PO(1),PH(1)	BS	AP	
56.	SALEHR	P(2)	1	T(1), HP(1)	PH(1)	BS	AP	
57.	GANGOT	P(2)	2	T(1)	PH(2)			
58.	DRIHN	P(1),M(1),H(1)	2	T(1)	PO(1),PH(1)	BS	AP	
59.	RESERVE JANGAL	P(2)	2	T(1),W(1),HP(1)	PH(1)	BS	AP	ED
60.	UMRI	P(1),M(1),H(1)	1	T(1), HP(1),S(1)	PO(1),PH(1)	BS	AP	
61.	TAMBAR	P(1),M(1),H(1)	1	T(1), W(1),S(1)	PO(1),PH(1)	BS	AP	ED

Source: Village Directory (2001), Himachal Predesh.

Abbreviations

Education
P : Primary school
M : Middle school
H : High school
C : Collage

Road
AR : Approach Road

Drinking water
T : Tap water
W : Well water
TW : Tube water
HP : Handpump
S : Spring
R : River

Transport facility
BS : Bus service

Post and telegraph
PO : Post office
PH : Telephone connection

Power Supply
ED : Electricity for domestic purpose

Table 3.6.5

Panchayat wise No. of Birth and Death in Study area

Sr. No.	No. of Panchayat	Birth	Birth Rate	Death	Death rate
1.	Aluha	37	17.8%	22	10.6%
2.	Gharna	52	21.3%	18	7.4%
3.	Khundian	31	11.8%	14	5.3%
4.	Rajol	10	6.9%	7	4.8%
5.	Surani	45	19.7%	17	7.4%
6.	Tihri	43	16.2%	20	7.5%
7.	Tippri	20	17.1%	7	6.0%

Source: Statistical Report,2006. Health & Family Welfare Department, Himachal Predesh

Table 3.6.6

Quality of Life Existing in the Area

S. No.	Villages	$QoL_{(s)}$	$QoL_{(o)}$	QoL(c)
1.	Sarab Nati	0.48	0.50	0.49
2.	Karal	0.49	0.51	0.50
3.	Aluha	0.47	0.49	0.48
4.	Tihri	0.45	0.47	0.46
5.	Gharna	0.47	0.49	0.48
6.	Kuwali	0.49	0.51	0.50
7.	Nahli	0.47	0.49	0.48
8.	Kali Dhar	0.49	0.51	0.50
9.	Salehr	0.47	0.49	0.48
10.	Jawalamukhi	0.53	0.55	0.54
	Average	**0.48**	**0.50**	**0.49**

$QoL_{(S)}$ - Subjective Quality of Life
$QoL_{(O)}$ - Objective Quality of Life
$QoL_{(C)}$ - Cumulative Quality of Life

Chapter 4

Anticipated Environmental Impact and Mitigation Measures

4.1 Environmental Impacts Associated with Drilling

The major element involved in the process of environmental impact assessment is identification as it leads to other elements such as quantification and evaluation of impacts. Although, in general number of impacts can be identified while describing the project, all the impacts may not be considered significant. Hence it is necessary to identify the critical impacts that are likely to cause significant impact on various components of environment due to proposed exploratory drilling.

A number of techniques are available for identification of impacts. In the present case for the activities proposed to be carried, adaptation of “Network Method” which involves understanding of cause-condition-effect relationship between an activity and environmental parameters for identification of impacts has been found to be most appealing tool.

The detailed list of activities and actions described earlier in this report has been taken into consideration for generation of cause-condition-effect network (i.e. chain of events). This type of method has been basically advantageous in recognizing the series of impacts that would be triggered by the proposed activities. Thus, this method has provided a “roadmap” type of approach to the identification of second and third order effects.

The idea was to account for the project activity and identify the types of impact, which would initially occur. The next was to select each impact and identify the secondary and tertiary impacts, which induced as a result. This process was repeated until all possible impacts were identified. The greatest advantage of this type of approach was that it allowed identifying the impacts by selecting the tracing out the events as they are expected to occur.

While identifying the impact networks for drilling operations in the study area all significant activities such as land acquisition, road/site clearance, drill site preparation, diesel generation sets, waste pits well development and work over operations have been accounted for. The availability of energy resource (oil/gas) the end product has been considered for the purpose of economic benefits.

The identified impacts for various components of environment viz. air, noise, water, land an socio-economic are presented in **Figs. 4.1-4.5** respectively. The comprehensive environmental impact network for proposed exploratory drilling in Kangra-Mandi Block is presented in **Fig. 4.6**. It is to be noted that in these illustrations the lines are to read, as “has an effect on”.

Several scientific techniques and methodologies are available to predict impacts of physico-ecological environment and socio-economic environment. Mathematical Air Environment models are the best tools to quantitatively describe the cause and effect relationships between sources of pollution and different components of environment. In case, it is not possible to identify and validate a model for a particular situation, predictions could be arrived based on extrapolations.

4.1.1 Air Environment

For the purpose of impact predictions on air environment emission sources can be classified into point and area sources. There are no areas sources considered for the purpose of predictions. The point sources identified are diesel generator sets at drill sites. These will be in operation 24 hours a day. Emissions from the generators will consist of mainly CO_2 and water and contain traces of NO_x, SO_2 and suspended particles. The concentration of SO_2 in the emitted gas will depend on the fuel source. Since diesel contains little sulphur, using diesel as fuel will lead to low SO_2 emissions. Emissions are expected during temporary well flaring in the event gas is discovered.

The meteorological data has been used for predictions for impacts of NO_x on air environment; an inter-active model that estimates short-term concentrations for a number

of arbitrarily located receptor points at or above ground level due to the point sources was used.

Modelling has been done for a test flare when 2000 m^3 gas could be flared in the event of a gas discovery. It has been estimated that maximum of 60 $\mu g/m^3$ of NO_x would result as GLC during 30 minutes of flaring. The maximum NO_x concentration of 30 $\mu g/m^3$ is generally found to occur in close proximity of the drill site due to operation of diesel generator.

4.1.2 Noise Environment

For hemispherical sound wave propagation through homogenous loss free medium, one can estimate noise levels at various locations due to different sources using model based on first principle.

$Lp_2 = LP_1 - 20 \text{ Log } (r_2 / r_1) - Ae_{1,2}$ ……………………………………(1)

Where Lp_2 and LP_1 are sound levels at points located distance r_1 and r_2 from the source $A_{e1,2}$ is the excess attenuation due to environmental conditions. Combined effect of all the sources can be determined at various locations by logarithmic addition.

It has been observed that generally all the noise sources in a rig installation are scattered in an area of about 100 m x 100 m. As the proposed drilling operations are carried out at 0.5 to 1.0 km away from the human habitation, the first approximation one can assume that for general population in the village, every drilling site is a "point" source of noise.

The average equivalent sound level of such a point source can be estimated by measurements of noise levels at approximately 50 meters in different directions from a hypothetical source by applying equation:

$Lp = Lw - 20 \log r - Ae - 8$ ……………………………………(2)

Where, Lw is sound power level of the source, Lp is sound pressure level at distance r and Ae is the environmental attenuation factor. The noise level at different location can be calculated using equation (2) for averaged equivalent noise source. The asymmetry of the source gets masked in this model due to working approximation, but it is allowable for distant receptors (>1 km).

When a mechanical rig is in operation at its maximum efficiency, the drilling platform (derrick) can be assumed as the location of the hypothetical source of noise at the drill site where maximum noise levels are recorded (102 dBA). Further the noise levels recorded in various directions at distance 50 m can be used for estimation of

magnitude of the average noise equivalent source. Noise level due to such a source works out to be 44 dBA at a distance of 1 km (**Table 4.1**). As environmental attenuation, particularly due to air absorption and crops/grass/shrubs cannot be neglected the levels will work out to be less by 7 to 10 dBA depending on the nature of vegetation, relative humidity and frequency of the noise. Therefore average noise levels at about 1 km from the drilling rigs would be around 37-44 dBA. The overall background noise levels would increase by 3-4 dBA and 2-3 dBA during day and night time respectively due to drilling operations. Deployment of electrical rigs would minimize the noise levels and impact can be minimized.

Day night sound level, Ldn is often used to describe community noise exposure which includes 10 dBA night time penalty. As per WHO recommendations there is no identified risk in damage of hearing due to noise levels less than 75 dBA (Leq 8 hrs). Most of the international damage risk criteria for hearing loss permit Leq (12 hrs) up to 87 dBA. Further, WHO recommendations for community noise annoyance, permits day time outdoor noise levels of 55 dBA Leq, and night time outdoor noise level of 45 dBA Leq to meet steep criteria i.e. Leq (24 hrs) = 52.2 dBA and Ldn = 55 dBA.

The damage risk criteria for hearing, as enforced by OSHA (Occupational Safety & Health Administration) to reduce hearing loss, stipulate that noise level up to 90 dBA are acceptable for eight hours exposure per day. At places except the drilling platform, continuous attendance of workers is not required. Hence, the noise levels only at the drilling platform are of concern for occupational consideration.

4.1.3 Land Environment

During the drilling operation, two major sources of solid wastes are envisaged: (i) drill cuttings, separated on a shaker (vibrating screen) which is a part of solids handling system attached to rig and (ii) rejected drilling mud with sand and silt separated in desander and desilter:

The mud used in drilling operation serves multiple functions such as: (i) to remove and carry the drill cuttings to surface, (ii) lubricate and cool the drill bit and suspension string, (iii) sealing of well wall and (iv) to balance formation pressure besides many other functions. Anticorrosion and anti-scaling agents such as ferrochromes, organopolyphosphates and amine derivates may be added. A total of approximately 700 m^3 of drilling mud is required for drilling. Some percentage of this mud will be recycled for use on subsequent wells.

Drill cuttings from the well are allowed to collect in the sump below the shale shaker and removed periodically whereas mud is recovered and sent to recycling tanks. Around 5 to 10 T/day of drill cutting are expected to be generated depending on type of formation and drill performed. Drill cuttings are washed before leaving shale shaker for recovery of attached mud. Though some mud particles are likely to be associated with drill cuttings, the overall nature of solids will be highly inorganic.

Mud portion, which is recovered in shale shaker, passes through desander and desilter where sand silt is removed by centrifugal action. The sand silt generated at this unit is contaminated with mud particle and is allowed to flow to waste pit by washing it down. These solids contain mainly bentonite, barite and small portion of organics along with heavy metals. These solids accumulate at the bottom of waste pit and posses the characteristics of natural earth materials shown in **Table 4.2**. Quantity of rejected fine sand, silt and mud is expected to be 200-250 kg/day and on an average 25 m^3/day wastewater will be generated.

It is anticipated that approximately @ 200-300 m^3/day of drill cuttings will be generated during drilling operation. It is planned to wash the drill cuttings and dispose it into lined waste pit and covered by native soil.

In order to predict the environmental impacts due to drilling mud reject pits, simulating field conditions carried out laboratory studies. The studies included investigation of leaching potential of possible hazardous constituents from these sources.

Subsurface soils were collected from the Ganga Basin and experiments for investigations of leaching potential of drilling mud and wastewater were carried out in laboratory. Since pH and alkalinity can directly affect the solubility of many parameters, especially the metals, the comparison of the two gave some indications of the mobility of the metals. Generally, solubility of metal decreases with increase in pH and alkalinity. On application of the drilling mud and wastewater to soils, this was found to be true as soils were alkaline in nature. The transportation of ions revealed that Na, Cl and metals would tend to be slightly elevated in subsurface soils close to the mud pits or emergency wastewater impoundments, however, most parameters will not migrate any significant distance away from the disposal/temporary storage facilities. Na, Cl was the only ions to show definite vertical migration through subsurface soils, specific conductance was used as the characteristic of zones with elevated ions.

The studies further revealed that amendment of drilling mud with subsurface soils also increases its water holding capacity and cation exchange capacity. Thus, drilling mud could benefit vegetative production. This could be attributed to the fact that

the drilling mud are by design impermeable suspensions of clays which form an even more impermeable contact surface between the mud and native soils.

As a result of these characteristics, the potential for leaching of constituents from mud pits is hypothetically negligible. In mud pits migration of constituent will be dominated by surface runoff rather than by percolation of precipitation downward through the relatively impermeable drilling mud clays.

4.1.4 Water Environment

It is estimated that approximately 700 m^3 of drilling fluid will be formulated during the course of one exploration well to be drilled. Drilling fluid or mud is basically a mixture of water, clay, polymers and weighting material with all individual components being environmentally friendly. This mud will be reused as much as possible. The mud circulation is a closed loop with the return mud going back to the mud tanks. At the end of drilling operations, the residual (unusable) mud is discharged in to the waste pit.

In order to estimate the effects of surface water runoff/ overflow of waste from the storage pits on aquatic ecosystems, short-term bioassay studies were carried out. The effects of toxic substances on fish food organisms are vital factors in determining whether fish can flourish or survive in polluted water, as in many cases the lower organisms upon which fish depend are even more susceptible to a poison than are the fish themselves. In order to predict the impacts, bioassay tests were conducted on algae (Scenedesmus), Zooplankton (Daphnia and Cypris) and fish (Lebistes reticulatus) on laboratory scale.

Pure culture of the organisms was used for the test and they were exposed separately at various dilutions of the waste. The result indicated that the waste was not toxic to algae. The growth of algae was stimulated in 30% within a period of 5 days. Among other organisms tested, the fish and Daphnia were the most resistant and susceptible to the waste. At 100% waste only 20% fish died in 48 hours.

Life cycle test with the juveniles (less than 24 hrs) of Daphnia was conducted through two generations at two nutrient fortified concentrations (50% & 80%) of waste in laboratory (31°-32°C) for 12 days. Only one juvenile was added at each concentration and control on zero day. Daphnia got matured and released 6 offspring (neonates) asexually at each toxicant level and control in fifth day. The parent Daphnia at 80% waste died on fifth day. However, in second generation 12% more and 33% less neonates were recorded at 50% and 80% waste respectively on twelve day. It was thus concluded that the waste at 50% dilution did not impair the growth of Daphnia.

Algal bioassay of mixed algal species showed that green and blue green algal species are much more resistant to drilling pit waste and water soluble fractions of crude oil, while diatoms and desmids are highly susceptible to these wastes. When exposed to these wastes phytoplankton community is dominated by green and blue-green algae only. These studies indicate that the phytoplankton community structure would change if surface run off of waste fluids present in waste pits mixes with surface water. Since, lined pits will be used for solar evaporating the drilling mud, the chance of run off are very less.

4.1.5 Biological Environment

Terrestrial Environment

Prediction of Impact on Biological Environment due to any developmental activity is practically difficult because:

- Living subjects has a natural variation in numbers, changes in numbers cannot always be directly attributed to changes in the environment
- Most of the impacts on the living system or ecosystem takes long time period to become fully visible externally

As such, the forests are getting vanished and the growing industrialization will affect the plant life due to industrial pollution load and influx of population. Therefore to minimize the adverse effect; it is proposed that the adequate management of these forest be taken up in a systematic manner.

The natural vegetation in the study area is not considerable. It will be affected due to increased pollution loads; however, it will improve due to follow up of Environmental Management Plan (EMP). Mangrove vegetation does not exist in the area hence no changes are anticipated.

Crops are grown in small portion of the study area and due to increased air pollution; some reduction in crop- yield is anticipated. However, with the construction of green belt and with the implementation EMP, restoration in crop-production is anticipated.

As regards species diversity, it is not significant due to very limited number of species present. No significant changes are anticipated due to drilling operations, however, due to EMP the conditions are expected to be improved because of green belt development. There are no rare and endangered plant and animal species in the study area and hence no changes are anticipated.

As regards soil microbiology, disposal of oil bearing waste may lead to changes in soil microbial conditions of adjacent area which is likely to be restored due to follow up of EMP.

Aquatic Environment

There are no rare and endangered aquatic species and hence no change will occur. The characteristics of the water bodies may not change significantly with and without EMP.

In general, due to operation of drilling, adverse impacts are anticipated in biological environment. Aquatic environment is likely to be affected more adversely than the terrestrial environment without EMP. However, with the proper follow up of EMP there will be significant improvement in biological environment covering terrestrial and aquatic ecosystems.

4.1.6 Socio-economic Environment

Critically analyzing the existing status of socio-economic profile vis-à-vis its scenario with proposed project, the impacts of the project would be of varying nature. The predicted impacts are as follows:

- The proposed activities would generate indirect employment in the region like workers will be required in site preparation and drilling activities, supply of raw material, auxiliary and ancillary works which will marginally improve the economic status of people
- The commissioning of project would lead to improvement in transport facilities as loose or soft surface rural roads and trails will be upgraded to facilitate movement of the drilling rig and supply vehicles
- In the event of commercial quantities of gas are discovered, more long term employment opportunities would be created and gas production would increase availability of gas to various industries in this region

4.2 Assessment of Significance of Impacts

4.2.1 Environmental Impact Evaluation

4.2.1.1 Ecology

Agricultural and fishing activities form the source of livelihood for residents living in proximity to the identified drilling areas of the Block. Minor and Major industry in the block area as source of employment for persons living in the area. Sugarcane, jowar and cotton field covers most of the area. The impacts on ecology of this area will be marginal

because the land has vegetation cover in the form of Prosopis Plant and vegetation are scattered.

4.2.1.2 Environmental Pollution

As the EMP recommends appropriate treatment and disposal of wastes, there will be negligible adverse impact on aquatic environment.

The air quality of area under reference will not be altered. However, control measures are proposed in environment management plan to mitigate any adverse impact. It has been proposed to plant select trees for trapping toxic hydrocarbons. It is proposed to re-establish crops, in most cases cane, consistent with prior use pattern on all well sites at the development phase of the project.

The evaluation of impacts on the land environment indicates some adverse impacts, as the proposed activities will contribute towards soil erosion and fertility however, the measures suggested in EMP would mitigate such adverse impacts.

Noise levels due to transportation would not rise. The noise levels are likely to increase (5-10) dB (A) near the drill site posing occupational health problems but the nearby population will not get affected.

4.2.1.3 Aesthetics

The proposed well sites will be restored to their former land use on abandonment such that no impacts to local aesthetics will occur. For any wells eventually put into production there would be minor facilities placed at wellhead. The other aesthetic parameters will show marginal effects.

4.2.1.4 Socio-economics

The impact on community health due to the proposed drilling activities is negligible but the social status will improve due to increase in employment opportunities. There will be positive impact on sanitation, transportation, communication and community health in the region. There will be occupational hazards due to proposed activities but these hazards will reduce through implementation of precautionary measures suggested in EMP.

4.3 Environmental Impact Statement

The impact statement focuses on the study area within block boundary of the proposed drilling sites. The five basic environmental components of concern are:

- Air Environment
- Noise Environment

- Water Environment
- Land Environment
- Socio-economic Environment

For each of the above components of environment, the impacts are identified through cause-condition network predicted through appropriate mathematical models and evaluated through environmental evaluation system.

4.3.1 Air Environment

The impacts on air emissions arising out of proposed activity are mainly due to construction activity, flaring and emissions from DG sets. These will have no adverse impact and it is anticipated that this will lead to marginal increase in SPM, NO_x, etc. also the activity is temporary in nature. The prediction of impacts due to oxides of nitrogen and hydrocarbons which lead to secondary air pollutants is difficult, because of contributions from other existing industries and those coming up in that region. However, the impact of these parameters will be negligible from the proposed activity since the terrain is plain and sufficient amount of atmospheric mixing is available in that region.

4.3.2 Noise Environment

The impact of noise generated by the drilling on the general population is expected to be insignificant. On the basis of expected noise levels calculated through standard attenuation model, it is observed that the noise levels in the region would be within the standard limits (IS: 4954). The increase will only be marginal in comparison to the existing noise levels.

The estimated background noise levels in the villages near the drilling site varied between 38 and 45 dB(A) and in sensitive places varied from 30 to 40 dB(A). It is estimated that the general noise levels near the drill site will vary from 30 to 45 dB (A). The impact of the noise on general population is therefore expected to be insignificant.

4.3.3 Land Environment

The proposed drilling activity will lead to temporary and minor soil erosion and loss of agricultural land.

4.3.4 Water Environment

No significant impacts on water quality are envisaged due to discharges of wastewater if properly treated as the baseline status show low dissolved solids, total hardness, chloride, sulphate, sodium, potassium and nutrients.

Groundwater quality around the drilling sites shows alkaline nature with a pH range of 7.4 to 8.7. The general quality of water is mineralized with phosphate and nitrate concentrations of groundwater are well within the prescribed limits.

4.3.5 Biological Environment

Vegetation in the vicinity of the drilling sites will not get affected by proposed drilling because of marginal change in ambient air quality. Re-establishment of crops by natural means is expected to adequately mitigate the impact due to emissions of pollutants.

4.1.6 Socio-economic Environment

The Proposed Exploratory Drilling Project activities in near Tihri village would bring forth certain socio-economic impacts (**Table 4.3**). Some of the impacts would be directly beneficial to the socio-economic environment due to employment potential, improvement in infrastructural facilities, whereas some of them would be of adverse nature.

The positive impacts due to proposed Exploratory Drilling project activities in the region would be:

Positive Impacts

- 70% respondence has favorable ranking about the proposed exploratory drilling project
- Proposed project would help to fulfill the Oil and Gas demand in the industrial sector of the region which will ultimately improve the backwardness of the region
- Increase in job opportunities operational phase for the qualified and skilled as well as unqualified and unskilled people in the study area will have distinctive impact on the socio-economic development of the region
- Enhanced infrastructure facilities, better employment opportunities the overall quality of life of the people will be upgraded
- Development in housing, medical facilities, market, education, power supply, transport and cultural in the study area
- The proposed project is expected to contribute to improvement of quality of life in the region (**Tables 4.4-4.5**).

Negative Impacts

- The project activity may disturb the Quality of air, land and water if not properly managed
- The project activity would create pollution in the area during the construction period if adequate care is not taken for pollution prevention
- Disturbance to human and wildlife, due to the vehicle and drilling equipment can create noise pollution in operation phase if proper abatement measures are not adopted
- Change in the local socio-economic environment due to increased activities

4.4 Mitigation Measures

- It is recommended that all equipment is operated within specified design parameters during construction and operational phases. This can be achieved by minimizing the duration of testing through careful planning and using high combustion efficiency, smokeless flare/ burners
- It is recommended that while deploying major noise generating equipment such as diesel generators etc. It should be checked that all mufflers are in good working order and that the manufacturers have taken the normal measures for minimizing the noise levels
- Noise barriers/shields in the form of well berm should be provided around the units wherever possible
- Use of ear muffs/plugs and other protective devices should be provided to the workforce in noise prone areas
- Wherever generator noise occurs in proximity to human settlements, sound deadening barriers must be provided
- The effluents (wastewater) generated during drilling operations are recommended to be collected in lined waste pits to avoid groundwater contamination
- The additional manpower requirement for drilling activities will increase employment opportunities for the local population, thus improving their social status

Table 4.1

Noise Exposure Levels for Drilling Rigs

	Mech. Rig	Elect. Rig (dBA)
Occupational Exposure		
Leq (12 hrs) (on the derrick)	83	71
Leq (12 hrs) (within the premises)	72	60
Human Settlement Exposure		
Leq (24 hrs) (villages 1 km away)	44	37
Ldn (village 1 km away)	46	39

Table 4.2

Characteristics of Typical Solid Wastes Produced at the Drill Site (Dry Weight Basis)

Parameters	Drill Cuttings	Sludge in waste pit (2-3 m depth)
Moisture (%)	2-10	70.0
pH	7.2	8.0
Loss on ignition	19.2	9.0
Total nitrogen (%)	0.05	0.1
Total phosphorus (%)	0.10	0.03
Manganese (mg/kg)	320.0	224.0
Copper (mg/kg)	90.0	34.0
Lead (mg/kg)	8.0	15.0
Nickel (mg/kg)	70.0	36.0
Zinc (mg/kg)	45.0	37.0
Iron (%)	1.52	0.92

Source : NEERI Report (Primary Data)

Table 4.3

Predication of Qualitative Impacts on Socio-economic Environment

Parameter	Local	Regional	Direct	Indirect
Employment	+	•	+	+
Income	+	•	+	+
Transport	-	•	+	+
Education	+	•	+	+
Medical facilities	-	•	+	+
Communication	+	•	+	+
Sanitation	-	•	-	•
Housing	+	•	+	+
Agriculture	+	•	•	-
Cost of living	+	•	+	+
Environmental Pollution	+	•	•	+
Recreation	+	+	•	+

+ : Positive Impact
- : Negative Impact
• : Insignificant

Table 4.4

Expected Change in Subjective Quality of Life

Sr. No.	Villages	QoL (s) Existing	QoL (s) after EMP welfare measure
1	Sarab Nati	0.48	0.51
2	Karal	0.49	0.52
3	Aluha	0.47	0.49
4	Tihri	0.45	0.47
5	Gharna	0.47	0.50
6.	Kuwali	0.49	0.51
7.	Nahli	0.47	0.49
8.	Kali Dhar	0.49	0.50
9	Salehr	0.47	0.50
10	Jawalamukhi	0.53	0.57
	Average	**0.48**	**0.50**

QoL(s): Subjective quality of Life

Table 4.5

Expected Change in Cumulative Quality of Life

Sr. No.	Villages	QoL (c) Existing	QoL (c) after EMP welfare measure
1.	Sarab Nati	0.49	0.52
2.	Karal	0.50	0.53
3.	Aluha	0.48	0.50
4.	Tihri	0.46	0.49
5.	Gharna	0.48	0.51
6	Kuwali	0.50	0.52
7	Nahli	0.48	0.51
8.	Kali Dhar	0.50	0.53
9.	Salehr	0.48	0.51
10.	Jawalamukhi	0.54	0.57
	Average	**0.49**	**0.51**

QoL(c): Cumulative quality of Life

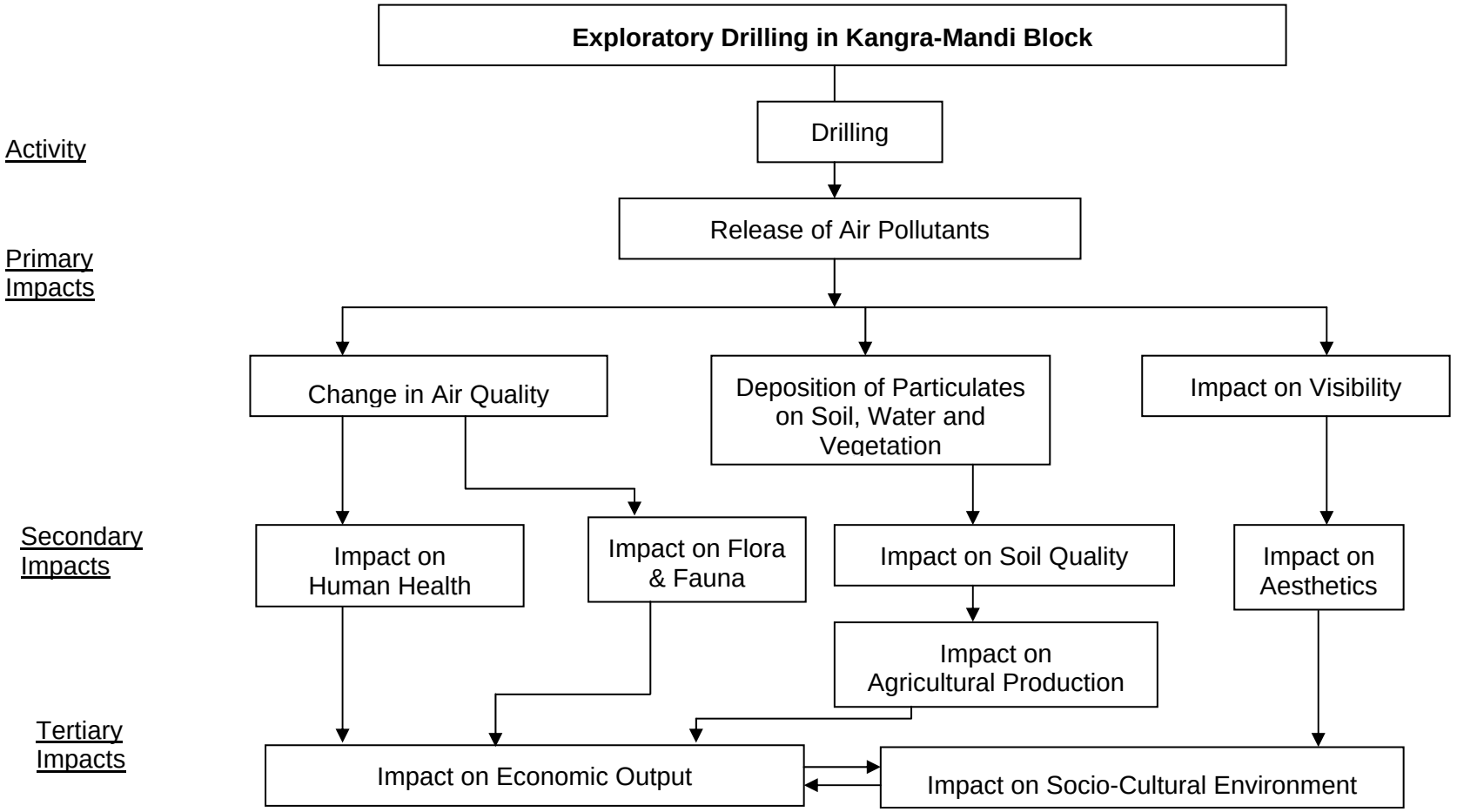

Fig. 4.1: Impact Network for Air Environment

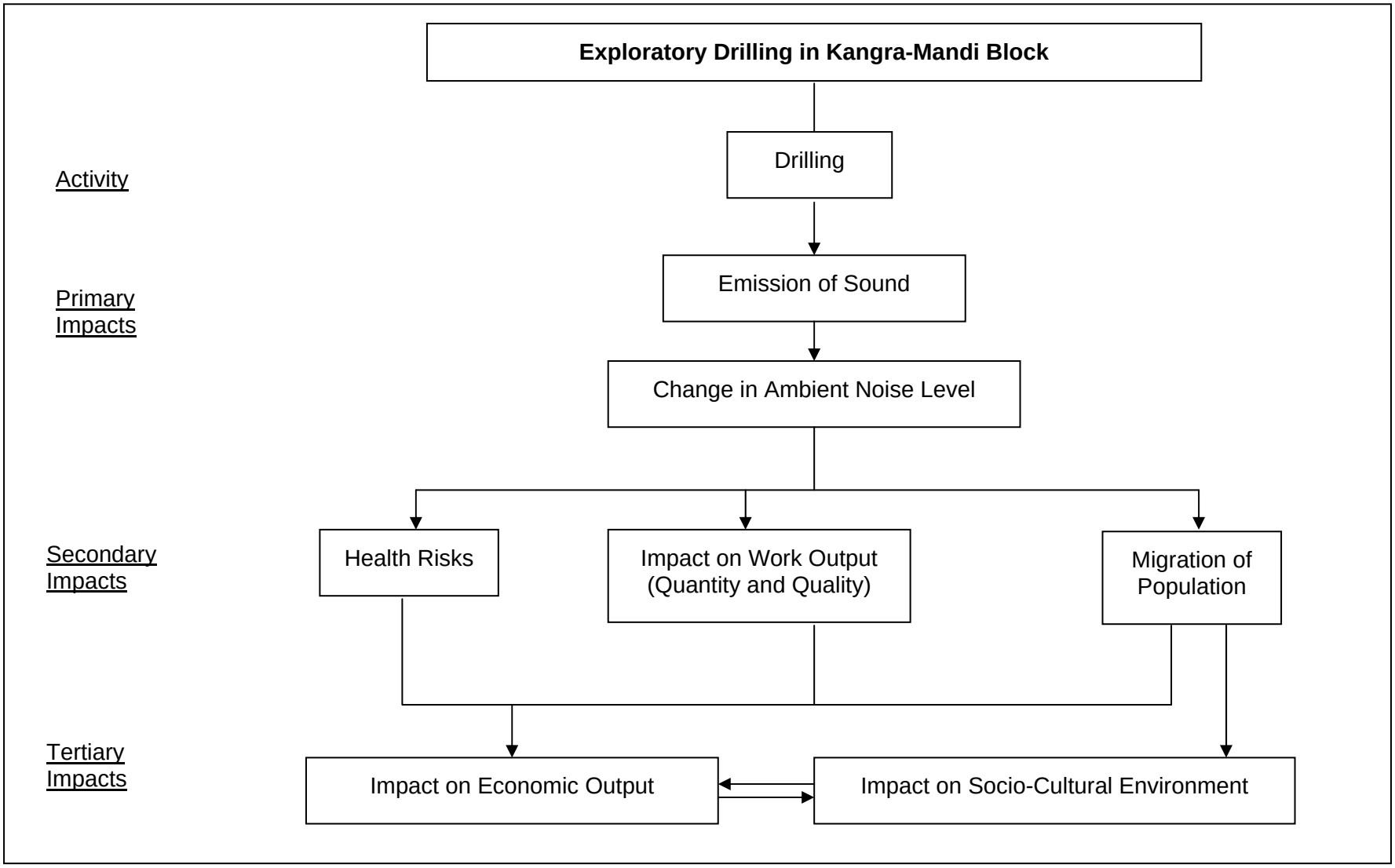

Fig. 4.2 : Impact Network for Noise Environment

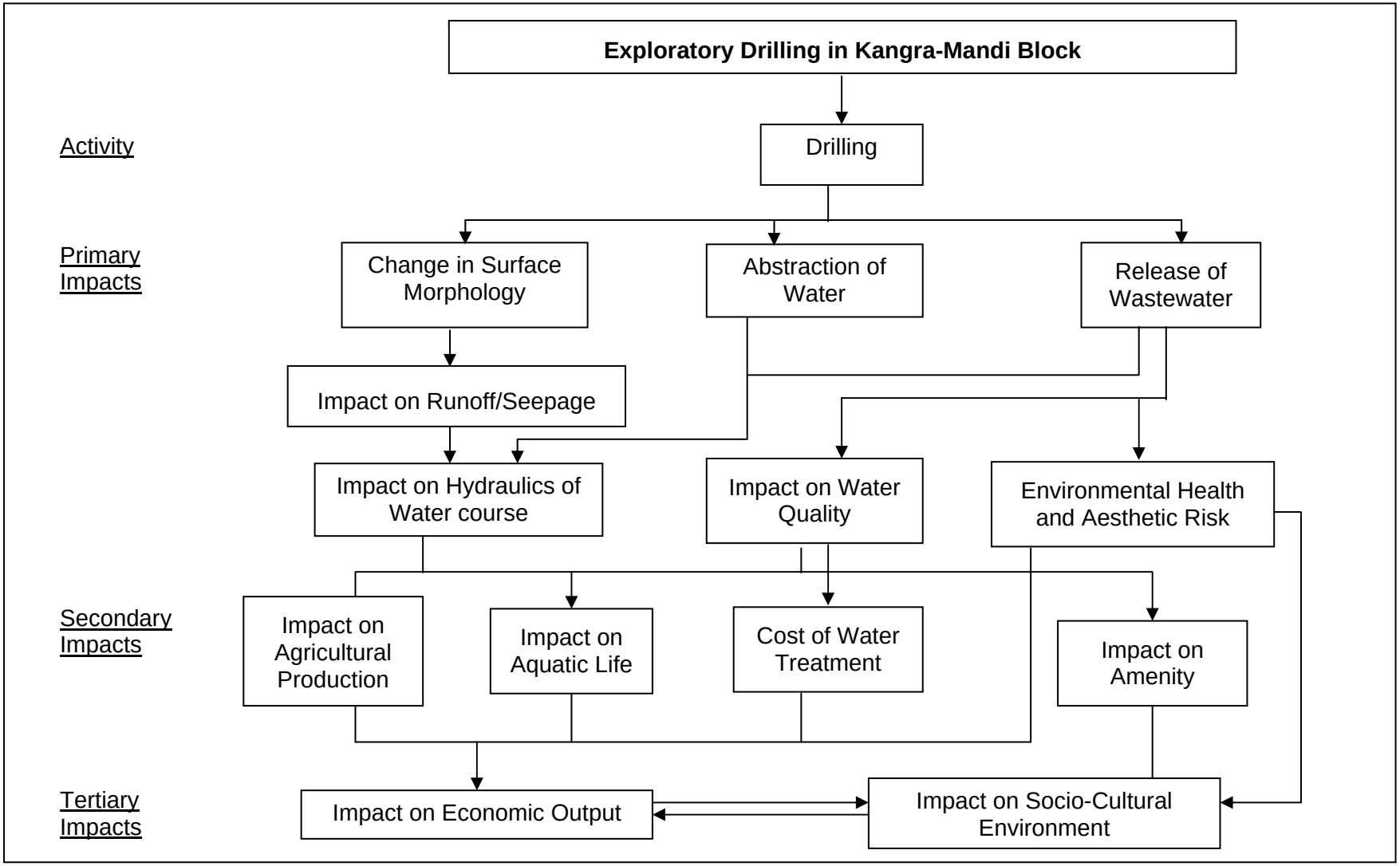

Fig. 4.3 : Impact Network for Water Environment

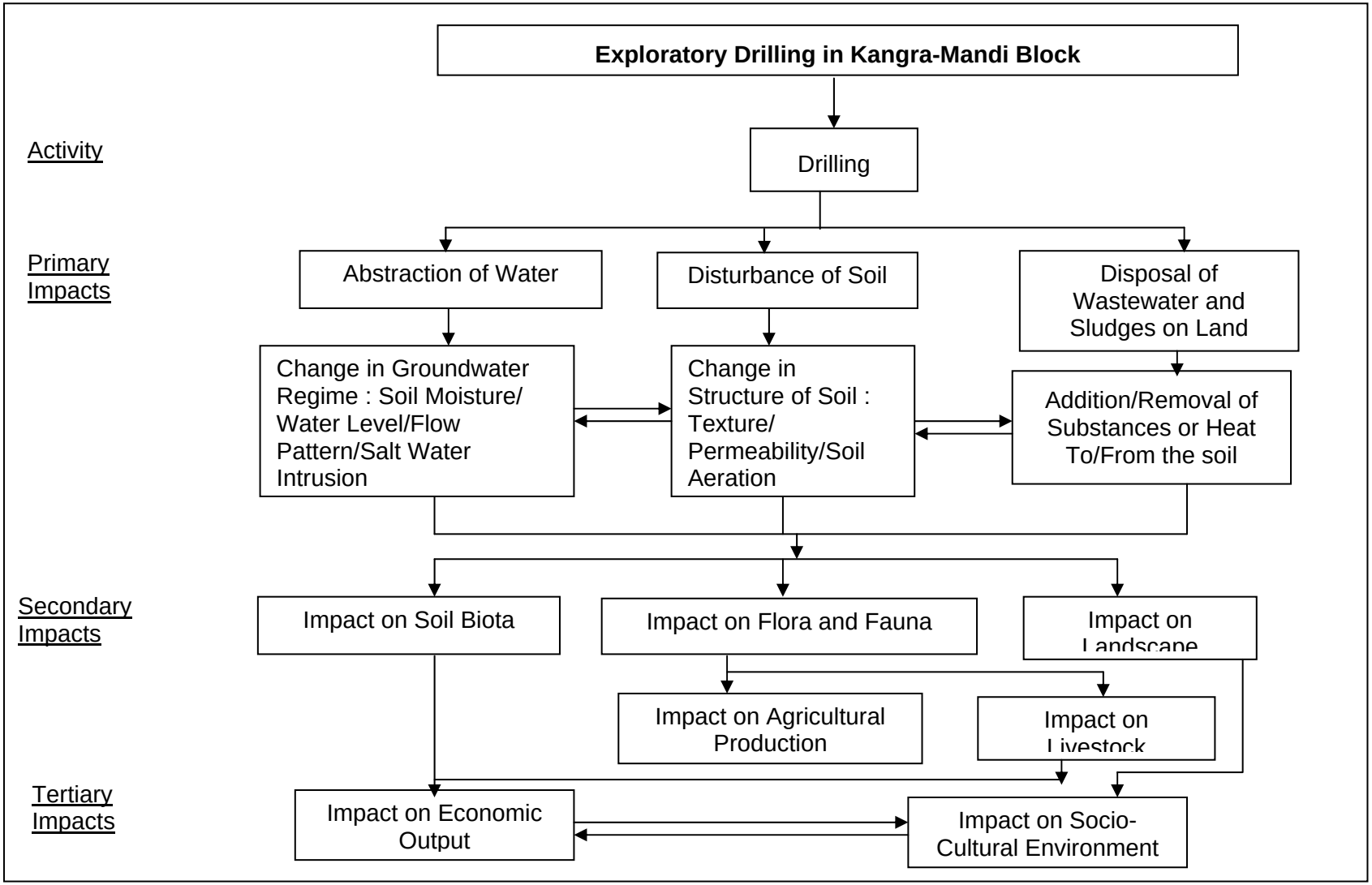

Fig. 4.4 : Impact Network for Land Environment

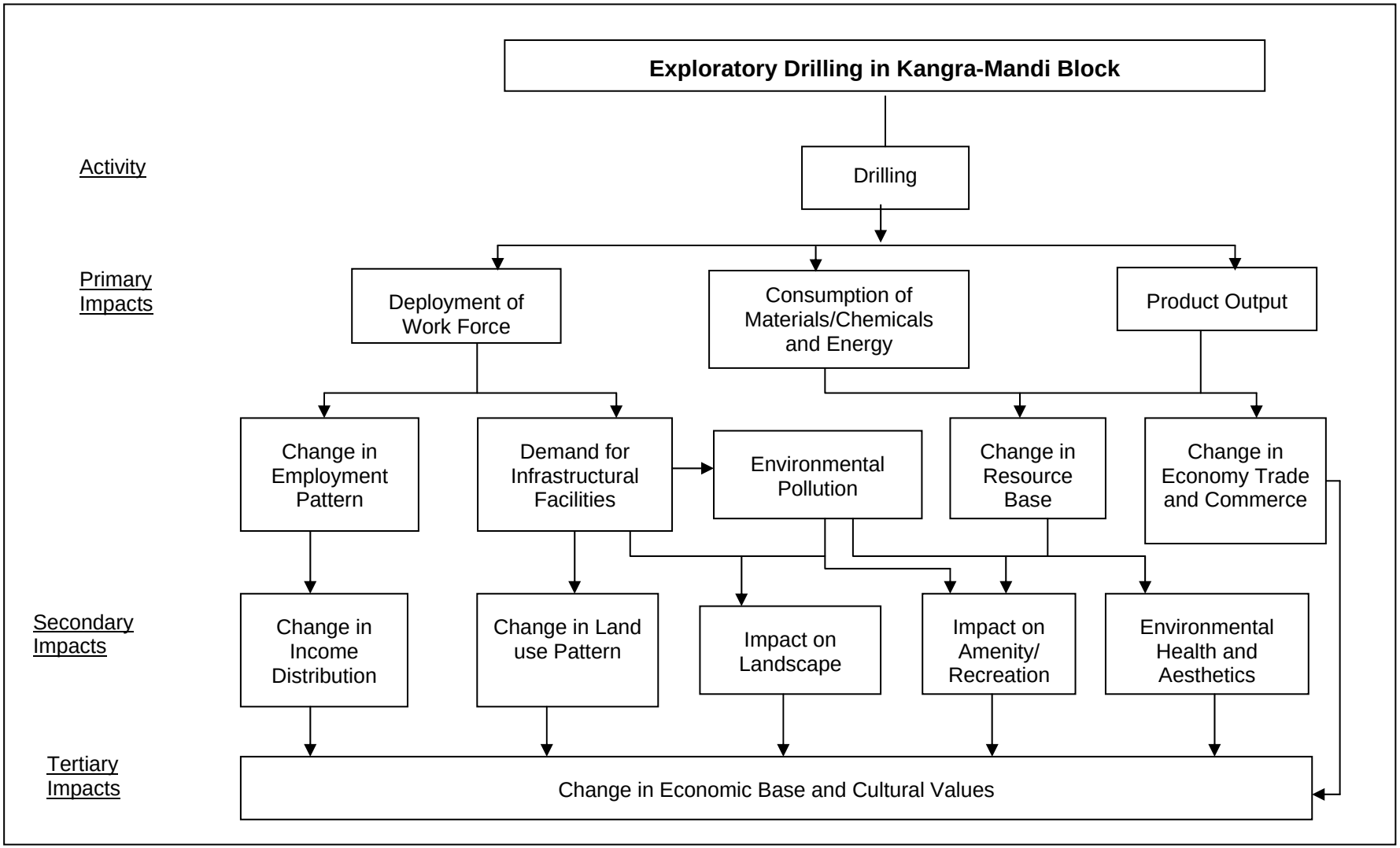

Fig. 4.5: Impact Network for Socio-economic Environment

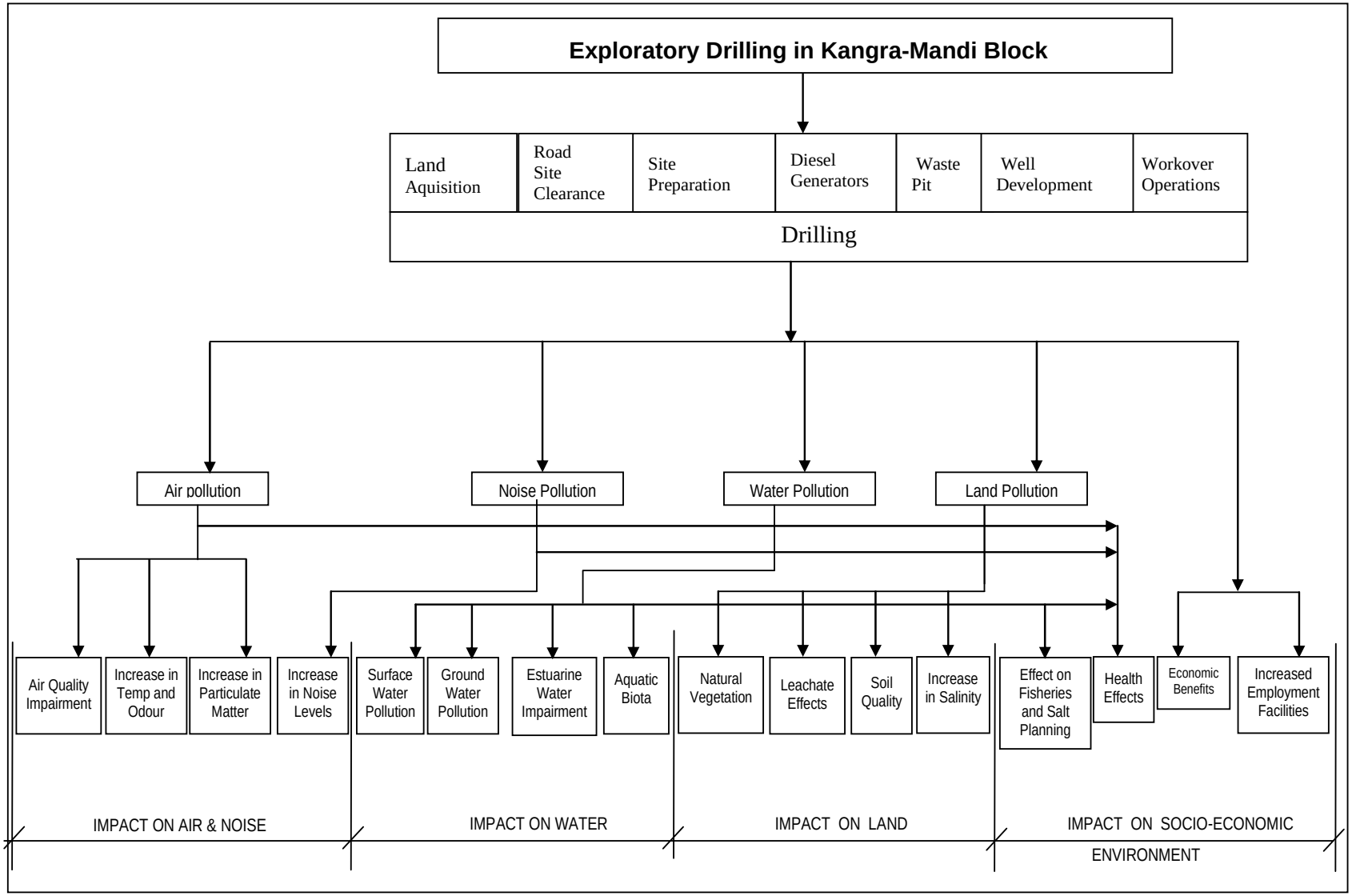

Fig. 4.6 : Comprehensive Environmental Impact Network

Chapter 5

Environmental Management Plan

The EIA for the proposed exploratory drilling programme has identified a number of impacts that are likely to arise during the site preparation, well testing and demobilization. The EIA has examined biophysical and socio-economic effects of the proposed activity from site clearance and preparation of the site and testing through to abandonment, demobilization and restoration. On evaluation of environmental impact, it is observed that the real benefits of proposed activity can result only if the risks of pollution are minimized. This can be accomplished through implementation of adequate preventive and control measures.

Where adverse impacts have been identified, the EIA has examined the extent to which these impacts would be mitigated through the adoption of industry standard practice and guidelines and following local legislative requirements. The Environmental Management Plan (EMP) describes both generic good practice measures and site specific measures, the implementation of which is aimed at mitigating potential impacts associated with the exploratory drilling activity.

The EMP provides a delivery mechanism to address potential adverse impacts, to instruct contractors and to introduce standards of good practice to be adopted for all project work. The EMP can be developed into a standalone document covering each stage of the exploratory drilling activity.

For each stage of the activity, the EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. For each impact, or operation, which could otherwise give rise to impact, the following information is presented:

- A comprehensive listing of the mitigation measures
- The parameters that will be monitored to ensure effective implementation of the action
- The timing for implementation of the action to ensure that the objectives of mitigation are fully met

The EMP comprises a series of components covering direct mitigation and environmental monitoring, an outline waste management plan and restoration plan.

ONGC is committed to the adoption of these measures and will carry out ongoing inspection to ensure their implementation and effectiveness by its contractors.

The exploratory drilling programme has been designed to avoid or minimize impacts to the environment. Where residual impacts remain, which may have moderate or significant impacts on the environment, mitigation measures have been prescribed in this EIA, which will either reduce the impact to an acceptable level or adequately offset it.

Based on the impacts identified, a conceptual Environmental Management Plan (EMP) is recommended as below:

5.1 General Recommendations

The present practices for mitigation of adverse impacts and technology options that can be considered to reduce the risks of marine pollution due to routine or accidental discharges of wastes are briefly described below.

5.1.1 Drilling Fluids

Drilling fluids mostly water based mud is used in exploratory drilling to maintain hydrostatic pressure control in the well and to lubricate the drill bit.

(A) Regulations

- The toxicity of chemical additives used in the drilling fluids (WBM) should be biodegradable (mainly organic constituents) and should have toxicity of 96 hr LC_{50} value > 30,000 mg/l as per mysid toxicity test conducted on locally available sensitive sea species

- Hexavalent chromium compound should not be used in drilling fluids. Alternate chemicals in place of chrome lignosulfonate should be used in drilling fluids. In case, chrome compound is used, the drilling fluids and drill cuttings should not be disposed offshore
- WBM should be recycled to a maximum extent

5.1.2 Drill Cuttings

- Drill Cuttings (DC) originating from on-shore should be separated from Water Base Mud (WBM) washed properly and unusable drilling fluids (DF) may be disposed off in a well-designed lined pit with impervious liner. The disposal pit should be provided with a leachate collection system
- Design aspects of the impervious waste disposal pit; capping of disposal pit should be informed by the oil industry to State Pollution Control Board (SPCB) at the time of obtaining consent
- In case of any problem due to geological formation for drilling, low toxicity OBM having aromatic content < 1% should be used. If the operators intend to use such OBM to mitigate specific whole problem/ SBM it should be intimated to Ministry of Environment and Forests/State Pollution Control Board
- The waste pit after it is filled up shall be covered with impervious liner, over which, a thick layer of native soil with proper top slope is provided
- Drilling wastewater including DC wash water should be collected in the disposal pit evaporated or treated and should comply with the notified standards for on-shore disposal
- Total material acquired for preparation of drill site must be restored after completion of drilling operation leaving no waste material at site. APPCB should be informed about the restoration work

5.2 Environment Management Plan

5.2.1 Air Environment

It is recommended that all equipment are operated within specified design parameters during construction, drilling and operational phases. Well testing (flaring) should be undertaken so as to minimise impacts of emissions. This can be achieved by minimising the duration of testing through careful planning.

5.2.2 Noise Environment

It is recommended that while procuring major noise generating equipment such as diesel generators etc. it should be checked that all mufflers are in good working order and that the manufacturers have taken the normal measures for minimizing the noise levels.

Use of ear muffs/plugs and other protective devices should be provided to the workforce in noise prone areas. Enclosures around noise sources may be provided depending on the size of the unit.

5.2.3 Land Environment

Soils in the region have moderate infiltration rates amenable to groundwater pollution. Considering this fact and poor ground water quality, every precaution would be taken to avoid spillages of chemicals on soils to avoid further deterioration of groundwater quality and danger to soil microbial populations in soils which are sensitive to hydrocarbon. Treated solid wastes, which have to be disposed on land, will be made on adequately prepared waste pits.

The earth cuttings (approx. 150 m^3 maximum) generated at drill site will be mostly inorganic in nature and can be used either for land filling or road making.

5.2.4 Water Environment

Wastewater generated during drilling operations would be around 30-35 m^3/d and 833m^3 per well (5000 barrels) operation. Wastewater characteristics would be of varied nature and likely to contain soil particulate matter along with organics. The treatment scheme comprises equalization, chemical coagulation, flocculation and clarification by settling and the treated wastewater will be disposed in waste pit. The effluents generated during drilling operations are recommenced to be collected in lined waste. This will eliminate any possibility of wastewater spills from waste pits to surrounding areas.

5.2.5 Biological Environment

In order to avoid adverse environmental impacts the discharge of the gaseous, liquid and particulate waste into the atmosphere must be minimized.

Destruction of natural habitat of animals should be minimum. Nesting, mating and other wildlife behavioral patterns should not be disrupted or destroyed. The removal of native vegetation has profound effects upon the natural environment and animal life. Rich and diverse vegetation in the study area should be maintained.

Attention may be given on publication of zoological articles, guides, books and monographs indicating importance of local and regional plant and animal life. Individuals who are local authorities are important resources and should not be overlooked.

- Water run off, erosion and siltation should be minimum, because these may have chronic impacts to the biota of the area.
- Special care must be taken to protect endangered and localized animals.
- Whenever necessary, wildlife habitat should be re-established or restored.

The concept of sustainable development should be accepted. This concept, if accepted widely, would seem to be the only conceivable way by which negative developmental impacts can be curtailed.

5.2.6 Socio-economic Environment

In order to mitigate the adverse impacts on social and economic aspects, due to the project, it is necessary to formulate certain EMP measures for the smooth functioning and commissioning of the project. The suggested measures are given below:

- Preference shall be given for employment of the local people during construction phase which will secure the economical life of the unemployed population on temporary basis
- Communication with the local community should be institutionalized & done on regular basis by the project authorities to provide as opportunity for mutual discussion
- Create various awareness campaigns in the community, specially related to basic health, hygiene and sanitation
- Vocational training programmes must be organized for the local people that may develop their capacity and skills and will be helpful for them in getting more employment opportunities
- Protection of persons against dust emissions during construction and transportation activities
- Welfare activities such as organizing medical check-up camps and extending facilities to local population must be undertaken
- Welfare measures may be decided and planned according to the priority and need of the community during development phase

- Environmental Awareness programmes must be organized to bring forth the environmental management measures being undertaken & the beneficial aspects of the proposed project for improving their quality of life.

5.3 Waste Management Plan

The waste management plan (WMP) covers disposal of all wastes with further reference to offsite disposal of those wastes, which cannot be dealt with onsite.

The objectives of the WMP are:

- To provide the necessary guidance for the reduction and appropriate management of wastes generated on drilling site
- To comply with all current Indian environmental regulations
- To meet industry standards on waste management and control
- To prevent occurrence of any environmental degradation within the locality due to waste handling

5.3.1 Disposal Options

The following disposal options will be available on site. However, it will be necessary to evaluate the suitability of various waste specific technologies for the site and select an option that will cause minimum environmental impact on the surrounding:

- **Landfill:** Non-hazardous inert drill cuttings and waste residual mud shall be disposed off by spreading, drying and covering as per Landfill guidelines (Waste mud and drill cuttings disposal plan)
- **Offsite Disposal:** Wastes which cannot be handled at the drilling site will be removed to a designated offsite and suitably disposed for reuse/recycling/ municipal disposal
- **Produced Hydrocarbon Flaring:** Hydrocarbons produced during well testing will be flared via a conventional burner system
- **Cuttings Solidification:** All the drilled cuttings generated during the operation will be mixed with native earth, incineration ash and an absorbent polymer to create an inert, stable, non-leaching solid which can then be buried
- **Sewage Disposal:** A sewage disposal system will be established in the campsite during the drilling operation. Being a temporary activity the sewage should be diverted to septic tank or soak pit.

The treated liquid waste will be used for agriculture purposes. The details regarding waste classification and their disposal options are described in **Table 5.1**.

5.3.2 Waste Reduction, Reuse & Recycle

Waste reduction effort will concentrate on reuse, recycling, minimization of packaging material, reduction in size of waste material and finally reduction of time spent on location via optimization of drilling efforts.

Minimization of waste material centers on reducing packaging materials. Use of large packaging such as bulk cement, barite or bentonite.

The volume of the waste material will be reduced via onsite compaction. This will reduce the number of vehicle movements required for waste removal, as well as reducing the size of the landfill required. Wherever possible, use of water will be minimized and recycled.

Plastic containers, especially those used for fluid and cementing chemicals, are prime targets for use as water containers. As some of these may contain substances, which can be harmful to humans, care will be taken to ensure that they are not removed from the drilling site intact. In general, after emptying chemical containers, which did not contain any substances, container will be punctured and eventually compacted and sent for disposal.

The drilling site will not have facilities for rinsing chemical drums containers. These containers will be fully emptied, labeled with contents and removed offsite for further handling and disposal.

Used medical wastes, inclusive of but not limited to bandage material, syringes etc., will be collected in a special collection drum to minimize manual handling. Contents of the drum will be labeled as biomedical waste and shipped offsite for treatment/ disposal.

5.4 Waste Mud & Drill Cuttings Disposal Plan

The section details recommendations and proposals for isolations, containment and disposal of drilling mud and drill solids from the exploratory program. The strategy recommended provides for maximum protection of the environment from any potential adverse impact of the drilling fluid and cuttings.

5.4.1 Waste Generation at Drill Site

Drill Mud

It is estimated that approximately 700 m^3 of drilling fluid will be formulated during the course of one exploration well (for a well of approx. 1500 m) of the type to be drilled. During fluid or mud is basically a mixture of water, clay polymers and weighting material with all individual components being environmentally friendly. The mud system is being a closed loop the mud is re-circulated and mainly retained in the well. A small quantity of residual unusable portions of mud retained in the mud tanks is disposed off at the end of drilling operations. The mud being inert material of bentonite and barite is filled in lined pits and dried. The dried mud is covered with excavated earth and native top soil.

Drill Cuttings

It is expected that approximately @ 200-300 m^3 /day of drill cuttings will be generated during the drilling of a well. Considering a specific gravity of the cuttings as the total weight will be 400 MT. It is planned to deposit the cuttings generated in the waste pit where they will be allowed to dry and finally they will be covered with topsoil.

5.5 Environment Protection and Reclamation Plan

- Construction activities will be coordinated in consultation with landowners to reduce interference with agricultural activities
- Topsoil will be stripped to color change or to plough depth and will be stored on the site. The depth of stripping will be on the basis of site specific soil survey
- If required for rig stabilization the well site will be temporarily padded with granular fill
- The drill site would be provided with sufficient sanitary facilities
- Combustible wastes generated would be burnt in a controlled manner or disposed off in an approved dump site
- Hazardous materials such as petroleum, spirit, diesel lubrication oil and paint materials required at the site during construction activities would be stored as per safety norms
- To ensure that the local inhabitants are not exposed to the hazards of construction the site would be secured with manned entry posts

- It would be ensured that both gasoline and diesel powered construction vehicles are properly maintained. The vehicle maintenance area would be so located that the contamination of surface/soil/water by accidental spillage of oil/diesel will not take place and dumping of waste oil will be strictly prohibited
- All irrigation canals and ditches encountered by the proposed well site access and well site will be maintained in a fully functional state
- No Construction material debris will be left on site

5.6 Socio-economic Environment

In order to mitigate the adverse impacts on social and economic aspects, due to the project, it is necessary to formulate for smooth functioning and commissioning of the project. The suggested measures are given below:

- Preference shall be given to local people for employment during operation phase considering their skills and abilities
- It must be ensured that the agricultural activity near the drilling sites must not get affected
- It must be ensured that the houses near to drill sites must not get affected
- Required collaboration between project authority and local bodies is necessary for the smooth functioning of the project as well as for the progress of the region
- For all the social welfare activities to be undertaken by the project authorities, collaboration should be sought with the local administrations viz. Gram Panchayat, C.D. Block office etc. for better co-ordination and also to reach to the public
- Sanitation facilities in rural area are inadequate. The unsanitary conditions cause health problems. As such it is necessary that following activities should be undertaken on priority basis
- Welfare activities such as organizing medical check-up camps and extending facilities to local population must be undertaken
- Separate and enhanced allocation of funds towards welfare activities for the local people

- Preventive measures should be taken for controlling the pollution, which may arise from the propose drilling project
- Adequate pollution control measures must be taken to keep the environment pollution free as much as possible
- Project Authority should provied educational and vocational training to unemployment youth

5.7 Plans for Well Site Operation and or Abandonment

- The site will be fenced in the event the well is successful. The well site will be reduced to approximately 30 m x 30 m for the production phase and all non-essential areas will be fully reclaimed.
- If the well becomes operational the site will be monitored and kept in a weed free state. Weed control will be achieved through either mechanical control or strategic and responsible application of an appropriate herbicide.
- In the event the well is unsuccessful the well bore will be cement plugged
- Any contaminated soils (eg. by accidental spills of fuel, lubricants, hydraulic fluids, saline produced water) will be treated on site or if necessary, be removed from the site to an appropriate landfill for further bioremediation.
- During site reclamation subsoil compaction will be relieved by scarifying, all topsoil will be evenly replaced
- On abandonment newly constructed access will be fully reclaimed unless specifically requested to do otherwise by the landowner.
- Any irrigation ditches diverted to accommodate a well site will be realigned to their pre-well site configuration in consultation with the landowner.

5.8 Drilling Program Safety Guidelines

All API, Indian Petroleum Act and Indian Mines Act shall be strictly adhered to. Drilling Contractor's safety guidelines shall be strictly adhered to as well as all Personnel Safety Guidelines.

The well site supervisor shall carry out regular safety checks. All crew members would be reminded frequently of working in a safe manner. Should unsafe equipment or procedures are observed, operations would cease immediately and the hazard duly corrected.

The well site supervisor would ensure that the Driller and above should have a valid “Well Control Certification”. Driller and above would have sound knowledge of the API specification relevant to Well Control Practices (API RP53 and those prescribed in it) and practice the same in all aspects of the job (**Table 5.1**).

Table 5.1

Classification of Wastes Generated during Proposed Drilling and their also Disposal Options

Type of Waste	Disposal Options
Plastic	Recycling or compaction followed by landfill off-site
Inert waste, such as glass, metal, construction materials	Recycling or compaction followed by landfill off-site
Black water	Treatment in packaged sewage treatment system and discharge to soak pit
Sludge from sewage treatment	Burial on-site after analysed as non-hazardous
Kitchen grease	Collection in grease traps in grey water system and disposed for landfill
Liquid wastes (eg paints, solvents, chemicals)	Labeled, sealed in containers and disposed off-site for further handling/disposal. Care to be taken that non-compatible liquids are not mixed
Mud or cement chemicals	Transported to next site
Contaminated soil	Labeled, containerized and sent off-site for further handling/disposal
Batteries	Labeled, containerized and sent off-site for further handling/disposal
Used medical wastes	Collected, labeled as biomedical waste, and sent off-site for disposal. Review possibility of safe incineration for readily combustible items
Spent oil spill containment material, absorbent etc.	Compacted, sealed, labeled and shipped off-site for treatment/disposal
Spent oil	Note that oil from engine oil changes may be designed as ‘hazardous’ based on quantity will be sent back to base for disposal
Produced hydrocarbons	Hydrocarbons will be flared through a conventional burner. Large quantities from extended tests will be shipped off-site for sale
Drill Cuttings	Solidification and burial in dedicated pit on-site (Waste mud and cuttings disposal plan)
Drilling fluids and completion brines	Treated through flocculation and solids removal so that supernatant can be safely discharged. Solids to cuttings pit for solidification and burial

Annexure I

Environmental Impact Assessment (EIA) Study for Exploratory Drilling of Oil Exploration in the Block PEL of Kangra-Mandi, Himachal Pradesh

1.0 Preamble

Oil and Natural Gas Corporation (ONGC) has been awarded a block for Oil Exploration in the block PEL of Kangra-Mandi in Himachal Pradesh (HP). As per the article 14 of PSC, Environmental Impact Assessment study is to be carried out for drilling activities to be undertaken. The well is to be drilled during the financial year 2008-09 in the first phase of exploration. Exploratory wells will be drilled and if successful results are obtained, other wells will be taken up in the same block. The present cost is Rs. 42 crores.

2.0 Objectives

The study report is aimed at obtained approvals from the regulatory agencies from the State as well as from the Ministry of Environment and Forests (MoEF), New Delhi. The studies shall cover the following :

- Collation and collection of enviornmental quality data/information for assessment of existing status/quality of air, noise, water, land, biological and socio-economic components of environment in and around the region proposed for drilling operations
- Identification, prediction and evaluation of significant environmental impacts due to proposed drilling operations
- Preparation of environmental impact assessment statement
- Delineation of Enviornmental Management Plan for mitigation of adverse impacts

3.0 Scope of Work

Preparation of Environmental Impact Assessment study report for exploratory drilling operations for Oil Exploration well in the block PEL of Kangra-Mandi in Himachal Pradesh (HP). The report shall comprise description of proposed operations, assessment of existing environmental quality status based on available secondary data supplemented by

collection of primary data for the region; Environmental Impact Assessment statement incorporating identification, prediction and evaluation of impacts and delineation of environmental management plan.

4.0 Work Plan

4.1 Baseline Environmental Quality Status

4.1.1 Air Environment

- Collection of surface meteorological data like wind speed, wind direction, relative humidity, rainfall, ambient temperature etc.
- Design of ambient air quality monitoring network
- Measurement of 24 hourly average background concentrations of SPM, RSPM (size < 10 μm), SO_2, NOx and Hydrocarbon

4.1.2 Noise Environment

- Establishing existing status of noise levels in residential, commercial, industrial areas and silence zones within the block area

4.1.3 Water Environment

- Collection of surface and groundwater resources for determining quality of water in the study area
- Assessment of biotic enviornment for water in terms of phytoplankton/ zooplankton (enumeration, indices and idstribution)

4.1.4 Land Environment

- Collection, characterisation and assessment of representative soil samples within the study area
- Assessment of productivity and fertility status of soil found within the study area
- Assessment of landuse pattern in the study area

4.1.5 Biolgoical Environment

- Collection of data on flora and fauna including rare and endangered species within the block area
- Collation of information on wildlife sanctuaries/reserve forest/marine sanctuaries, if any in the vicinity of the project area
- Assessment of species diversity, density, abundance etc. in the study region

4.1.6 Socio-economic Environment

- Collection of baseline data including demographic details, such as households, population, literacy, employment pattern, general health, tribal, transport, communication and welfare facilities such as hospitals, educational institutions, project awareness amongst the public, infrastructure facilities, economic resources, cultural and aesthetic attributes etc. as per the requirements under MoEF Questionnaire and Applications

4.2 Prediction of Impacts

- Prediction of adverse impacts due to activities related to proposed exploratory drilling
- Assessment of adverse impacts due to the proposed activity on air, land, water, biological and on human interests

4.3 Environmental Impact Assessment

- Evaluation of impacts on air, water and soil environment due to proposed drilling operations through :
    - ♦ Eco-toxicological data
    - ♦ Describing transport/dispersion, fate and effect of discharged of drilling fluids and drill cuttings
- Assessment of negative impacts on various environmental components including parameters of human interests

5.0 Environmental Management Plan

Environmental Management Plan (EMP) will be drawn after identifying, predicting and evaluating the significant impacts on each component of the environment with a view to maximizing the benefits from proposed project. Post-project Environmental Monitoring (PPEM) for various environmental components will be delineated. Recommendations on details environmental audit programmes and methodologies to be pursued by project developer will also be included. The following measures will also be included in EMP :

- Recommend mitigation measures required to address environmental concerns such as, clearing and timber salvage, wildlife and habitat protection, cultural and archaeological sites protection, terrain stabilization, maintaining fresh water horizons, debris disposal and conservation of natural drainage and water flow

- Assess additional infrastructure for treatment of produced water, proposed access cuttings, sewage, solid/hazardous waste with hydrogeo morphological details
- Provide a comprehensive and detailed plan covering environmental and social variables to be monitored, the location and timing of sampling and the use to be made of monitoring data to ensure compliance with the applicable environmental rules/regulations throughout the life of the project
- Delineate post-closure plan, coexisting with natural surroundings for abandonment of wells, rig dismantling and site completion and reclamation for abandonment.

Annexure II

Guidelines for Disposal of Drill Cuttings & Drilling Fluids for Offshore and On-Shore Oil Drilling Operations

Agenda item on the subject matter was placed in 17th Peer & Core Committee meeting. Dr. I. Haq. Senior Scientist of the Central Pollution Control Board made a brief presentation on the proposed guidelines for disposal of drill cutting and drilling fluids for on-shore and offshore oil drilling operations.

Oil drilling operators expressed their views on the clause Nos. 1.1,1.2, 2.1,2.3,2.4,3.1,3.2,3.5,3.7,4.2,and 4.3 of the proposed guidelines, for modification pertaining to the following :

(i) toxicity value for drill cuttings/drilling fluids;
(ii) prohibition of diesel base mud;
(iii) aromatic content in the preparation of oil base drilling fluids;
(iv) discharge rate of drill cuttings/drilling fluids;
(v) disposal of drill cuttings below sea surface;
(vi) availability of the record on payment made to companies for re-injection;
(vii) drill cuttings wash water limits; and
(viii) on use of chrome-lignosulphonate.

Modification as finalized during the meeting on above-said clauses are as follows :

Clause – 1.1,1.2,2.3,& 2.4 : Toxicity limit i.e. 96 hr LC_{50} value for disposal of drill cuttings and drilling fluids on-shore be retained as proposed by CPCB.

Clause – 1.3 : This clause shall be deleted.

Clause – 2.1; In place of prohibition of diesel base mud, "use of diesel base mud is prohibited" – be inserted.

Clause - 3.1 : "The discharge rate of drill cutting/drilling fluids should be intermittent and an average rate of 50 bbl/hr/well from a platform" – be revised.

Clause – 3.2 & 4.3 : Drill cuttings separated from water base drilling fluid should be disposed into sea, so as to have proper dilution & dispersion without any adverse impact on marine environment.

Clause – 3.5 ; In place of 'payment made to companies for re-injection' following be inserted ; " the use of oil base mud (HC<1%) for re-injection should be recorded and made available to the regulatory agency".

Clause – 3.7 ; The following was suggested : "The drill cuttings wash water should be treated to conform with limits notified under EPA, before disposal into Sea. This should be monitored on regular basis".

Clause –4.2 ;Sentence – "The chromium concentration in effluent to be disposed shall meet the EPA standards at 0.1mg/l for Cr^{6+} and 1 mg/l for total Cr" – be deleted.

Monitoring Frequency & Enforcing Authority for Off-Shore Installation;

It was decided that the oil drilling operators are required to record daily discharge of drill cuttings & drilling fluids to off-shore and daily monitoring as per standards notified and to submit the compliance report once in every six months to MoEF;

Enforcing Authority and the frequency for monitoring of ambient air & marine water quality in respect of offshore installation may be decided by the Ministry of Environment & Forest (IA Division).

Based on the above discussions, the proposed guidelines were finalized, which are follows;

2.1 Disposal of Drill Cuttings & Drilling Fluids for On-shore Installations;

a) Drill cuttings originating from on-shore or locations close to shore line and separated from Water Base Mud (WBM) should be properly washed and unusable drilling fluids such as WBM, Oil Base Mud (OBM), Synthetic Base Mud (SBM) should be disposed off-site or on-site. The disposal pit should be provided with leachate collection system.

Details of design in respect of the impervious waste disposal pit and capping of disposal pit and capping of disposal pit should be provided by the oil industry to concerned SPCB at the time of obtaining consent.

b) Use of diesel base mud is prohibited. Only WBM should be used for on-shore oil drilling operations.

c) In case of any problem arising due to geological formation for drilling, low toxicity OBM having aromatic content > 1% should be used. If the operators intend to use such OBM to mitigate specific hole problem, it should be intimated to MoEF and SPCB.

d) The chemical additives used for the preparation of drilling fluids should have low toxicity i.e. 96 hr LC_{50} . 30,000 mg/l as per mysid toxicity or toxicity test conducted on locally available sensitive sea species. The chemicals used (mainly organic constituents) should be biodegradable.

e) Drill cuttings separated from OBM after washing should have oil content <10 gm/kg for disposal into disposal pit.

f) The waste pit, after it is filled up, shall be covered with impervious liner, over which, a thick layer of native soil with proper top slope be provided.

g) Low toxicity OBM should be made available at installation during drilling operation.

h) Drilling wastewater including drill cuttings wash water should be collected in a disposal pit, evaporated or treated and should comply with the notified standards for on-shore disposal.

i) Barite used in preparation of drill fluid shall not contain Hg > 1 mg/kg & Cd > 3 mg/kg

j) Total area acquired for preparation of drill site must be restored after completion of drilling operation leaving no waste material at site.SPCB should be informed about the restoration work.

k) In case, environmentally acceptable methods for disposal of drill waste such as (i) Injection to formation through casing annulus, if conditions allow, (b) land farming at suitable location (c) bio-remediation, (d) incineration or (e) solidification, are considered for adoption by oil industry, then proposal shall be submitted to SPCB and MoEF for approval.

Disposal of Drill Cuttings & Drilling Fluids for Offshore Installations;

a) Use of diesel base mud (OBM) is prohibited. Only water base mud (WBM) is permitted for offshore drilling. If the operators intend to use low toxicity OBM or SBM to mitigate specific-hole problems in the formation, it should be intimated to MoEF and SPCB. The low toxicity OBM should have aromatic content < 1%.

b) The toxicity of chemical additives used in the drilling fluids (WBM or OBM or SBM) should be biodegradable (mainly organic constituents) and should have toxicity of 96 hr LC_{50} value > 30,000 mg/l as per mysid toxicity of test conducted on locally available sensitive sea species.

c) Hexavalent chromium compound should not be used in drilling fluids. Alternate chemicals in place of chrome lignosulfonate should be used in drilling fluids. In case, chrome compound is used, the drilling fluids and drill cuttings should not be disposed offshore.

d) Bulk discharge of drilling fluids in offshore is prohibited except in emergency situations.

e) WBM / OBM /SBM should be recycled to a maximum extent.Unusable portion of OBM should not be discharged into Sea and shall be brought to on-shore for treatment & disposal in an impervious waste disposal pit.

f) Thoroughly washed drill cuttings separated from WBM / SBM & unusable portion of WBM /SBM having toxicity of 96 hr LC_{50} > 30,000 mg/l, shall be discharged off-shore into Sea intermittently at an average rate of 50 bbl/hr/well from a platform so as to have proper dilution & dispersion without any adverse impact on marine environment.

g) Drill cuttings of any composition should not be discharged in sensitive areas notified by MoEF.

h) In case of specific whole problem, use of OBM will be restricted with zero discharge of drill cuttings. Zero discharge would include re-injection of the drill cuttings into a suitable formation or to bring to shore for proper disposal. In such case, use of OBM for reinfection should be recorded and such records made available to the regulatory agency. Low toxic OBM having aromatic content < 1% should be made available at the installation.

i) In case, drill cuttings are associated with high oil content from hydrocarbon bearing formation, then disposal of drill cuttings should not have oil content .>10 gm/kg.

j) The drill cuttings wash water should be treated to conform with the limits notified under EPA, before disposal into sea. The treated effluent should be monitored regularly.

k) Discharge of drill cuttings from the installatilon located within 5 km away from shore should ensure that there is no adverse impact on marine eco-system and on the shore. If, adverse impact is observed, then the industry has to bring the drill cuttings on-shore for disposal in an impervious waste disposal pet.

l) If any, environmental friendly technology emerges for substitution of drilling fluids and disposal technology it may be brought to the notice of MoEF and regulatory agencies. If the operator desires to adopt such environment friendly technology, a prior approval from MoEF is required .

m) Barite used in preparation of drilling fluids shall not contain Hg > 1 mg/kg & Cd > 3 mg/kg.

n) Oil drilling operators are required to record daily discharge of drill cuttings & drilling fluids to offshore and also to monitor daily the effluent quality, and submit the compliance report once in every six months to MoEF.

Enforcing Authority and the frequency for monitoring of ambient air & marine water quality in respect of offshore installations, as discussed, may be decided by the MoEF before notification of these guidelines.

Annexure III

General Procedure for Sampling and Preservation of Samples

Type of samples

Grab or catch samples : A sample collected at a particular time and place can represent only the composition of the source at that time and place. However, when a source is known to be fairly constant in composition over a considerable period of time or over a substantial distance in all directions, then the sample may be said to represent a large time period or volume or both, than the specific point at which it was collected. In such circumstance same source may be well represented by single grab sample. When a source is known to vary with time, grab sample collected at suitable interval can be of great value in documenting the extent, frequency, and duration of these variations. In case, the composition of a source varies in space rather than in time, a set of samples collected from appropriate location with less emphasis on timing may provide the most useful information.

Composite samples : The term composite refers to mixture of grab samples collected at the same sampling point at different time intervals. Sometimes the term 'time composite' is used when it is necessary to distinguish this type of sample from others. Time composite samples are most useful for observing average concentrations as an alternative to separate analysis of a large number of samples, followed by computation of average and total results. A composite sample of 24 hours duration is considered to be standard for most determinations. Composite samples, cannot be used for determinations of components or characteristics subject to significant and unavoidable changes on storage.

Integrated samples : Mixture of grab samples simultaneously collected from different points or as points as close as possible to each other is called integrated sample. Such sampling method is followed for rivers or stream that vary in composition across their width and depth. The need for integrated samples may also arise if a combination of treatment is proposed for several separate wastewater streams. The preparation of integrated samples require special equipment to collect samples from a known depth, without contamination by overlying water. Prior knowledge of volume, flow and composition of various zones of water body being sampled is also necessary

Sampling containers

It is advantageous to measure the quality .of water in-situ using sensors which are lowered into position rather than drawing samples. However, this being not always possible. Water samples are collected in suitable containers. A sampling container must satisfy the following requirements ;

a. It should be easily freed from contamination
b. It should not change the representative water characteristics
c. It should have adequate capacity for storing the sample
4 It should be resistant to impact and to internal pressure which sometimes get increased by release of dissolved gases at elevated temperature on storage.

The sampling bottles may be made of either glass or polyethylene and they must be capable of being tightly sealed. The bottles should be soaked with 10% HCl for 24 hours and then thoroughly cleaned and rinsed with distilled water.

The specific situation will determine the use of borosilicate glass bottles (bsbg) or polyethylene containers (pec.). Sampling containers should be rinsed with chromic acid (35 ml of saturated $Na_2Cr_2O_7$ in one liter of conc. $H_2SO_{4)}$) followed by washing with tap and distilled water and then dried.

If metals are to be analyzed, the container must be rinsed with 20% HNO_3 followed by distilled water and for analysis of phosphorous 50% HCl should be used instead of nitric acid.

Sampling equipment

Although various types of sampling equipments have been devised, the sampler design becomes immaterial except for dissolved gases or constituents particularly affected by atmospheric gases. Sampling equipments are briefly described below ;

Grab samplers : Grab samplers can be divided into two broad categories: those appropriate for taking samples in which only non-volatile constituents are analysed and those for taking samples in which dissolved gases and other volatile constituents are analysed. Grab sampler can also be divided into discrete (surface or specific depth) and depth integrating samplers. A grab sample may be taken using a “sampling iron” with an appropriate bottle or a pump type sampler. Composite samples can be made from several grab samples mixed in equal proportions or in proportions according to the flow at the time of sampling.

Depth integrating samplers : Depth integrating sampler (Fig. IV 1) is a device made of iron and painted with a rust inhibitor. The weight of the sampler is approximately 2.7 kg. Typically, this design permits the use of two liter sampling bottle when the bottle neck holder is in the upper position. Smaller bottles may be used when the holder is located in lower position.

The sampling bottles are placed in the sampler and protected by neck holders. In some cases, sampling irons may have provision for additional weights to ensure a vertical drop in the strong currents. A depth integrated sample is taken by permitting the sample to sink to the desired depth at a constant rate and then retrieving it at approximately the same rate. The rate should be such that the bottle has just been filled when reaching the surface.

Discrete samplers : Discrete samplers are used to collect water at specific depth. An appropriate sampler is lowered to the desired depth, activated and then retrieved FIG. IV.1. The Keimmerer style sampler is one of the oldest types of messenger operated vertical samplers. The samples should be taken at a known depth and without aeration. Depth samples can be collected with a bottle which can be closed by a stopper, controlled by a cord permitting samples to be taken at any given depth. The total weight to lifted out of the water will be atleast twice that of the sample. This sampler is also adequate for dissolved oxygen (DO) samples.

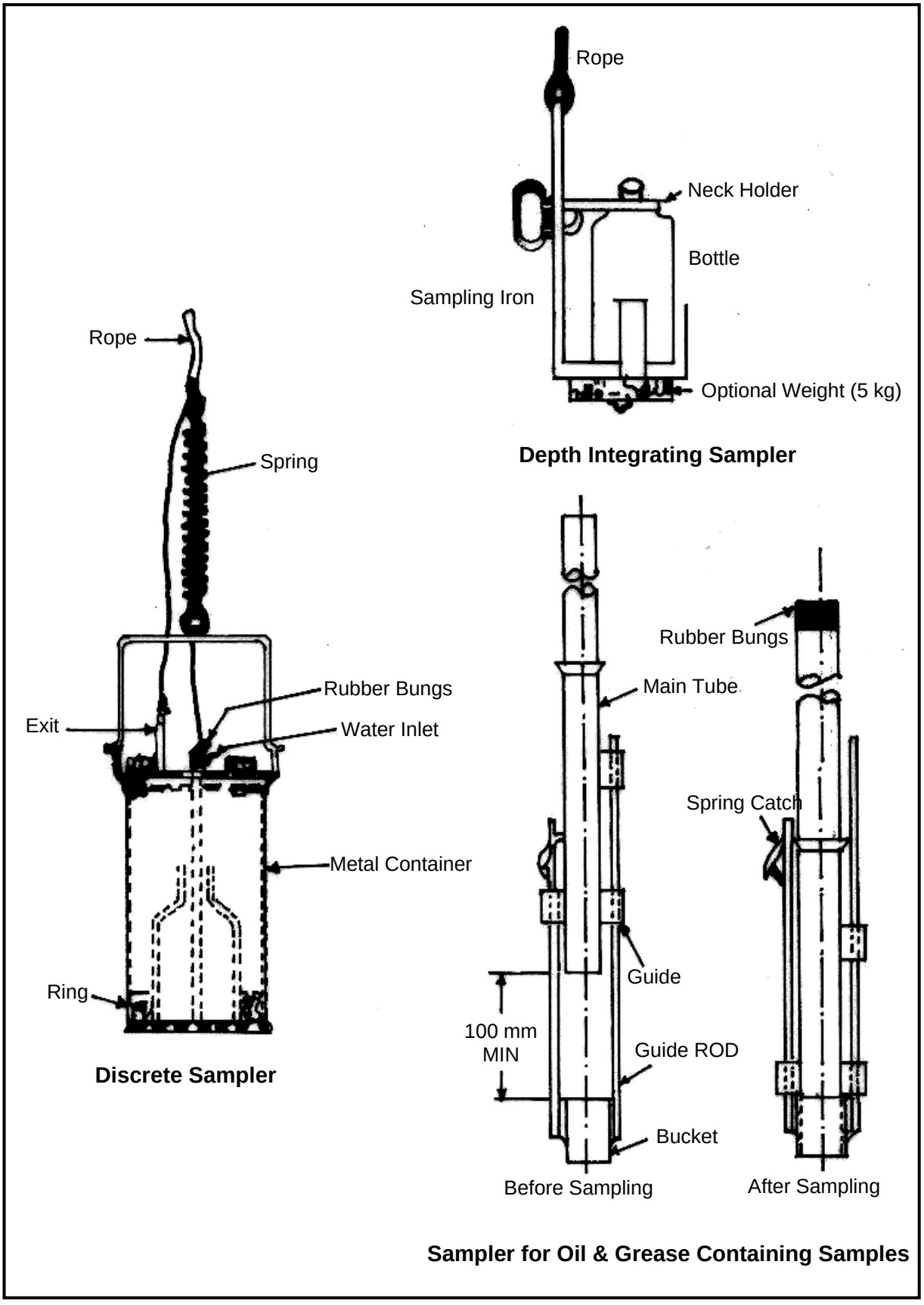

Fig. III-1 : Types of Samplers for Water Sampling

Sampler for oil and grease available commercially are designed for various purposed viz. automatic and manually operable. The Neshkin sampler (pp Fig. 2.52) is most suitable for depth sampling. However, the most satisfactory method of sampling two-phase liquids (oil and grease) is to use a sampling tube that is capable of drawing a complete section of the effluent as it flows in a rectangular culvert or trough; in most instances, however, the effluent will have to be sampled from the outfall of a pipe or from a stream and in these circumstances, some of it should first be collected in a large cylindrical vessel having a capacity of 10 to 15 litres. A sectional sampling tube, suitable for sampling effluents that do not contain highly viscous matter (for example, tar), is shown in **Fig. III.1**. The sampler consists of a heavy gauge brass tube, 1 metre long, with an outside diameter of 40 mm. Over one end of the tube is fitted a brass bucket made from piece of tube, 50 mm long and sealed at one end. The bucket has an internal diameter 1.5 mm greater than the outside diameter of the main tube. To opposite sides of the bucket are brazed two brass rods, 6 mm in diameter, which pass through guides brazed to the sides of the main tube. The rods are so arranged that the top of the bucket can be drawn to a distance of not less than 10 mm from the bottom of the tube and they guide the bucket into a position covering end of the tube when it is pushed back again. A suitable spring catch is provided on use of the guide rods so that the bucket is automatically locked into the top position when it is raised to its highest point. The open end of the sampling tube is fitted with a rubber bung.

To take a sectional sample, the spring catch is released and the bucket is drawn away as far as possible from the end of the main tube. The rubber bung is drawn from the other end . The tube is lowered vertically through the liquid to be sampled until the bottom of the bucket rests on the bottom of the culvert or of the vessel that has been filled with the effluent. The main tube is then pushed down, guided by brass rods, to the limit of its travel, whereupon the spring catch locks the bucket in raised position covering the end of the tube. The rubber bung is tightly inserted in the open end and the tube is withdrawn. The outside of the sampler is wiped free from the adhering liquid, the bucket and the lower part of the tube are inserted into a wide-mouthed bottle of suitable capacity and the rubber bung is removed. The sample section of the liquid will flow into the bottle, leaving a small quantity of liquid in the bucket. The tube is then, numbered so that this liquid is added to the main bulk of the sample. The operation is repeated until a sufficient quantity has been collected.

Flow measurement

In order to calculate the mass load in case of wastewater and its dispersion and dilution in receiving bodies, flow measurement is a neutral parameter. A number of methods of measuring flow in streams and wastewater carrying pipes are available. The choice of the method solely depends upon the location of the sampling point and sampling facilities available. Various sampling methods and devices in use are given below:

Bucket method : This method is applicable to a free fall of waste from pipe or sewer. Time required for a known volume of sample gives a flow rate in litre/min.

Surface float method : This method is applicable to shallow and small streams in which the time (t) required for a float to travel a known distance (d) is observed and the average velocity is obtained by V=d/1.2 t. If the cross sectional area 'A' is measured, then discharge is given by Q = V.A.

Salt concentration method : In case of certain complicated drainage, where physical devices/methods cannot be employed, salt concentration method works very well. A known strength of NaCl solution is added through a feeder channel at a constant rate. Concentration of chlorides in wastewater at upstream and downstream station is found out by taking 4 or 5 quick samples to give a replication. The flow is measured by following formula ;

$$F = \frac{f(S_1 - S_3)}{(S_3 - S_2)}$$ where,

F = stream discharge
f = flow of feeder channel
S_1 = salt concentration in feeder channel
S_2 = salt concentration at the upstream station
S_3 = salt concentration at the downstream station

Use of weirs ; The weirs are commonly used for flow measurement/ Rectangular or V notch weir is normally used for the discharge below 10 cft/sec. The flow in a notch is calculated according to the following formula.

$2.52\ H^{2.47}$ = cft/sec
H = Head of water in weir in feet,

The conversion of head on the weir to flow is given in **Table III.1**.

TABLE : III.1

CONVERSION OF HEAD ON THE WEIR TO FLOW

Discharge over 90^0 'V' notch

Head in cm	Q m^3/hr	Head in cm	Q m^3/hr	Head in cm	Q m^3/hr
1.0	0.055	17.5	65.255	34.0	336.562
1.5	0.151	18.0	69.957	34.5	348.920
2.0	0.307	18.5	74.856	35.0	361.544
2.5	0.533	19.0	79.953	35.5	374.435
3.0	0.828	19.5	85.229	36.0	384.520
3.5	1.225	20.0	90.752	36.5	397.847
4.0	1.696	20.5	96.459	37.0	428.717
4.5	2.279	21.0	102.375	37.5	428.717
5.0	2.954	21.5	108.501	38.0	442.974
5.5	3.741	22.0	114.841	38.5	457.510
6.0	4.635	22.5	121.395	39.0	472.327
6.5	5.652	23.0	128.168	39.5	487.425
7.0	6.787	23.5	135.160	40.0	502.807
7.5	8.048	24.0	142.375	40.5	518.474
8.0	10.114	24.5	149.814	41.0	534.428
8.5	10.964	25.0	157.477	41.5	550.671
9.0	12.626	25.5	165.374	42.0	567.203
10.0	16.380	26.5	181.857	43.0	601.146
10.5	18.842	27.0	190.450	43.5	618.560
11.0	20.715	27.5	199.280	44.0	636.270
11.5	23.133	28.0	208.350	44.5	654.278
12	25.697	28.5	217.660	45.0	672.580
12.5	28.423	29.0	227.214	45.5	691.196
13.0	31.315	29.5	237.013	46.0	710.109
13.5	34.374	30.0	247.060	46.5	729.326
14.0	37.605	30.5	257.355	47.0	748.850
14.5	41.010	31.0	267.902	48.0	788.822
15.0	44.592	31.5	278.702	48.0	788.822
15.5	48.354	32.0	289.756	48.5	809.273
16.0	52.298	32.5	301.068	49.0	830.037
16.5	56.428	33.0	312.638	49.5	851.115
17.0	60.746	33.5	324.469	50.0	872.507

Sample collection

The determinands for water quality monitoring may be classified as (1) conservative which does not changes with time but can be stabilized for at least 24 hours by appropriate treatment and (3) Non-conservative which changes rapidly with time and cannot be stabilized. The first two groups can be measured by taking representative samples for subsequent analysis in a laboratory. The third, group including temperature, pH and dissolved oxygen, need to be measured in the field immediately after sampling.

The sampling may be carried out either manually or automatically using appropriate samplers. The simplest manual sampling is carried out by a plastic bucket or stainless steel jar fasten by a rope. However, it has got a drawback that while the sample is taken from the surface a lot of floating matter is also collected. An alternative is to immerse the sample bottle directly in water. Sample from various depths may be collected by using any of the sampler described earlier. A wide range of indigenous automatic sampling equipments are also available for taking sample mechanically at fixed intervals or continuously. Any sampling technique may be used, however, adoption of a particular technique depends upon what is being analysed and what constituents are to be determined.

Other points requiring attention are

Sample where water is well mixed. Weirs enhance the settling of solids upstream and accumulate floating solids and oil downstream, therefore, such location should be avoided as a sample source.

- Avoid large non-homogenous matter such as leaves, rags,twigs and other floating material in the sample
- Sample preferably at 0.6 m depth in a shallow channel where velocity of mixing is sufficient to prevent solids deposits. For depths greater than 0.6 m collect two samples at 20% and 80% below the surface
- Sample facing upstream to avoid contamination by slowly drawing water from the source into the container.
- Force sampling container through the entire cross section of the stream, whenever possible
- Ascertain that the sampler operate at proper time before sampling with a depth sampler. If doubt exists, discard and resample
- The schedules of the factory for waste discharges must be known in order to avoid the sample from a batch dumping
- Provide complete information on the source and conditions under which the sample was collected

Attach a record tag to the sample container by noting sample number, source of sample, analysis required, temperature and name of person taking the sample. The tag should be signed, time recorded and dated by the person taking the sample.

Field measured parameters : A number of parameters including pH, conductivity, dissolved oxygen, ammonia, CO_2 ,temperature, turbidity and residual chlorine should be measured at the sampling site immediately after collection of sample. However, in-situ measurements of these parameters are recommended.

Preservation and handling

Between the time that a sample is collected in the field and until it is actually analysed in the laboratory, physical changes, chemical and biochemical reactions, may take place in the sample container which will change the intrinsic quality of the sample. It is necessary therefore to preserve the samples before shipping, to prevent or minimize their changes. This is done by various procedures such as keeping the samples in dark, adding chemical preservatives, lowering the temperature to retard reactions by freezing or by a combination of these methods.

Physico-chemical determinands of interest are :

Physical & Mineral Group	:	Temperature, specific conductance, turbidity, pH, acidity, alkalinity, chlorides, sulphide, sulphate, silica, total solids, suspended solids and dissolved solids
Nutrient group	:	Kjeldahl-N, ammonia-N, nitrate-N, ortho and total phosphate
Demand group	:	TOC, COD, BOD
Organic group	:	Oil & grease, phenol, organochlorine compounds, polycyclic aromatic hydrocarbons, PCB's and chlorophenoxy
Dissolved gaseous group	:	Dissolved oxygen and carbon dioxide; free or combined, residual chlorine unionsed, hydrogen sulphide
Metal group	:	Arsenic, boron, chromium, mercury, sodium, copper, iron zinc, manganese, calcium, magnesium, potassium, aluminium, cadmium, barium and lead

Recommended sample container, sample volume, preservation and maximum holding period for above determinands is detailed in **Table III.2**

TABLE : III.2

SAMPLE REQUIREMENTS AND MODE OF PRESERVATIONS

Determination	Container	Minimum sample size ml	Preservation	Maximum storage recommended
Acidity	P, G(B)	100	Refrigerate	24 h/14 d
Alkalinity	P, G	200	Refrigerate	24h/14 dG(B)
Alkalinity	P, G	200	Refrigerate	24h/d
BOD	P, G	1000	Refrigerate	6h/48 h
Boron	P	100	None required	28 d/6 months
Bromide	P, G	-	None required	28 d/28d
Carbon, organic, total	P, G	100	Analysed immediately : or refrigerate & add HCL to pH <2	7 d/28 d
Carbon dioxide	P, G	100	Analyze immediately	Stat/NS
COD	P, G	500	Amalyze as soon as possible, or add H_2SO_4, to pH <2; refrigerate	7d/28 d
Chlorine residual	P, G	500	Analyze immediately	0.5 h/stat
Chlorine dioxide	P, G	500	Analyze immediately	0.5 h/N.S
Chlorophyll	P, G	500	30 d in dark	30 d/NS
Color	P, G	500	Refrigerate	48 h/48/h
Conductivity	P, G	500	Refrigerate	28 d/28 d
Cyanide; Total	P, G	500	Add NaOH to pH>12	24 d/14 d;
			Refrigerate in dark	24 d if sulfide present
Amenable to chlorination	P, G	500	Add 100 mg Na_2SO_4/l	stat/14d; 24 h if sulfide is present
Fluoride	P	300	None required	28 d/28d
Hardness	P, G	100	Add HNO_3 to pH<2	Months/6 6 months
Iodine	P, G	500	Analyze immediately	0.5 j/NS
Metal, general	P(A0,G(A)		For dissolved metals filter immediately , add HNO_3 to pH,2	6 months/ 6months
Chromium VI	P(A0,G(A)	300	Refrigerate	24 h/24h
Copper By colorimetry				
Mercury	P(A),G(A)	500	Add HNO=, to pH,2 4C, refrigerate	28 d/28 d

Determination	Container	Minimum sample size ml	Preservation	Maximum storage recommended
Nitrogen : Ammonia	P,G	500	Analyze as soon as possible or add H_2SO_4 to pH<2, refrigerate	7 d/28 d
Nitrate	P,G	100	Analyze as soon as possible or refrigerate	48 h/48 h (28 d for chlorinated samples)
Nitrate	P,G	200	Add H_2SO_4 to pH<2, Refrigerate	None/28 d
Nitrite	P,G	100	Analyze as soon as possible or refrigerate	None/48 h
Organic, Kjeldahl	P,G	500	Refrigerate; add H_2SO_4 to pH<2,	7d/28 d
Odor	G	500	Analyze as soon as possible Refrigerate	6 h/NS
Oil and grease	G, wide-mouth calibrated	1000	Add H_2SO_4 to pH<2, refrigerate	28 d/28d
Organic compounds pesticides	G(S), TFE-lined cap		Refrigerate;1000 mg ascorbic acid/L if residual chlorine present	7 d/7d until extraction; 40 d after extraction */28d
Phenols	P,G	500	Refrigerate, add H_2SO_4 , to pH<2 Refrigerate, add	7d/14 d
Purgeables by purge and trap	G,TFE-lined cap	50	HCL to pH<2;1000 mg ascorbic acid.L if residual chlorine present	0.5 h/stat 8 h/8 h
Oxygen, dissolved	G, BOD bottle	300	Analyze immediately Titration may be delayed after acidification	0.5 h/stat
Electrode Winker				
Ozone	G	1000	Analyze immediately	0.5 h/stat
pH	P,G		Analyze immediately	2 h/stat
Phosphate	G(A)	100	For dissolved phosphate filter immediately; refrigerate	48 h/NS
Salinity	G,wax seal	240	Analyze immediatlly or use wax seal	6 months/NS
Silica	P	-	Refrigerate, do not freeze	28 d/28 d

Determination	Container	Minimum sample size ml	Preservation	Maximum storage recommended
Sludge digester gas	G, gas			N.S
Solids	P,G		Refrigerate	7d/2-7 d;
Sulfate	P,G		Refrigerate	28 d/28 d
Sulfide	P,G	100	Refrigerate; add 4 drops 2N zinc acetate/100 mL; add NaOH to pH>9	28 d/7d
Taste	G	500	Analyze as soon as possible; refrigerate	24 h/N.S.
Temperature	P,G		Anakyze immediately	Stat/stat
Turbidity	P,G		Analyze same day;;store in dark upto 24 h, refrigerate	24 h/48 h

For determinations not listed, use glass or plastic containers; preferably refrigerate during storage and analyze as soon as possible.

Refrigerate	=	Storage at 4 ^{o}C, in dark
P	=	Plastic (polyethylene or equivalent)
G	=	Glass
G(A) or P(A)	=	Rinsed with 1+ 1 HNO_3
G(B)	=	Glass, borosilicate
G(S)	=	Glass, rinsed with organic solvents
N.S.	=	Not stated in cited reference
Stat	=	No storage allowed, analyzed immediately

Source ; Standard Method for examination of water and wastewater, AWWA,WPCF, 17th Edn., (1990)

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)
(July 2003)

Pollutant	Time weighted average	Concentration in ambient air			
		Industrial area	Residential, Rural & mixed use area	Sensitive area	Method of measurement
Sulphur dioxide (SO_2)	Annual average*	80 μg/m^3	60 μg/m^3	15 μg/m^3	- Improved West & Caeke method
	24 hours**	120 μg/m^3	80 μg/m^3	30 μg/m^3	- Ultraviolet fluorescence
Oxides of Nitrogen method (as NO_2)	Annual average*	80 μg/m^3	60 μg/m^3	15 μg/m^3	- Jacab & Hochheiser(Na-Arsenite)
	24 hours**	120 μg/m^3	80 μg/m^3	30 μg/m^3	- Gas phase chemiluscence
Suspended Particulate Matter (SPM)	Annual average*	360 μg/m^3	140 μg/m^3	70 μg/m^3	- High volume sampling (average flow rate not less than 1.1 m^3/min)
	24 hours**	500 μg/m^3	200 μg/m^3	100 μg/m^3	
Respirable Particulate Matter (size less than 10 μm) (RPM)	Annual average*	120 μg/m^3	60 μg/m^3	50 μg/m^3	- Respirable particulate matter sampler
	24 hours**	150 μg/m^3	100 μg/m^3	75 μg/m^3	
Lead (Pb)	Annual average*	1.0 μg/m^3	0.75 μg/m^3	0.50 μg/m^3	- AAS method after sampling using EPM 2000 or equivalent filter paper
	24 hours**	1.5 μg/m^3	1.00 μg/m^3	0.75 μg/m^3	
Carbon Monoxide (CO)	8 hours**	5.0 mg/m^3	2.0 mg/m^3	1.00 mg/m^3	- Non-dispersive infrared spectroscopy
	1 hour	10.0 mg/m^3	4.0 mg/m^3	2.00 mg/m^3	
Ammonia (NH_3)	Annual average*		0.1 mg/m^3		
	24 hours**		0.4 mg/m^3		

* Annual arithmatic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

NOTE

1. National Ambient Air Quality Standards : The levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property
2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations
3. The above standards shall be reviewed after five years from the date of notification

Annexure IV

INDIAN STANDARDS/SPECIFICATIONS FOR DRINKING WATER
IS : 10500 - 1991

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Essential Characteristics						
1.	Colour, Hazen unit	5	Above, consumer acceptance decreases	25	4 of 3025, 1983	Extended upto 25 only if toxic substances are not suspected in absence of alternate source
2.	Odour		Unobjectionable	-	5 of 3025, 1983	a. Test cold and when heated b. Test at several dilutions
3.	Taste		Agreeable	-	-	Test to be conducted only after safety has been established
4.	Turbidity, NTU	5	Above, consumer acceptance decreases	10	8	-

Annexure V

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
5.	pH value	6.5-8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	8	-
6.	Total hardness, mg/L as $CaCO_3$	300	Encrustation on water supply structure and adverse effects on domestic use	600	-	-
7.	Iron (as Fe), mg/L	0.3	Beyond this limit, taste/appearance are affected, has adverse effect on domestic uses and water supply structures, & promotes iron bacteria	1.0	32 of 3025, 1964	-
8.	Chlorides (as Cl)m mg/l	250	Beyond this limit, taste, corrosion and palatability are affected	1000	32 of 3025, 1988	-

Annexure V Contd….Page 2

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
9.	Residual free chlorine, mg/L	0.2	-	-	26 of 3025, 1986	To be applicable only when water is chlorinated Tested at consumer end, When protection against viral infection is required, it should be min 0.5 mg/L
Desirable Characteristics						
10.	Dissolved solids, mg/L	500	Beyond this palatability decrease and may cause gastrointestinal irritation	2000	16 of 3025, 1984	
11.	Calcium (as Ca), mg/L	75	-	200	40 of 3025, 1984	
12.	Copper (as Cu), mg/L	0.05	Astringent, taste discoloration of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025, 1964	

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
13.	Manganese (as Mn), mg/L	0.1	Astringent taste, discoloration of pipes, fitting and utensils will be caused beyond this	0.3	35 of 3025, 1964	
14.	Sulphates, (as SO_4), mg/L	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400	24 of 3025, 1986	May be extended upto 400 provided (as Mg) does not exceed 30 mg/L
15.	Nitrates (as NO_3), mg/L	45	Beyond this methaemoglobinemia takes place	100	-	-
16.	Fluoride (as F), mg/L	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	23 of 3025, 1964	-
17.	Phenolic substances, mg/L (as C_6H_5OH)	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025, 1964	

Annexure V Contd…Page 4

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
18.	Mercury (as Hg), mg/L	0.001	Beyond this, the water becomes toxic	No relaxation	see note mercury ion analyser	To be tested when pollution is suspected
19.	Cadmium (as Cd), mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	see note mercury ion analyser	To be tested when pollution is suspected
20.	Selenium (as Se) mg/L	0.01	Beyond this, the water becomes toxic	No relaxation	28 of 3025, 1964	To be tested when pollution is suspected
21.	Arsenic (As), mg/L	0.05	Beyond this, the	No	37 of 3025, 1988	To be tested when
22.	Cyanide (CN), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	27 of 3025, 1986 pollution is suspected	To be tested when
23.	Lead (Pb), mg/L	0.05	Beyond this, the water becomes toxic	No relaxation	See note 86	To be tested when pollution plumbosolvency is suspected
24.	Zinc (as Zn), mg/L	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	39 of 3025, 1964	To be tested when pollution is suspected

Annexure V Contd....Page 5

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
25.	Anionic detergents, mg/L (as MBAS)	0.2	Beyond this limit, it can cause a light froth in water	1.0	Methylene blue extraction method	To be tested when pollution is suspected
26.	Chromium (as Cr^{+6}), mg/L	0.01	May be carconogenic above this limit	0.05	28 of 3025, 1964	To be tested when pollution is suspected
27.	Polynuclear aromatic hydrocarbons (as PAH), mg/L	-	May be carcinogenic	-	-	-
28.	Mineral oil, mg/L	0.01	Beyond this limit undesirable taste and odour after chlo-rination takes place	0.03	Gas chromatographic method	To be tested when pollution is suspected
29.	Pesticides, mg/L	Absent	Toxic	0.001	58 of 3025, 1964	-
30.	Radioactive materials					
	a. Alpha emitters Bq/L	-	-	0.1	-	-
	b. Beta emitters pci/L	-	-	1.0	-	-

Annexure V Contd....Page 6

S. No.	Substances or Characteristic Max.	Requirement (Desirable limit)	Undesirable effects out-side the desi-rable limit	Permissible limit in absence of alternate source	Method of Test Cl Ref of IS : 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
31.	Alkalinity (as $CaCO_3$), mg/L	200	Beyond this limit taste becomes unpleasant	600	13 of 3025, 1964	-
32.	Aluminimum (as Al), mg/L	0.03	Cumulative effect is reported to cause dementia	0.2	31 of 3025, 1964	-
33.	Boron (as B), mg/L	1	-	5	29 of 3025, 1964	-

Note : Atomic absorption spectrophotometric method may be us

Annexure VI

Ambient Air Quality Standards in Respect of Noise*

Category of Area	Noise Level in Leq dB(A)	
	Day Time	Night Time
Industries Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence zone	50	40

* Notification of MoEF, GOI dated 26.12.1989

Note :

1. Day time is reckoned in between 6 am and 10 pm
2. Night time is reckoned in between 10 pm and 6 am
3. Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
4. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply

Abbreviations

BOD	:	Bio-chemical Oxygen Demand
COD	:	Chemical Oxygen Demand
CPCB	:	Central Pollution Control Board
Cr	:	Chromium
DO	:	Dissolved Oxygen
EEZ	:	Exclusive Economic Zone
EMP	:	Environmental Management Plan
G	:	Glass Container
G(B)	:	Glass (Borosil)
H	:	Head of Water in Weir
HC	:	Hydrocarbon
IOSN	:	Indian Ocean Standard Net
LC_{50}	:	Lethal Concentration (50% Mortality)
MARPOL	:	Marine Pollution
OBM	:	Oil Base Mud
P	:	Polyethylene
P,G	:	Polyethylene, Glass
SPCB	:	State Pollution Control Board
TOC	:	Total Organic Carbon
USEPA	:	United State Environmental Protection Agency
WBM	:	Water Base Mud

Annexure VIII

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