4 ASSESSMENT OF IMPACTS

4.1 Assessment of Impacts on the Environment

The methodology used for environmental impact assessment follows the sequence summarized in **Fig 4.1** with consultations incorporated into every phase:

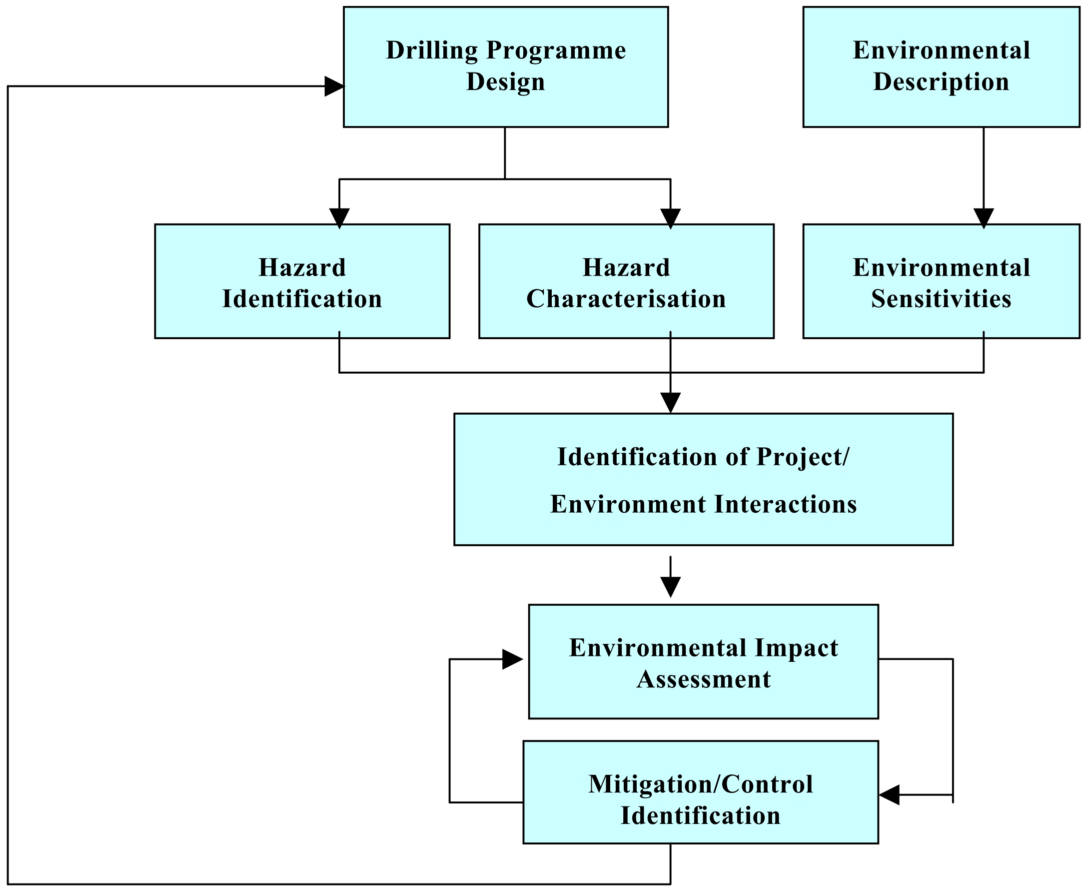

Fig 4.1: Methodology for Environmental Impact Assessment

The main supporting information required for an assessment includes a description of both the project (Chapter 2) and the environment in which it will take place (Chapter 3). The information presented in these two chapters allows identification of the interactions between the planned drilling operations and the environment.

In this section, the interactions between the project and the environment are identified, impacts on environmental components due to project activities are assessed and key mitigation majors are suggested.

4.2 Identification of Interactions

Matrix methodology is adopted for the impact assessment of this project. This method incorporates a list of impacting activities and their likely environmental impacts, presented in a matrix format. Combining these lists as horizontal and vertical axes in the matrix allows the identification of cause-effect relationships, if any, between specific activities and impacts. In this case, the entries of the matrix are qualitative estimates of these cause-effect relationships. **Table 4.1** summarizes the interactions between the proposed project and the sensitivities of the local and regional environment. At this stage the interactions are not quantified but simply identified for further consideration in the environmental impact assessment.

Table 4.1: Interactions between Project Operations and Environmental Sensitivities

Impacts due to Project Activities	Environmental Sensitivities											
	Physical				Biological		Socio-Economic					
	Soil and sediment	Water Quality	Air Quality	Noise	Flora	Fauna	Living conditions of local people	Economy	Personnel/support crews	Archaeology	Tourism/Leisure	Land Use
Site Selection												
Site Preparation and Installation of Facilities					X	X						
Road Construction			X	X	X	X	X	X			X	X
Drilling Operations												
Physical Presence					X	X	X	X				X
Noise & Vibration				X	X	X	X		X			
Atmospheric Emissions			X		X	X			X		X	
Waste Water Generation		X										
Solid /Hazardous Waste Disposal	X						X		X			X
Impact on Land due to Drilling	X											X
Socio-economic Impacts due to Drilling Operation							X	X				

X - Positive or negative impact due to project activity
Blank spaces indicate no significant co-relation.

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4.3 The Major Activities that may have Impact on Environment

Physical Presence: The rig support equipments can represent a temporary obstacle to other activities.

Atmospheric Emissions: Routine emission to air results from power generation. Generally the testing of the well also results in emission to atmosphere by the way of flaring of produced hydrocarbons.

Noise & Vibration: Noise and vibration is expected to be generated from DG sets and mud pumps during drilling operation.

Waste Water Generation: Waste water is expected to be generated from the operations, in the form of excess drilling fluid discharge.

Solid/ Hazardous Waste Disposal: Waste includes spent mud, wastewater, drill cuttings, sewage and garbage/refuse (solid waste). These will be collected and treated for disposal or transferred. Any effects from controlled disposal of such waste should be negligible.

Impact on Land due to Drilling: Soil compaction due to equipment transport and movement off-road vehicles during drilling activity could result in loss of topsoil and decrease in soil productivity. Soil contamination due to spillage of liquids from drilling activities, surface disturbance associated with activities such as road well pads, removal of vegetation.

4.4 Assessment of Impacts and Control Measures

4.4.1 Physical Presence

The drilling sites will be located on a small platform and the undulations around the platform will be leveled by earthmoving machinery. Pits for drilling mud, sludge and waste water will also have to be dug. Site-preparation will take place in parallel with the road-construction. Once the site has been prepared and the drilling equipment set up, the disturbance level is likely to go down.

Drilling will be confined to a relatively small area and staff will be restricted to the fenced location or along the access road. Overall, experience shows that interference can be avoided over the short drilling period by introducing good management practices and the impact of the physical presence of the drilling program is anticipated to be negligible.

4.4.2 Noise and Vibration

The noise generated due to the diesel engines operating the rig along with the mud circulation system is considered to be the most significant of the noise generating sources in the drilling operation. Generally, the noise sources in a drilling well are scattered within an area of about 100 m x 100 m. It may be noted that the drilling operations will be carried out at a distance of more than 1 km away from human habitation. Thus the noise pollution can be considered as negligible for the nearest human habitation.

The noise propagation modeling performed for noise generation due to operation of the diesel engines shows the following exposure levels (**Table 4.2**) in terms of the occupational and human settlement exposure levels.

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Table 4.2: Occupational and Human Exposure Levels

Type of exposure	Predicted exposure level dB(A)
1. Occupational exposure	
L_{eq} (8 h) at drilling platform (rig, mud circulation system, Diesel engines)	110
L_{eq} (8 h) at the site boundary (about 50 m from drilling platform)	90
2. Human settlement exposure	
L_{eq} (24 h) at villages 0.5 km or more away	54

It is found that the background noise level in the rural/ residential areas is 31 - 63 dB (A) during day (Chapter 3) and 28 - 48 dB (A) during the night and in the towns and commercial places, the noise level is 40 - 63 dB (A) at day time and 34 – 49 dB (A) at night time.

The damage risk criteria for hearing, as enforced by OSHA, USA, stipulate that noise levels up to 90 dB (A) are acceptable for 8-hour exposure per day. In this context, it is to be noted that:

- At places, excepting the drill floor and near the mud pumps, continuous attendance of workers is not required. Hence, the workers, other than those working at the drilling platform, will not be exposed to continuously high noise levels.
- The noise level at the drilling platform is of concern from occupational consideration and adequate protective measures aimed at reducing the effect of noise levels will have to be taken for these workers.
- The noise levels predicted for the human settlements will be below the levels specified by the CPCB for residential areas.

4.4.3 Air Environment

For the purpose of impact predictions on air environment, emission sources can be classified into point and area sources. There is no area sources considered for the purposes of predictions. The point sources identified are diesel engines/generator sets at drill site and flaring of gas subsequent to drilling, in the event of striking oil/gas. In this respect, the following are taken into consideration:

- The diesel engines and associated generators will be in operation 24 hours a day during the drilling period, to provide power to the drilling rig, and mud circulation system and for providing power to accommodation units at site.
- Diesel will be used as a fuel for operation of diesel engines/power generators and will contain negligible sulphur and ash content.
- The gas flaring during testing of wells. The gas normally has very little sulphur and ash content.

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Dispersion Modeling for Emission from Flare Testing

Results obtained from dispersion modeling done using meteorological conditions were used to assess the incremental increase in NOx in ambient air. The dispersion model had considered following two possible scenarios that are also applicable in the present case:

- Flaring at the rate of 10,000 m^3/day of natural gas at the drilling site. Such a scenario may occur in case of an oil well having associated gas. For this scenario, computer modeling indicates that a maximum of about 3.5 µg/ m^3 of NOx would result as an 8-hour average GLC (Ground level concentration) due to flaring emissions at a distance of about 100 m from the flare.
- Flaring at the rate of 150,000 m^3/day of natural gas at the drilling site. Such a scenario may occur in case of gas well only. For this scenario, computer modeling indicates that a maximum of about 50 µg/ m^3 of NOx would result as an 8-hour average GLC (Ground level concentration) due to flaring emissions at a distance of about 320 m from the flare.

The concentration limit for NOx (as NO_2) in the ambient air, as specified by CPCB is 80 µg/m^3 for residential, rural and other areas (120 µg/m^3 for industrial areas, 30 µg/m^3 for sensitive areas) and the average baseline ambient air concentration of NOx in the area was found to lie in the range of 3.1 – 12.6 µg/m^3. However, it is to be noted that the monitoring stations for the ambient air quality were located near the towns and human habitations (as otherwise necessary infrastructure facilities were not available) surrounding the Block boundaries, far away from the actual drilling site selected. Hence, the predicted impact level due to the flaring operation will remain within the prescribed limits of CPCB for the ambient air quality.

The dispersion modeling studies conducted for the flaring of natural gas are based on the following assumptions:

- The NOx emission rate is 2.17 g/ m^3 of natural gas flared. (Source: Database "FIRE" generated by the U.S. Environmental Protection Agency).

- The heat emission rate due to the flaring of natural gas is 4.91 x 10^6 Joules/sec. (Source: Robert H. Perry, Don W. Green in Perry's Chemical Engineers' Handbook (7th Edition), McGraw-Hill Publication.)

Emission of gases from power generation on the drill rig is of relatively low volume. Although such power generation emissions will contribute in a small way to the overall pool of greenhouse and acidic gases in the atmosphere, totals emitted are relatively small and local environmental effects will be negligible.

Dispersion Modeling for Stack Emissions

The model

The impact of DG Sets on ground-level concentrations (GLCs) of NOx in ambient air was predicted using the United States Environmental Protection Agency (EPA) SCREEN3 model. Only the impacts of the three DG Sets were considered in the modeling. GLCs were forecast based on the worst meteorological conditions, i.e., high atmospheric stability and low wind speed.

Model Inputs

The only source of emission is from DG Sets used during drilling operation. As a result, stack emission from generators would constitute mainly NO_x. The details of the DG sets are given in **Table 4.3.**

Table 4.3: Stack & Emissions Characteristic

Parameters	Particulars
No. and Capacity of Generators (kW)	448 x 4 (one standby)
Total HSD Fuel Consumption	20 KLD
No. of Stacks	3
Stack Height above the Ground level (m)	30
Stack Diameter (m)	.3048
Flue Gas Exit Velocity (m/s)	22.85
Flue Gas Exit Temperature (K)	623
Emission Rate (g/s)	
NO_x	0.541

Modeling Results

24 Hourly Maximum Ground-Level Concentrations (GLC's) for NO_x to maximum distance (m) in 1 km study area are presented in **Table 4.4.**

Table 4.4 Predicted Maximum GLCs

Parameter	24-Hourly Maximum Concentration (μg/ m^3)	Distance to Maximum (m) & Direction
NO_x	16.8	258 m South West

The 24 hourly maximum GLC's of NO_x is predicted to be 16.8 μg/m^3 at a distance of 258 m from the source towards the south west direction. The baseline concentration of NO_x in the ambient air was observed to be varying from 3.1 – 12.6 μg/m^3. The resultant ground-level concentrations for NO_x after the project will be 19.9 – 29.4 μg/m^3. The GLC's for NO_x is well within the prescribed limits of National Ambient Air Quality Standards (i.e. 80 μg/m^3) for NO_x in residential and commercial area.

The maximum ambient SO_2 levels throughout the area was found not exceeding 8.9 μg/m^3 .It is proposed to use diesel having 1% sulphur as fuel which is lesser than MoEF prescribed limit of 2 % sulphur in fuel. This will lead to low SO_2 emissions. This is not likely to significantly alter SO_2 levels of ambient air.

It is to be noted that the Ambient Air Quality Monitoring stations were located at areas where some amount of human and other activities were present. Compared to this, the well sites will be located far from the human settlements and activities, where the parameters are expected to have even lower values. Thus, the contribution of the drilling activities to the overall ambient air quality will be insignificant considering the actual background values.

Practical steps to limit atmospheric emissions are undertaken during all drilling operations and these will be adopted during the drilling program for the proposed exploration wells. These include:

- Advanced planning to ensure efficient operations;
- Well maintained and operated equipment and generators;
- Regular monitoring of fuel consumption.
- An alternative way of sampling down hole liquids and gases and checking their pressures will be used to reduce the amount of exposure to hydrocarbons at surface (RFT). In this method of testing the well, flaring is eliminated, however results are limited and interpretation is used to extrapolate results. The results are then used to identify key sands to be tested conventionally.

4.4.4 Water Environment

The survey of the water environment in the area reveals that both surface water and ground water sources are free from the usual contaminants (Chapter 3). However, the surface water is likely to be bacteriologically contaminated. The water can be used for drinking and other purposes after appropriate disinfection procedure.

During the drilling operations, the wastewater generated will consist of the spent drilling fluids, waste liquid and water used for washing. This wastewater will be appropriately treated and temporarily contained in specially designed lined pits (HDPE liner) pits during the drilling process. This is in line with CPCB regulations and will ensure no percolation into the ground. The composition of the drilling fluid is largely water and barite, bentonite with additives like K_2SO_4 and glycol. The samples of barite & bentonite to be used will be tested for heavy metals to confirm that heavy metals are below the prescribed discharge limits set by the CPCB. The wastewater will be treated mainly through flocculation & precipitation of sulphates & diluted prior to discharge.

Separate drainage facilities will be provided for storm water and other non-harmful effluents. This run off will be channeled to a drilling mud source water pit to be used for drilling and dilution operations. These measures will ensure minimum infiltration into ground water resources of the area.

The toilets and urinal at the site for use by the onsite personnel will be attached to a standard sewage system comprising of soak pits and septic tanks with concrete base to avoid infiltration of sewerage water into the soil and ground water system.

Other possible contaminants are chemicals associated with the cementing process these will be caught in the return fluid during cementing and treated with the mud effluents.
In order to minimize potential environmental impacts on water bodies, the following measures will be incorporated into the drilling and Environment Management Plan (EMP):

- Installation of cuttings and fluid cleaning/treatment equipment to ensure optimal cleaning of cuttings to reduce as far as practicable, the amount of fluid that will be discharged with the cuttings. The waste fluid generated will be treated and either reused or diluted and discharged.
- Putting in place management procedures to ensure optimal performance of the cuttings cleaning equipment and shaker screen housekeeping.
- Maintaining a continuous drill fluid mass balance throughout the drilling programme.
- Ensure that the surface water in the vicinity of the drill rig (if any) is monitored during drilling for any possible adverse impact.

Water generated from rig wash down may contain trace amounts of drill fluid, lubricants and residual chemicals resulting from small leaks or spills. The volume of these discharges depends on the frequency of wash down and amount of rainfall. The wash down areas, all storage areas and areas that might otherwise be contaminated with oil will be made of concrete and would be segregated from other areas to ensure that any accidental spills are contained and the fluid separately treated.

4.4.5 Land Environment

The major waste product from a drilling operation is the generation of rock cuttings, plus small amount of associated residual fluids adhering to the cuttings. These cuttings will be treated and then stored at site in HDPE lined pits.

Other waste products include garbage, food scraps, scrap metal, waste oil and surplus chemicals. Careful attention will be given to minimizing the amount of waste generated and controlling its eventual disposal. Where possible all waste material will be segregated by type, color, and garbage will be stored in a designated area. These wastes will be stored in suitable containers and will be recycled or disposed of in a controlled manner through authorized waste contractors. Material like scrap metal, waste oil and surplus chemicals will be sent for recycle or reuse as far as practicable.

Also, regarding the disposal of sewage, a septic tank and a soak pit arrangement will be provided at site comprising of two-compartment waterproof chamber (designed as per the no. of users) which will receive all waste from the toilet blocks. The night soil will undergo decomposition in the first chamber through an anaerobic process and subsequently flow into the second chamber. The two chambers will have an orifice between at a designed level normally 1-1.5 meters above the floor level. Most of the decomposed waste will be retained in the first chamber and any suspended waste settles down in the second chamber. The effluent water will be allowed to move into a soak pit, which is a deep circular pit dug below the NGL, partially lined at the circumference and stacked with brick bats. The structure will be covered at the top. Water will trickle through the bricks and be soaked in the ground.

The other impacts on the land environment will be due to vegetation loss during construction of the access road and preparation of the drilling site. The removal of trees/bushes will be kept to a minimum required for operations.

4.4.6 Socio-Economic Environment

The drilling activities are likely to have the following impacts on the existing socio-economic profile of the area:

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- The proposed activities will generate employment in the region due to the requirement of workers in road construction, site preparation, supply and transport of raw materials and equipment, auxiliary and ancillary works, etc. These would give temporary relief to the people of the locality and their socio-economic conditions would improve.
- The activities would also result in enhancement of the local skill levels through exposure to drilling activities and technology, and help in capacity building for future employment opportunities.
- As the existing surface roads, tracks will be upgraded to facilitate the movement of the heavy equipments and vehicles, the project in turn would lead to improvement in transport facilities in the area.
- In the event of commercial quantities of hydrocarbon reserves being discovered, more long-term employment opportunities are likely to be created. Besides, the hydrocarbons brought to the surface will help in contributing to the ongoing efforts of the government to meet the national demand of petroleum resources.
- There can be occupational hazards such as personal injuries, accidents during installation and operation of drilling rigs, in case safety measures are not adequately implemented. However, Block operator will follow stringent Health Safety and Environment practices for all its operations, which are to be followed by all employees, consultants and contractors working for this exploration programme.
- To generate goodwill and improve the quality of life of the people, the proponent may develop a strategy to invest in the social welfare of the area.