

## **4.0 IMPACT ASSESSMENT AND MITIGATION MEASURES**

This chapter presents the identified environmental impacts due to the proposed exploratory drilling and proposed mitigation measures for minimizing or avoiding adverse impacts as well as other best practices. The proposed mitigation measures will be implemented during exploratory activities.

### **4.1 Impact Assessment**

Generally, the environmental impacts can be categorized as either primary or secondary. Primary impacts are those, which are attributed directly by the project and secondary impacts are those, which are indirectly induced and typically include the associated investment and changed patterns of social and economic activities by the proposed action.

The drilling programme can be considered as a temporary activity which lasts for about 4-5 months at each well location. No above ground permanent structure, except the well head will be built at the well locations during the exploratory drilling phase of the project. The well site once drilled will be temporarily suspended / permanently abandoned based on the success and the rig will be moved to next location. Anticipated impacts from the proposed project can be classified into the following phases:

#### a) Well site and Access Road construction

- Impacts from location of drill sites on land-use, aesthetics, vegetation and drainage pattern;
- Impacts on vegetation and soil from site clearance;
- Impact on ambient air from fugitive dust and vehicular exhaust emissions;
- Impact on soil from construction activities;
- Impact on socio-economics from local employment and use of local resources; and
- Impact on local community from temporary land acquisition, noise and disturbance.

#### b) Drilling Operation

- Impacts from handling and disposal of drill cuttings and waste drilling mud;
- Impact on ambient air from DG set and vehicular emissions;
- Impacts from wastewater generation during drilling and camp site operations;
- Impacts from noise generating equipments e.g. DG sets, land rig and vehicles;
- Impact from transportation of material;
- Impact on local water resources due to use of water for drilling operations; and
- Impact from well testing on local environment.

#### c) Decommissioning and Site Restoration

- Impacts from waste handling and management;
- Impacts on local drainage pattern;
- Potential impacts from migration of fluids in well bore; and
- Impact on local community (farm owner).

#### 4.1.1 Method of Impact Identification

Both beneficial as well as potential adverse impacts may be expected on the environment from the proposed drilling activities. The impacts may be direct or indirect, short or long term and reversible or irreversible. The present environmental quality has been taken into consideration while assessing the magnitude and importance of specific impacts.

The techniques used for assessment of impacts are both qualitative and quantitative. Qualitative assessment is based on historical evidence and available literature. Quantitative assessment has been carried out for potential air and noise pollution impacts, the results of which will be used for siting of well sites, i.e., by maintaining safe distances from sensitive receptors.

## 4.2 **Anticipated Impacts from the Project**

The potential environmental impacts from the project are discussed in the following sections.

#### 4.2.1 Land use and Aesthetics

Impact on land use and aesthetics is expected to be from vegetation clearance, excavation, leveling and grading of the site. Thus there might be need for clearing crops and trees. As the land requirement for each drill site is quite small (1.5-2.0 ha) compared to the large stretches of agricultural land there would be insignificant change to land use. Movement of heavy vehicles, earth moving equipments, piling of removed soil at the site periphery during construction would have aesthetic impacts.

#### 4.2.2 Land Required for Drilling Activity

Though exploratory / appraisal drilling is a temporary activity yet the period for which the land is required would depend on discovery of hydrocarbons. Approximately, 15,600 m<sup>2</sup> of land for drilling rig facilities would be impacted for each drill site. The actual drilling platform area would be approximately 5,200 m<sup>2</sup>. The parcel of land would be temporarily acquired as per the applicable laws and in consultation with the land owners. Adequate compensation for loss of income from that piece of land, including crop loss, tree loss and any other direct or indirect loss as determined by the local revenue officials would be paid to the landowner.

Drilling rig activities will result in disturbance and compaction of soils within a 1.0 ha zone around the drilling rig due to equipment, vehicles. Access roads to the drilling sites will also impact top soils. The total loss of soils as a result of exploration drilling with probably be in the order of 3-5 ha per well, depending on the length of access road required to access each site.

#### 4.2.3 Topography & Drainage

There would be slight change in topography at the drill site as it will be elevated from ground level to avoid storm water accumulation. The study area has hilly terrain and is almost devoid of approach roads with elevations varies from MSL 400 m to 2000 m. There would be minor changes in the natural drainage pattern at

immediate vicinity of the well site. This impact would be substantially further reduced as the identification of wells sites would consider local drainage patterns in the area. Additionally the grading of the drilling site will be done keeping in mind that the existing aerial drainage flow pattern of the well site location. As drilling is a single point activity at each well location there will not be any change in subsoil drainage patterns.

#### 4.2.4 Impacts on Soil Quality

During construction the major impacts on soil would occur due to excavation, compaction due to movement of heavy equipment and levelling as well as pollution due to addition of moorum. Site preparation will entail stripping and removal of the topsoil which contains most of the nutrients and organisms that give soil a living character and productivity. This will in turn result in minor changes in soil hydrology and small changes in the topsoil structure. However, as the project design takes into account the preservation of the top soil and its subsequently use for topping up of the rehabilitated land. The impact on soil quality will be insignificant considering the mitigation measures implemented.

The hazardous wastes generated from the exploratory drilling operations include drill cuttings, drilling mud, spent lube oil and waste oil (Category 2.2, 2.3, 5.1 and 5.2). Apart from the above, packaging wastes, used containers and any contaminated soil arising out of any accidental oil spillages during the Drill Rig movements and operations etc. are also expected to be generated from proposed drilling activities.

##### 4.2.4.1 *Soil Contamination*

Drilling wastes are generated during drilling operation through various geological formations to reach the reservoir that might hold the hydrocarbons. The mud used brings the rock cuttings (generated from drilling) to the surface, which along with the mud are called drilling wastes. Drilling operations are typically associated with a range of wastes such as drilling mud, used oils, hydraulic fluids and various discarded chemical products, empty drums and sacks, acids, surfactants, cement, biocides, solvents, and camp wastes.

The chances of soil contamination are from the storage and handling practices of chemicals and fuels, surface runoff carrying contaminated substances. The drilling mud and the cuttings could also add to the sub surface contamination if not handled appropriately. ONGC has considered all the above aspects and have incorporated all these aspects in the well sites design.

##### 4.2.4.2 *Alteration of Soil Quality by Loss of Topsoil*

Loss of topsoil in these areas, either by mechanical removal or by erosion would alter the soil structure with resultant implications for revegetation.

Measures inherent in the design of the project to minimize loss of topsoil and overburden are as follows:

- Topsoil suitable for supporting agriculture, removed during site clearance will be retained, stored as a berm on the edge of the well site, protected from erosion by plastic sheeting;

- Native vegetation, wherever appropriate will be kept at the edge of the well site as a seed bank, or replanted at an alternate location or will be used to protect/stabilize soil surfaces on slopes;
- On demobilization, adequate measures would be provided to facilitate re-growth and hence retention of topsoils; and
- Planned and systematic tree replanting program will be put in place.

On consideration of the poor vegetation cover, the physical features of the proposed exploration block, the impact of drilling operations on soil quality will be insignificant. It is, however, important that mitigation measures are monitored to ensure that they are effective.

Summary of impacts on soil and land use are given in **Table-4.1**.

**TABLE-4.1**  
**SUMMARY OF IMPACT ASSESSMENT: SOIL AND LAND-USE**

Impact Area	Nature of Impact <sup>1</sup>	Targets/Interests <sup>2</sup>	Magnitude and extent <sup>3</sup>	Overall Magnitude <sup>4</sup>
<b>Land Use</b>	Change in original land use, land degradation, reversible (partially)	Original land use	Well sites and access roads only, small scale; beneficial effect for afforestation and all weather access roads.	○ Minor
<b>Derogation of Soil Quality</b>	Cumulative contamination with dust, surface run-off; reversible	Soil quality, flora and fauna, including grazing livestock	Localised near sources; small contribution to existing background levels;	○ Minor
	Physical effects on soils due to topsoil removal, nutrient loss; reversible	Soil quality, flora	Around the well location small scale degradation of soil quality	○ Minor
<b>Soil Contamination</b>	Subsurface contamination due to spillage and handling of the chemicals and other waste materials, reversible(partial)	Soil quality, groundwater flora and fauna and the grazing livestock	Localised near the source of operation and could be nullified with proper house-keeping & waste management	○ Minor

<sup>1</sup> Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc

<sup>2</sup> Targets and interests potentially affected.

<sup>3</sup> Adverse or beneficial; small, large, etc; very localised (sites only), local, regional national.

<sup>4</sup> Overall significance against criteria (○ minor; •moderate, some significance; ••major)

The mitigation measures inherent in the design of the well site, together with rigorous implementation of the waste management plan will ensure that significant impacts in relation to soil quality are not anticipated at the well site.

#### 4.2.5 Impact on Topography and Climate

##### 4.2.5.1 *Impact on Topography*

The envisaged topographical changes would be due to the manmade structures like drilling rig and other associated structures. As mentioned previously drilling exploratory well is a short duration activity at each drilling location, typically encompassing a period of 3-4 months from land acquisition to site abandonment. The impact would therefore be localised, temporary and minimal.

##### 4.2.5.2 *Impact on Climate*

Impact on the climatic conditions from the drilling will not be significant. The maximum temperatures of the exit gas from the DG stack and flare stack will be around 300°C and 400°C respectively. In terms of total emission of green house gases and consequent impact on global warming or on potential for local increase of ambient temperature, considering the quantum of exit gas and the total duration of flow, the impact on the local or global climate will be insignificant.

#### 4.2.6 Impact on Air Quality

The potential sources of air emissions at the well sites will be as follows:

- Dust from earth works (during approach road and site preparation);
- Emissions from DG sets;
- Emissions from possible flaring during well testing; and
- Emissions from vehicles.

During the short period of site preparation mechanical shovels and earthmovers will be used for vegetation clearance, cut and fill and other site leveling activities. These activities could generate dust particles which will be mobilized by wind, and deteriorate the ambient air conditions. However, these activities will be only temporary and with the clay nature of the soil, the impact to ambient air quality would be within the close proximity of well site.

All the anticipated air emissions other than dust arise from combustion of hydrocarbons. The pollutants of concerns are NO<sub>x</sub>, SO<sub>2</sub>, CO, Particulate, and un-burnt hydrocarbons.

##### 4.2.6.1 *Potential Impacts*

Ambient air quality effects are normally assessed in relation to their potential to cause:

- Health deterioration and nuisance in local communities;
- Health deterioration amongst on site workers; and
- Damage to vegetation.

The gaseous emissions from the DG set will be controlled by efficient combustion of fuel in the DG set. The flaring of oil and gas during well testing is a short duration activity (about 14 - 21 days) and will be done within a ground level enclosed pit. Wherever, required special precautions will be taken to minimize the impact on the local environment and habitat.

The impact on ambient air quality is assessed hereunder considering the following:

- The air quality impacts have been predicted for the proposed drilling; and
- Site-specific meteorological parameters have been recorded. Short-term 24 hourly GLC's incremental values were estimated using the site-specific meteorological data.

#### 4.2.6.2 Fugitive Emissions

Air pollution during construction would be primarily due to fugitive emissions from vehicular movement, site preparation activities and material handling. Weathering of soil would take place as a result of clearing of vegetation, excavation and movement of heavy vehicles. The weathered soil generates dust due to re-entrainment during vehicular movement and equipment mobilization. Such dust emissions as experienced in other similar construction activities are of larger than  $10\mu$  (more than respirable range) and propagates to short distances. These emissions only have nuisance factor affecting workers at site. Use of dust masks would be adequate to mitigate impacts on workers.

Fugitive emissions of VOC may result from the vents from the venting of un-burnt methane from well testing. However, the testing phase will be short duration of 14 - 21 days.

Fugitive emissions in the form of material dust is expected during drilling operations (loading, unloading, handling of drilling fluid, chemical additives, cement and cement additives). Some fugitive emissions are also anticipated from storages of volatile chemicals and fuel at the site if the storages are not properly capped or are handled without due care. However, such emissions will not disperse widely and can only affect workers and people at site. Fugitive emissions during drilling operations are however not as significant as during site preparation. Fugitive emissions during drilling are not expected to travel beyond project boundaries. Workers working near fugitive emission sources are only susceptible which would be mitigated through use of PPEs in these areas.

#### 4.2.6.3 Air Pollution Modeling

Prediction of impacts on air environment has been carried out employing mathematical model based on a steady state Gaussian plume dispersion model designed for multiple point sources for short term. In the present case, **AERMOD** dispersion model based on steady state gaussian plume dispersion, designed for multiple point sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from point sources.

#### 4.2.6.4 Pollutants/Model Options Considered For Computations

The model simulations deal with two major pollutants viz., Sulphur dioxide ( $SO_2$ ) and Oxides of Nitrogen ( $NO_x$ ) emitted from the DG sets.

### **Model Options Used For Computations**

The options used for short-term computations are:

- The plume rise is estimated by Briggs formulae, but the final rise is always limited to that of the mixing layer;
- Stack tip down-wash is not considered;
- Buoyancy Induced Dispersion is used to describe the increase in plume dispersion during the ascension phase;
- Calms processing routine is used by default;
- Wind profile exponents is used by default, 'Irwin';
- Flat terrain is used for computations;
- It is assumed that the pollutants do not undergo any physico-chemical transformation and that there is no pollutant removal by dry deposition;
- Washout by rain is not considered;
- Cartesian co-ordinate system has been used for computations; and
- The model computations have been done for 10 km with 1000-m interval.

#### *4.2.6.5 Model Input Data*

- ***Emissions from DG Stacks***

Air pollution from point sources at the drill site will be primarily contributed by the DG sets. Drilling requires a considerable amount of electric power and as a result will need the installation of DG sets which can supply around 2250 KVA of power at peak periods. The primary pollutants emitted by DG Sets consist of Oxides of Sulphur and Nitrogen, Carbon monoxide, Carbon dioxide and Hydrocarbons. Combustion of fuel in a DG set typically happens at high temperatures resulting in generation of considerable amounts of NO<sub>x</sub>. The SO<sub>2</sub> concentration in emissions is dependant on the Sulphur content in fuel burnt and particulate matter consists of unburnt Carbon particles.

The emission from each of the power generator sets in the drilling rig will be due to combustion of diesel. For a particular drilling site during drilling operation, there will be 3 operating DG sets, as detailed in **Table-4.2**.

**TABLE-4.2**  
**DETAILS OF DG SETS**

<b>Location</b>	<b>DG Capacity</b>	<b>Operational</b>	<b>Stand by</b>	<b>Fuel Requirement</b>
Drilling Site	750 KVA	3	1	HSD - 6 KL/day

The operational DG sources are considered as source for the modeling. The emission from each of these diesel generators will be due to combustion of diesel.

- ***Emissions from Flare Stack***

Another major source of emission from a single point is flaring pit. Flaring will be conducted only in the event of a hydrocarbon discovery. Flaring will be avoided as far as practicable for liquid hydrocarbons as these would be collected for surface testing and transported to legally approved entities. There is maximum



probability of only gas being flared from a specially designed pit. Though flaring is a point source yet the dispersion of emission starts at the ground level as it would be carried out in a pit. Flaring of gases is a high combustion process which generates nitrogen oxides as pollutant. There are negligible quantities of particulates, Sulphur dioxide or other pollutant. Improper flaring may however lead to escape of unburnt hydrocarbons (primarily) CH<sub>4</sub>.

- **Modelling Scenarios**

Emissions from diesel generator sets will be continuous throughout the drilling operations. The main pollutants from diesel generator sets include NO<sub>x</sub> and SO<sub>2</sub> while NO<sub>x</sub> is the main pollutant expected to emit from test flare. As the fuel used is low sulphur HSD, insignificant amount of particulate emissions and gaseous emissions are envisaged. Similarly, during flaring also, particulate emissions are negligible.

The emission characteristics considered for the modeling exercise from DG generator sets and test flaring are given in the **Table-4.3**. The emission rate calculations for air dispersion modeling are given in **Annexure-VII**.

**TABLE-4.3**  
**EMISSION CHARACTERISTICS-MODEL INPUTS**

Sr. No	Particulars	DG Set (3 x 750 KVA)
1	No of engines and stacks	3
2	Height above ground level (m)	7.5
3	Diameter (m)	0.5
4	Gas temperature (°C)	300
5	Gas velocity (m/s)	15
6	Emission rate (g/s) - Sulphur dioxide - Oxides of Nitrogen	1.25 0.15

#### 4.2.6.6 Presentation of Results

Model stimulation was carried out for pollution SO<sub>2</sub> and NO<sub>x</sub>. The results for SO<sub>2</sub> and NO<sub>x</sub> [1<sup>st</sup> maximum] are presented in **Table-4.4**. The isopleths for SO<sub>2</sub> and NO<sub>x</sub> concentrations are depicted in **Figure-4.1** and **Figure-4.2**.

**TABLE-4.4**  
**PREDICTED 24-HOURLY SHORT TERM INCREMENTAL CONCENTRATIONS**

Season	SO <sub>2</sub>		NO <sub>x</sub>	
	Maximum Incremental Conc. (µg/m <sup>3</sup> )	Distance (km)/ Direction	Maximum Incremental Conc. (µg/m <sup>3</sup> )	Distance (km)/ Direction
Winter & pre-monsoon	2.8	1.0, N	6.4	1.0, N

- **Comments on Predicted Concentrations**

A perusal of **Table-4.4** reveals that the maximum incremental short term 24 hourly ground level concentrations for SO<sub>2</sub> and NO<sub>x</sub> likely to be encountered due to DG





sets are  $2.8 \mu\text{g}/\text{m}^3$  and  $6.4 \mu\text{g}/\text{m}^3$  occurring at a distance of 1.0 km in north direction.

The predictions indicate that the  $\text{SO}_2$  and  $\text{NO}_x$  concentrations are likely to be well within the prescribed limit for residential and rural zone. Based on the above it can be inferred that the ambient air quality in the study area is unlikely to be affected due to the proposed drilling.

• **Resultant Concentrations After Implementation of the Project**

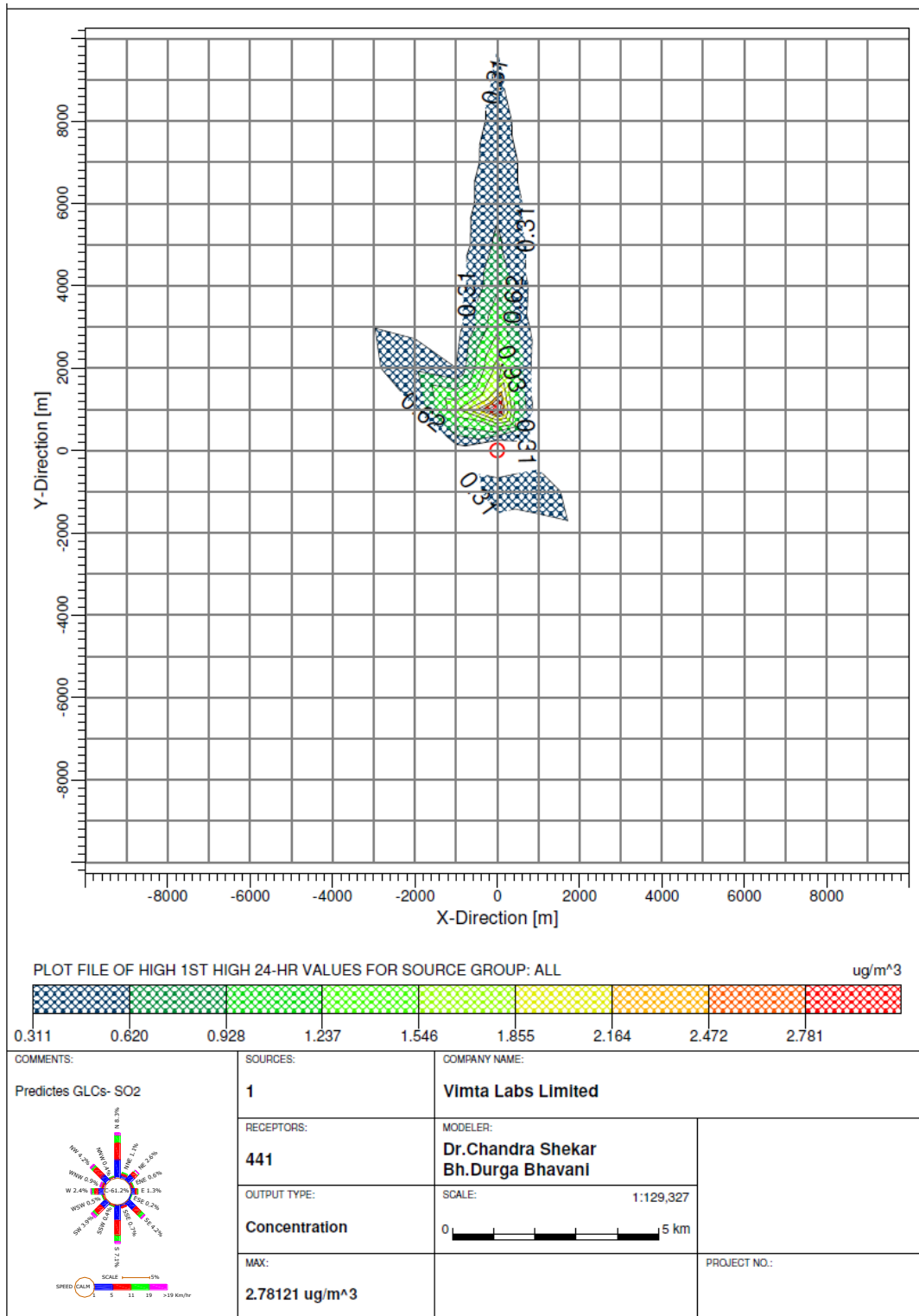
The maximum incremental GLCs due to the proposed project for  $\text{SO}_2$  and  $\text{NO}_x$  are superimposed on the maximum baseline  $\text{SO}_2$  and  $\text{NO}_x$  concentrations recorded during the study to arrive at the likely resultant concentrations during winter season after commissioning of the proposed drilling. The cumulative concentrations (baseline + incremental) after implementation of the project are tabulated below in **Table-4.5**.

**TABLE-4.5**  
**RESULTANT CONCENTRATIONS DUE TO INCREMENTAL GLC's**

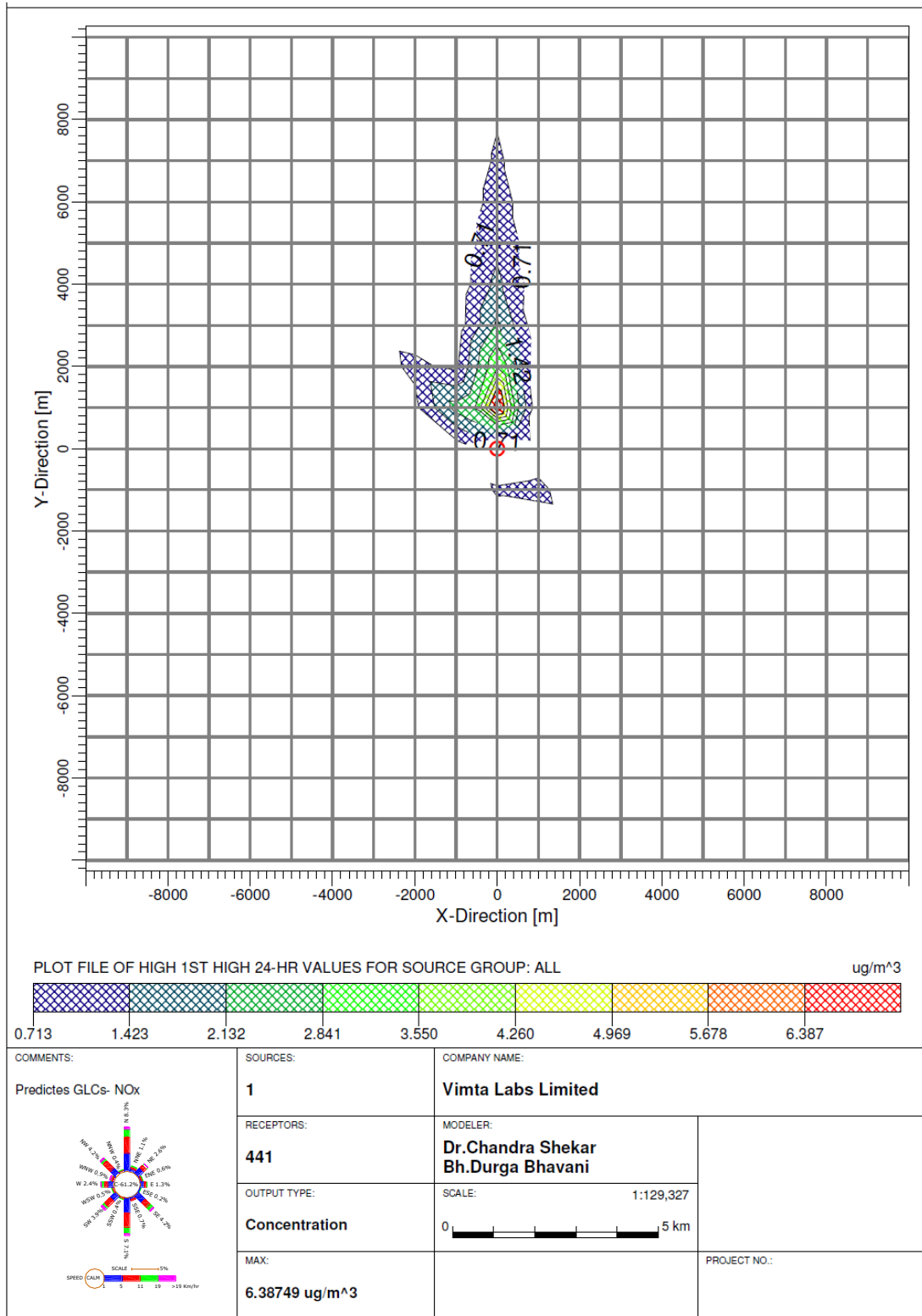
<b>Pollutant</b>	<b>Maximum AAQ Concentration Recorded During the Study</b>	<b>Incremental Concentration due to drilling</b>	<b>Resultant Concentration</b>
<b>SO<sub>2</sub></b>	12.7	2.8	15.5
<b>NO<sub>x</sub></b>	13.8	6.4	20.2

All values are in  $\mu\text{g}/\text{m}^3$

The maximum GLCs for  $\text{SO}_2$  and  $\text{NO}_x$  after implementation of the proposed project are likely to be within the prescribed standards for rural and residential areas. However, the maximum GLCs are occurring during test flaring which is for a period of 14-21 days at each location. Further considering that the maximum GLCs occur at about 1.0 km, which is in the vicinity of the site boundary, no impact on outside environment is envisaged. Based on the above details, it can be inferred that the ambient air quality in the study area is unlikely to be affected due to the proposed activity.



**FIGURE-4.1**  
**SHORT TERM 24 HOURLY GLCs OF SO<sub>2</sub>**



**FIGURE-4.2  
SHORT TERM 24 HOURLY GLCs OF NOx**

#### 4.2.7 Impact on Surface Water and Groundwater Quality

The study area is having small tributaries river system. The block area is drained by some small tributaries. Location of well sites near to the rivers and major water bodies is however ruled out and thus any direct impact on water bodies is not anticipated.

Therefore considering the water availability and abundant sources, there would be insignificant impacts on water resources due to usage in the project.

Surface water quality in the region has been found to be of good quality and is being used by villagers for irrigation and other domestic purposes. Ground water in the region is potable in nature.

##### 4.2.7.1 Sources of Pollution

In general circumstances, the surface water impacts that could be potentially caused from the drilling activities are as follows:

- Withdrawal of groundwater;
- Accumulation of the wastewater in the drilling site;
- Potential wastewater discharges may arise from the following sources:
  - Treated domestic effluent (sewage and kitchen waste);
  - Spent drilling muds, cuttings and completion fluids disposal;
  - (Potentially) contaminated storm water drainage from the derrick floor and other systems;
  - Seepage of drilling mud fluid into subsoil from mud collection & recirculation pond;
  - (Potentially) high sediment loads in runoff from unpaved well site areas during heavy shower; and
  - Any produced water and liquid hydrocarbon fractions collected in the test separator during well testing.
- Potential accidental spills of fuel, lubricants or chemicals and leaks from engines (i.e. power generators, vehicles) and liquid hydrocarbons during testing; and
- Waste handling particularly spent lubricants and chemicals during disposal may give rise to accidental releases.

##### 4.2.7.2 Potential Surface and Groundwater Impacts

Based on the above-mentioned activities, the following potential impacts have been identified:

- Potential for water logging during monsoon in the site;
- Potential for adverse impact on the surface water quality;
- Potential for adverse impact on the groundwater quality; and
- Likely change in the aquifer potential within the study area.

#### 4.2.7.3 Water Pollution

- **Process Wastewater**

Approximately 15-20 m<sup>3</sup>/day of wastewater would be generated from the drilling operation including minor quantities from washing and cleaning of rig floor and other equipments. Water based drilling mud is non-hazardous in nature. The primary pollutants in the wastewater would thus be suspended solids, dissolved solids and traces of floating oil from washing of rig floor and other equipments.

Effluents can cause significant pollution to water bodies especially ponds and lakes if disposed untreated. However, the wastewater will be collected in lined pits and clarified wastewater will be treated in packaged treatment plant located at the well sites to meet norms specified by CPCB and MPCB for discharge to land and surface water bodies.

- **Sewage**

It is estimated that approximately 8 m<sup>3</sup>/day of sewage will be generated from each well site. The sewage will be discharged into septic tanks and then to subsoil through soak pits. The subsoil in the area is found to be rich in organic content and micro-organisms. No impacts are thus envisaged from sewage disposal from site.

- **Pollution Potential from Surface Runoffs**

As the area experiences high rainfall, the site will generate considerable volume of runoffs during such rainy periods. The storm water generally contains high concentration of suspended matter eroded from the soil by the runoff. There is also a potential for contamination of the storm-water if the runoff picks up contaminants in the form of chemicals, oil and lubricants, etc. that could have been spilled or if material is stored in open areas (uncovered) in any particular area like the fuel storage or the non-hazardous chemical storage areas. This may result in a potential impact to the receiving water body.

- **Potential Impacts on Ground Water and Hydrogeology**

There is a probability that during excavations, especially if conducted immediately after monsoon may lead to development of springs which may have to be dewatered.

- **Reduced Infiltration**

The compaction of the working areas for setting up heavy machineries and equipments like the rig may lead to increased runoff and reduced infiltration, thereby affecting localised subsurface groundwater recharge. However, given that the occupation of the area is temporary and the area experiences high rainfall and thereby high recharge potential, the effect on the groundwater regime of the area will not affect water availability in neighbouring wells and tube wells and any resulting conflict with other users of groundwater in the area.

#### 4.2.7.4 Impact to Surface Water Quality

The probability of contamination of surface water bodies and sub-surface water bodies was discussed above. The impact to the surface water bodies could arise from discharge from the site, disposal practice of spent drilling mud, cuttings, completion fluids, handling of liquid hydrocarbons, fuels etc. With the proposed concrete pavement and secondary containment provisions, the surface water quality contamination will be negligible.

Noticeable impacts to water quality in nearby watercourses are more likely to occur as a result of increased suspended particle load. During the well site preparation the extent of impact to nearby watercourses will be function of:

- Area cleared;
- Amount of rainfall from the period between site construction and drilling;
- Distance of the watercourse from the well site; and
- Mitigation measures to prevent any soil erosion within well site.

However, if the site preparation activities were conducted in dry season, the above impact would be negligible or insignificant. Overall, with the appropriate measures to protect the well site and prevent discharges, installation of soil erosion control measures, prevention of spillages while handling and management of chemicals, the likely chances of impact on surface water will be minor.

#### 4.2.7.5 Impact on Groundwater Regime

The water is used for preparing drilling mud and for domestic needs of the campsite. The water requirement is primarily depended upon the depth of the proposed well and time required for the drilling the well. The drilling fluid will be recycled and fresh water will be used as makeup water and for general washing and daily maintenance. The water requirement is proposed to be met from the local sources through water tankers. Since the drilling activity being temporary and water requirement is meager, no adverse impact on ground water resources is envisaged.

ONGC is using water based non-toxic biodegradable fluids with inhibitive and encapsulative characteristics as drilling mud. Additionally, the drilling mud collection and recirculation pond is lined with impervious layer to prevent seepage and loss of drilling fluid into the subsoil. Further, proper casing installation and cementing will ensure least groundwater contact.

Apart from the mud characteristics, the waste and spent mud would be disposed in polyethylene propylene lined pits for all the storage areas as per the EHS Management Plan – Civil works. The mud components during the storage form a bentonite (clay) lining along the pit wall preventing the seepage of water to the underground strata. Any hydrocarbons contamination will be skimmed off from site before proceeding to the next site so as to ensure that no leaching or subsurface contamination finally reaches the groundwater table. The waste oils and the skimmed oils collected from the drill site will be sent to the MPCB authorized recyclers.

Overall, with the appropriate management practices in place impacts on groundwater quality at the site is likely to be insignificant. The summary of impacts on water resources is given in **Table-4.6**.

**TABLE-4.6**  
**SUMMARY OF IMPACT ASSESSMENT: WATER RESOURCES**

Impact Area	Nature of Impact <sup>1</sup>	Targets/Interests affected <sup>2</sup>	Magnitude and extent <sup>3</sup>	Overall significance <sup>4</sup>
<b>Surface Water</b>				
<b>Physical Impact</b>	Long term modification to the distribution of rain water catchment, if located near it	Local inhabitants depending on the water harvesting for water	Local, could be mitigated by avoiding water harvesting areas	• <b>Minor</b>
	Short term due to increase in siltation load of the water bodies in rainy season	Localized impact to surrounding Rivers and adjoining the water bodies in monsoon	Regional, and for short term	• <b>Moderate</b>
<b>Chemical Impact</b>	Short term contamination of surface water flows due to untreated effluent, run-off, seepage from water holding tanks etc.,	Localised impact to surrounding nallahs and the river bodies in monsoon	Local, small scale mitigated by well site design and operations	• <b>Minor</b>
	Long term contamination in the region due to surface runoffs from well sites during flash floods	Could also result in sub surface contamination around the region	Regional, dependent on occurrence of flood. Good engineering practices will reduce risk of flooding and overflow	• <b>Moderate</b>
<b>Ground Water</b>				
<b>Groundwater quantity</b>	Long & medium term, reduction due to percolation of subsurface contamination	Shallow aquifers surrounding the well sites	Local/Regional possibility remote with mitigation measures	• <b>Minor</b>
<b>Resource Management</b>				
Resource Management	Long term, medium reduction	Judicious abstraction of water for usage	Regional, Can be mitigated by sourcing water from water surplus catchment areas. Drill site borewell can be used by locals after drilling, if water quality is acceptable	• <b>Minor</b>
<sup>1</sup> Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc <sup>2</sup> Targets and interests potentially affected. <sup>3</sup> Adverse or beneficial; small, large, etc; very localised (sites only), local, regional national. <sup>4</sup> Overall significance against criteria (○ minor; • moderate, some significance; •• major)				



#### 4.2.8 Impact on Noise Levels

##### 4.2.8.1 Sources

During the drilling operation at the well sites, there would be various sources of noise in the area. These sources would be:

- Drilling draw works/rotors;
- Mud Pumps;
- Power generators;
- Vehicular Movement; and
- Cranes and material handling equipment.

##### 4.2.8.2 Potential Impacts

Ambient noise quality is normally assessed in relation to its potential to cause:

- Health deterioration and nuisance in local community;
- Health deterioration amongst on site workers; and
- Disturbances and fragmentation to local habitats.

##### 4.2.8.3 Assessment of Noise Impacts due to Site Activities

Driller rotors and the power generators and pumps would be the main sources of noise pollution during the drilling activity. Noise due to vehicular movement will be intermittent, but will also add to the background noise levels. The well site during excavation phase of the site preparation where heavy earth moving machinery will be in operation, noise level of the vehicle should not be more than the 90 dB (A).

Typically, the noise generating sources for the onshore drilling activity are provided below (in the immediate vicinity)

- |                           |                  |
|---------------------------|------------------|
| • Diesel Generator        | : 90 to 95 dB(A) |
| • Pumps at the Rig        | : 85 to 90 dB(A) |
| • Miscellaneous           | : 80 to 85 dB(A) |
| • Control Room & Quarters | : 50 to 60 dB(A) |

In order to predict ambient noise levels due to the proposed drilling the preparative modeling has been done. For computing the noise levels at various distances with respect to the plant site, noise levels are predicted using an user friendly model the details of which is elaborated below.

##### 4.2.8.4 Details of Noise model

- **Mathematical Model for Sound Wave Propagation During Operation**

For an approximate estimation of dispersion of noise in the ambient from the source point, a standard mathematical model for sound wave propagation is used. The sound pressure level generated by noise sources decreases with increasing distance from the source due to wave divergence. An additional decrease in sound pressure level with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

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 principles, as per the following equation:

$$L_{p2} = L_{p1} - 20 \log(r_2 / r_1) \quad (1)$$

Where  $L_{p2}$  and  $L_{p1}$  are Sound Pressure Levels (SPLs) at points located at distances  $r_2$  and  $r_1$  from the source. The combined effect of all the sources then can be determined at various locations by the following equation.

$$L_{p(\text{total})} = 10 \log(10^{(L_{p1}/10)} + 10^{(L_{p2}/10)} + 10^{(L_{p3}/10)} \dots) \quad (2)$$

Where,  $L_{p1}$ ,  $L_{p2}$ ,  $L_{p3}$  are noise pressure levels at a point due to different sources.

Based on the above equations an user friendly model has been developed. The details of the model are as follows:

- \* Maximum number of sources is limited to 200;
- \* Noise levels can be predicted at any distance specified from the source;
- \* Model is designed to take topography or flat terrain;
- \* Coordinates of the sources in meters;
- \* Maximum and Minimum levels are calculated by the model;
- \* Output of the model in the form of isopleths; and
- \* Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured  $L_{eq}$  levels.

#### 4.2.8.5 Input for the Model

The incremental increase in noise levels due to the operation phase of the exploratory drilling has been done. Noise levels are mainly generated from DG sets, air compressors, pumps and transformers. The noise sources have been defined with respect to center of drill site. The input data pertaining to corresponding noise level are tabulated below in **Table-4.7**.

**TABLE-4.7**  
**INPUT DATA FOR NOISE MODELING**

Sr. No.	Location	Noise Levels dB(A)
1	Diesel Generator sets	90 to 95
2	Pumps and the rig	85 to 90
3	Miscellaneous	80 to 85
4	Control Room and Quarters	50 to 60

#### 4.2.8.6 Presentation of Results

The model results are discussed below and are represented through contours in **Figure-4.3**. The predicted noise level at 100 m distance from the boundary of well site is 52.0 dB (A) and are tabulated in **Table-4.8**.

**TABLE-4.8**  
**PREDICTED NOISE LEVELS**

Sr. No.	Distance from well site boundary	Noise Level, dB(A)
1	25 m	58.0
2	50 m	55.0
3	75 m	54.0
4	100 m	52.0

#### 4.2.8.7 Observation

##### Occupational Health Hazards from Noise Pollution

Exposure to noise levels, above Threshold Limit Value (TLV), has been reported to have detrimental effect on the workers' health. Personnel's working for more than 4 to 4.5 hours per shift near the sound pressure level of 90 dB(A) will be greatly affected, unless suitable mitigatory measures are taken. The adverse effects of high noise levels on exposed workers may result in:

- Annoyance;
- Fatigue;
- Temporary shift of threshold limit of hearing;
- Permanent loss of hearing; and
- Hypertension and high blood cholesterol, etc.

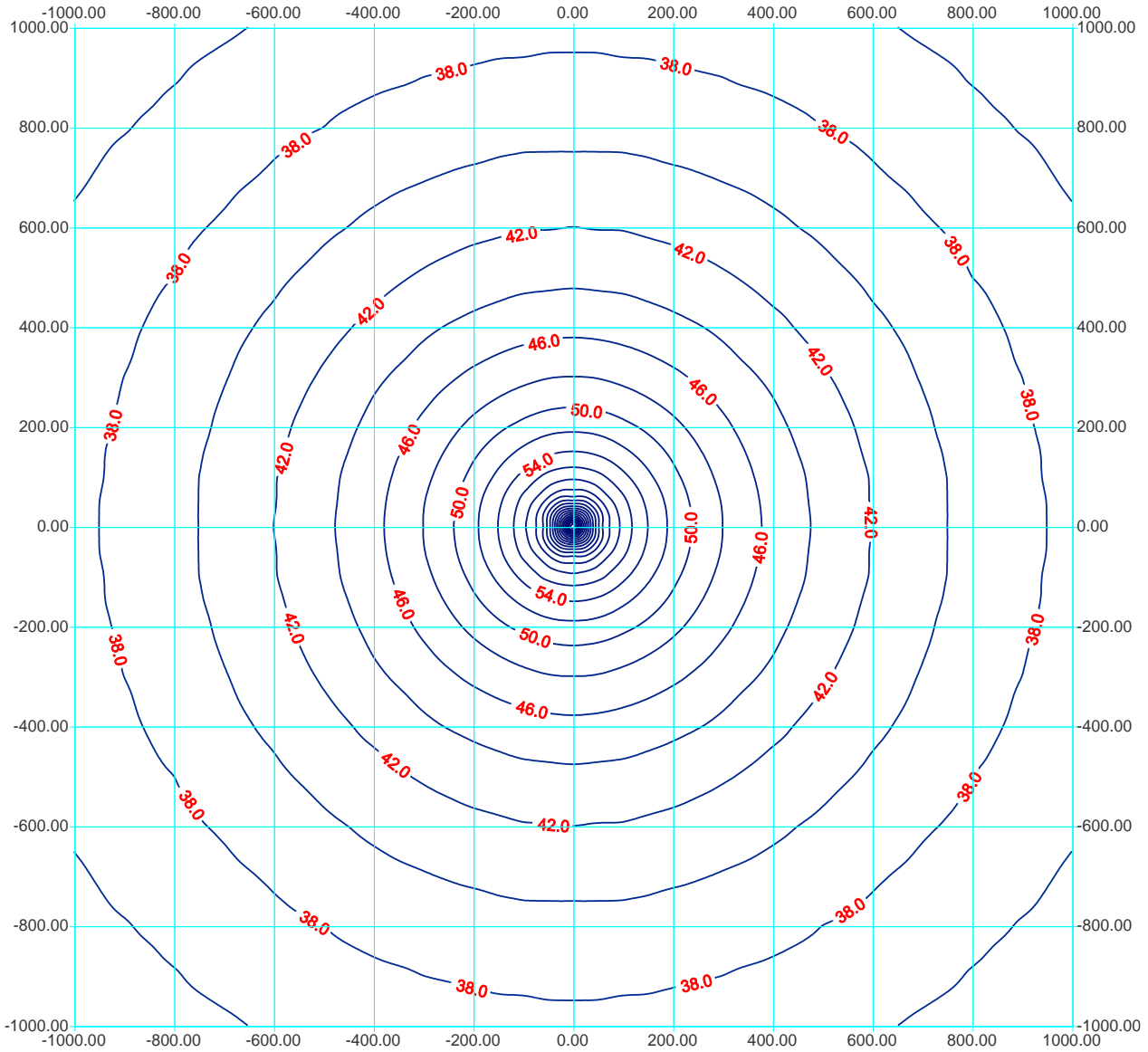
Noise pollution poses a major health risk to the workers near high noise source. If the magnitude of noise exceeds the tolerance limits, it is manifested in the form of discomfort leading to annoyance and in extreme cases to loss of hearing. Detrimental effects of noise pollution are not only related to sound pressure level and frequency, but also on the total duration of exposure and the age of the person. **Table-4.9** below gives noise levels and associated mental and physical response of humans.

**TABLE-4.9**  
**NOISE EXPOSURE LEVELS & ITS EFFECTS**

Noise Levels (dB(A))	Exposure Time	Effects
85	Continuous	Safe
85-90	Continuous	Annoyance and irritation
90-100	Short term	Temporary shift in hearing threshold, generally with complete recovery
Above 100	Continuous	Permanent loss of hearing
	Short term	Permanent hearing loss can be avoided
100-110	Several years	Permanent deafness
110-120	Few months	Permanent deafness
120	Short term	Extreme discomfort
140	Short term	Discomfort with actual pain
150 and above	Single exposure	Mechanical damage to the ear

**Source: OSHA**

During drilling operation, the personnel required to continually present in high noise source like DG is remote. All personnel working on rig are given noise abatement personnel protective equipments like earmuffs etc.



**FIGURE-4.3**  
**NOISE LEVEL CONTOURS**

- **Community Noise Level**

The maximum predicted noise level at about 100 m from the boundary of the drill site is about 52.0 dB (A). The ambient noise levels at most of the places in the region are within the CPCB standards. Since, the drilling operations last for only 3-4 months at each location, impact of the noise pollution due to the proposed exploratory drilling will be insignificant on the community.

It can be concluded that the impact due to elevated noise is confined only up to a distance of 100 m from the drilling point and in areas beyond this distance, the ambient noise levels are within the stipulated ambient noise quality norms.

#### 4.2.9 Ecological Impacts

Impact on the ecology of the study area will vary with the proximity of the habitats from the drilling locations. However, the impacts are of temporary nature, which will last only for few months at each drill location during the exploratory drilling activities and will thus allow subsequent recovery after the activities stops.

The SAS block area in Golaghat district is mostly confined in amidst agrarian habitations comprising of paddy fields dotted with few betel nut trees and cash crop of tea gardens in the homesteads.

Considering the above aspects the chance of irreversible ecological impact at the exploration stage is minor. The primary form of impact could be in form of habitat disturbances, which would normalize after completion of the drilling activity. During the site preparation activities vegetation clearance would be nominal or minor. Efforts will be made to avoid areas of comparatively dense vegetation cover, unless absolutely essential.

The land use in the block area is predominantly devoid and forest area. Efforts will be made to avoid areas of comparatively dense vegetation cover, unless absolutely essential. The impact due to air pollution on flora & fauna would be negligible, as the impact predictions based on the air dispersion modelling found to be well within the prescribed standards. Hence, the impact on ecology will be negligible.

The flora and faunal habitats in the study area may be affected by erosion, siltation and water stagnation arising from run-on and runoff at the well site, if suitable mitigative measures are not implemented. The mitigative measures pertain to surface run-off from well site, wastewater discharges, solid waste disposal, erosion abatement measures, etc;

As long as strict environmental management measures are put in place, including adequate measures for supervision of contractors and staff, negative effects on fauna will be minimised. There are, however, likely to be some residual, unavoidable, impacts, linked to the requirement of optimal clearing the vegetation to facilitate drilling activities. The summary of impact on flora and fauna are given in **Table-4.10**.

**TABLE-4.10**  
**SUMMARY OF IMPACT ASSESSMENT: FLORA AND FAUNA**

Aspect	Nature <sup>1</sup>	Targets/Interests <sup>2</sup>	Magnitude <sup>3</sup> and extent	Overall Significance <sup>4</sup>
Loss of habitat	Loss of vegetation land	Flora and fauna, flora typically type vegetation, faunal comprise grazing animals and dependent mammals and reptiles.	Small & localised.  . Beneficial, Medium,	○ <b>Minor</b>
Disturbance	Light, noise. Surface run-off. Project duration only	Local community, Breeding birds, and flora and other fauna.	Small, localized. Mitigative measures in-built in equipment /well site design to meet ambient limits.  Flaring would cause disturbance of transient nature for a very short duration	● <b>Moderate</b>
Invading species	Colonisation by species associated with human activity	Avifauna and fauna	Small, Localised. No migration route / paths reported in the block.	○ <b>Minor</b>
Waste disposal/ run-off	Contaminated water/rain water,	Fauna, especially birds and reptiles	Small, Localised. No off-site disposal is likely to occur from the exploratory drilling operation. Area fenced and maintained even after drilling operation completed	○ <b>Minor</b>
<sup>1</sup> Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc <sup>2</sup> Targets and interests potentially affected. <sup>3</sup> Adverse or beneficial; small, large, etc; very localised (sites only), local, regional national. <sup>4</sup> Overall significance against criteria (○ minor; ● moderate, some significance; ●● major)				

#### 4.2.10 Impact on Socio-Economic Aspects

Although the well site would be selected to avoid any major social impacts, there will, nevertheless, be some issues that need to be addressed in the region.

The drilling programme would involve setting up the actual drilling rig, construction of campsite for accommodation and operational crew. An approach road from the road head to the drilling rig will also be developed and also to facilitate regular transport from campsite.

It is anticipated that the drilling activity would involve direct and indirect impacts on socio-economic environment. These impacts are short term in nature.

ONGC proposes to avoid any settlements, there is expected to be no displacement of people for the proposed drilling campaign. The well sites are expected to be in non-residential lands/ human settlement zones.

The types of impacts due to drilling activities have been summarized below:

- Land required for drilling activity
- Partial loss of productivity of land due to the project
- Temporary losses during the drilling activity
- Common Property Resources

#### 4.2.11 Demography and Socio-Economics

##### 4.2.11.1 *Impact on Civic Amenities*

The area has limited network of roads and communication in the village areas. Many villages have been electrified during the last decade. There are few business centers and industrialized zones in the project block area, covered in both the districts. Although, the level of existing communications and support services in the area are considered adequate based on the population density, establishment of the proposed project would be a distinct beneficial impact. The overall impact is considered to be positive.

##### 4.2.11.2 *Impact on Health*

Impact on health due to emissions and noise from drilling activity has been assessed to be minimal. In addition employees working at the drill site would be provided protective devices like ear plugs/ear muffs for ensuring minimum impact on human health.

##### 4.2.11.3 *Social well being*

At the camp sites, while communication between locals and outside workers may sometimes be good (exchange of information about places and lifestyle) there is a risk that an influx of migrant population from outside areas could well lead to social tensions. As a general rule, base campsites would be located away from centers of population in order to minimize these risks.

Development and exploration drilling programme is expected to generate local employment in the order of 50 to 80 unskilled and semi- skilled people, for a period of approximately 3 – 4 months at each drilling site location. While this benefit is small by most standards, it is a significant employment opportunity in the block.

#### 4.2.12 Impact due to Vehicular Movement

The anticipated traffic volume during the construction phase of about 30 days, would approximately be 30 truck loads per day of material movement. The installation of the drill site equipment / facilities involves about 80 trailer loads spread over 10 days and during regular drilling operations on an average 5 truck



movements per day with 10 small vehicles for the visitors and the drilling team would take place.

Considering the sparse vehicular movement in the block as a whole, the above anticipated traffic volume and the resulting emissions will be well within the stipulated ambient air quality norms.

#### 4.2.13 Other Impacts on Resources and Infrastructure

As highlighted earlier, infrastructure is very scarce in the study area, especially in the vicinity of the proposed well sites. Preparation and drilling operations could conceivably affect the following infrastructure.

##### 4.2.13.1 *Glare from Flaring*

During well testing, flaring will take place continuously for 14 - 21 days period. This activity will cause a significant change in the background levels of light due to glare in the local vicinity of the site, especially during the night, during the period of flaring. There will be some impact on the surrounding fauna and habitat whose living patterns will be disturbed significantly, due to the glare during the flare testing. Given that the duration of the flare testing will be relatively short, it is anticipated that the impact will be of temporary nature with no residual impacts after the well testing has been completed. Nevertheless, ONGC will fore warn the communities in advance of well testing.

Exploratory drilling is a temporary activity which lasts for about 3-4 months at each location. Thus, the environmental impacts are transient in nature and there will not be any residual impact on the environment.

### 4.3 **Environment Management Plan**

The objective of the Environmental Management Plan (EMP) is to identify project specific actions that will be undertaken to mitigate and manage impacts associated with the proposed drilling programme.

In view of the proposed exploratory drilling project, the adequacy of the proposed pollution control measures has been analysed to meet the standards and norms of concerned authorities. The EMP reflects statutory requirements, ONGC's own corporate operational guidelines for onshore hydrocarbon exploration and development projects. Cognizance has been taken of all the applicable standards and guidelines (amongst others) in the preparation of the EMP.

The following sections discuss the mitigation measures for each potential effect. Actions and monitoring requirements are summarized **Table-4.11**. 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 in the "AA-ONN-2009/3" block.

#### 4.3.1 Environmental measures during well construction

- i. As a preventive measure to avoid impacts the well site will be located based on the following consideration:
  - Located at least 300 - 500 m away from the nearest village habitat / sensitive receptors;
  - Located at least the height of the well mast away from public road;
  - Located at least 300 - 500 m away from existing water bodies;
  - Ensure natural drainage channels are avoided or drainage channels rerouted to ensure unhindered flow of rain / flood water. Where necessary adequate erosion control measures will be provided;
  - Located in a manner to avoid plantations of timber yielding trees
- ii. Construction activities will be coordinated in consultation with landowners and local authorities to reduce interference with agricultural activities.
- iii. In dry weather conditions, water sprinkling during excavation, levelling and transportation will be implemented.
- iv. Topsoil will be stripped below plough depth from the well site and stored on the site. The depth of stripping will be on the basis of site specific soil survey. Topsoil will also be stripped from and stored adjacent to the site.
- v. The well site ground level will be raised and hard standing provided. Drainage channels around the site area will be constructed to ensure no obstruction to flow pattern.
- vi. The approach roads will be routed in a manner so that disturbance to existing activity and to the local community is minimized. Routing through village habitat areas will be avoided, as far as practical. The road surface will be maintained to minimize generation of vehicular movement dust in the local area.
- vii. The drill site would be provided with sufficient and suitable sanitary facilities and these will be connected to well designed and maintained septic tanks.
- viii. Hazardous materials such as diesel, lubrication oil and paint materials required at the site during construction activities would be stored and disposed as per hazardous waste authorisation conditions.
- ix. To ensure that the local inhabitants are not exposed to the hazards of construction the site would be secured by fencing and manned entry posts.
- x. The chemical and diesel storage area will be paved and provided with spill containment walls. Pits for storage of water, drilling mud and drill cuttings will be provided with impervious liner. Sufficient free-board will be provided to prevent overflow.



- xi. It would be ensured that diesel powered construction vehicles are properly maintained. Vehicle maintenance would be carried out authorised service centres. Service centres will be so selected to ensure that these conform to statutory regulations.

#### *4.3.3.1 Soil Erosion*

Well site design and planning incorporates certain best practices principles such as grading and levelling of ground and ensuring the local drainage patterns are disturbed to the minimum, minimum clearance of vegetation, restoration of topsoil and drainage system to minimize the soil erosion. Efforts will be taken up to reduce long-term soil erosion and loosening of the soil in the site preparation activities. With the adequate management plan for restoration of the soil cover and proper management plan the impact on soil erosion will be minimized.

#### *Soil Contamination*

ONGC also has a detailed waste management plan to ensure safe disposal practices and minimize potentiality of soil or sub surface contamination. Some of the specific measures included in the management plan are:

- Only effluent from treated sewage (septic tank system) will be discharged to the local environment;
- The clarified waste water will be collected in lined pits and treated through packaged treatment plant for oil and suspended solids removal to ensure that it meets land or water discharge standards depending on discharge point;
- Spent lubricants and other waste or unused materials will be removed from site as soon as is practicable (and certainly prior to leaving the site) for appropriate off-site disposal or use elsewhere;
- An inventory will be maintained of all fuel, lubricants and chemicals stored on the site. Oil and chemicals, will be stored in dedicated paved and contained areas;
- Waste oil resulting from equipment lubrication will be stored and handled as per the provisions of the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008; and
- Implementation of the waste management plan actions as described in the earlier points are subjected to regular audits to ensure effectiveness

All oil handling and storage areas will be provided with concert paving and secondary containment. The impact on surrounding soils from any accidental fuel spills will depend upon the season and the nature of the spillage. During the dry season, small spills are likely to cause only localized impact on soil. During the monsoon season, however, when surface soils are likely to be water saturated, pollutants are more likely to travel along the surface as runoff. Oil spill response plan will be put in place including the provision of absorbents and in case of unlikely event of a significant spill, soil remediation measures will be taken to clean up the contaminated area.

#### 4.3.2 Removal of Equipment and Materials

In the event that economic quantities of hydrocarbons are found, the well will be suspended with a wellhead in place, but all other equipment and materials will be removed from the site.

All empty drums, wastes, used and unused drilling fluids, fuel and lubricants will be removed from the drilling site. Water supply and effluent discharge hoses and associated equipment will be removed. The access road(s) would be reinstated.

##### 4.3.2.1 *Restoration of Cutting Containment Area*

At the conclusion of well testing at each drilling site, the lined pits of drilling wastes will be covered with soil and left onsite. All these sites will be fenced as per the HSE Management. With appropriate lining of the pit in place, it therefore does not pose any environmental hazard.

##### 4.3.2.2 *Restoration of Well Sites*

Grading will take place to ensure natural runoff. Any remaining topsoil that has been stocked during site clearance will be re-spread over appropriate portions of the site. All efforts will be taken to restore the land suitable for pre-project land use condition.

#### 4.3.3 Decommissioning upon Abandonment

In the event that no economic quantities of hydrocarbons are found, a full abandonment plan will be implemented for the drilling sites in accordance with the applicable Indian petroleum regulations.

The overriding principle being that the environment should be reinstated to broadly to its original condition. Until such time as this is achieved, ONGC would actively manage the reinstatement process.

All concrete or steel installations would be removed to at least 1 m below ground level so as to ensure that there are no protruding surface structures. In the unlikely event that soil is found to be contaminated, measures would be taken to remove or treat appropriately all contaminated topsoil to promote its remediation.

#### 4.3.4 Atmospheric Emissions

Other potential sources of emissions which can cause impacts on environmental components are gaseous emissions and noise pressure levels at the rig. The gaseous emissions would routinely be contributed by D.G. sets deployed for power generation. But in this project, diesel with low sulphur content will only be used.

The incremental concentrations of SO<sub>2</sub> and Oxides of Nitrogen due to the operation of DG sets and flaring will be negligible. There will be no sensitive receptors to the emissions of combustion products in the vicinity of the proposed drilling operations apart from the crew of the drilling rig. The impacts caused are therefore, considered to be negligible. Measures to ensure minimal impacts include:

- Appropriate management of DG sets to achieve fuel efficiency and therefore reduce emissions;
- Use of low sulphur diesel oil (<0.05% sulphur content) if available;
- Environmental monitoring during drilling and well testing to ensure compliance to the standards ;
- Flaring towards any standing vegetation will be avoided. In case if it is inevitable, a suitable barrier will be erected to prevent any vegetation scorching due to direct heat radiation; and
- Prior to flaring, the critical equipment such as burners, anti glare accessories will be thoroughly tested.

#### 4.3.5 Noise Environment

The modeling results show that the noise levels will attenuate to below permissible levels within the drilling site boundary. However, the following measures that already exist on the drilling rig will be followed.

- Generators will be properly enclosed;
- The exhausts will be provided with silencers; and
- Operators/personnel working near the noise sources at the DG sets of drilling rig will be provided with earmuffs and earplugs.

#### 4.3.6 Management of Drilling Wastes

The major waste product of a drilling operation is the generation of rock cuttings with residual mud adhering to the drill cuttings and spent drilling fluid. About 250-300 m<sup>3</sup> drill cuttings per well and 40 m<sup>3</sup>/day spent drilling fluid would need to be disposed off.

Following measures to be adopted for disposal of drill cutting and residual drilling fluids:

- Drill cuttings separated from WBM should be properly washed and unusable / residual drilling fluids WBM should be disposed off in a well designed pit lined with impervious liner located offsite or on sit.
- The chemical additives used for preparation of DF should have low toxicity i.e 96 hr LC<sub>50</sub> > 30,000 mg/l as per mysid toxicity or toxicity test conducted on locally available sensitive species. The chemicals used (mainly organic constituents) should be biodegradable.
- 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 MPCB discharge standards.
- Barite used in preparation of DF shall not contain Hg > 1 mg/kg & Cd > 3 mg/kg.

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

The proposed control measures include:

- Use of water based drilling mud; Only in case of problem due to geological formation Synthetic Based Mud would be used. Proper washing and disposal as per MOEF guidelines vide GSR 546 (E) would be adhered to in case of use of SBM.
- Mud recovery from cutting during drilling and recycling of drilling fluid;
- Management of drill fluid losses as part of the standard operational procedures of the drilling rig;
- Impervious layer lined storage pond for the storage and recycling of drilling mud;
- Drill cuttings to be stored in impervious lined drill cutting pits; and
- Drill cutting and spent drilling fluid to be treated with flocculant and liquid fraction solar evaporated. The solids to be solar dried and covered with an impervious lining and buried in a lined secure pit and the disposal pit covered with soil and closed. The disposal pit location to be fenced to prevent any stray animal / unauthorised man entry.

Most of the hired drill rigs are provided with facility for maximum recycle of drilling fluids. The site during construction phase is provided with waste pit to hold treated/settled liquid wastes. The cuttings are segregated and stored in confined area and used later on being inorganic in nature for reclaiming the site or for preparation of approach road. Waste pits are provided with adequate holding capacity to store the wastewater generated during entire drilling phase of the rig. The waste pits are lined with impervious material to prevent leachate and percolation into groundwater.

#### 4.3.7 Management of the Solid Wastes

Small amounts of solid wastes will be generated during normal operation at the drilling rig. Measures for effective waste management include:

- Solid wastes generated on the Drilling Rig will be properly segregated;
- The wastes will be disposed on compliance with local and national legislations;
- Spent waste oil to be stored in a secure paved area and disposed to MoEF/ MPCB approved waste oil recyclers;
- Ensure that a waste management programme is implemented to minimize the amounts generated. ONGC has a well established waste management plan which is strictly implemented at all well sites;

- Ensure all waste packaging material are suitably stored and kept to prevent unintended use;
- Drill cuttings and sludge from drilling mud to be buried within the impervious lined pit and covered with soil as part of the site abandonment plan;
- Biodegradable waste arising from kitchen and canteen activities to be scientifically composted and the bio-manure so generated to be used for green belt development. Alternatively, the food wastes to be disposed as domesticated animal feed;
- Proper training and information on regulatory requirements shall be provided to the staff responsible for waste disposal to ensure proper disposal of the waste; and
- Inventory of solid waste generation and type shall be prepared and disposal facilities should be audited for suitability prior to the commissioning of drilling programme.

The drill cuttings are washed on the screen and separated. Quantity of cutting vary from well to well depending on well drill programme, casing policy and depth of well. About 250-300 m<sup>3</sup>/well of drill cuttings - are envisaged per well. These cuttings are inorganic in nature and stored at the corner of a drill site and later removed from the site when site is reclaimed.

#### 4.3.8 Management of Discharge of Aqueous Effluents

Wastewater generated from drilling rig wash down possibly contains mud, lubricants and residual chemicals in traces resulting from small leaks or spills. Though, these are all relatively low volume discharges containing small residual quantities, measures shall be taken to ensure no waste is discharged directly onto the land or in a manner to impact any water body. Potential control measures include:

- The drilling rig should be equipped with suitable containment and treatment systems as part of the contract specifications;
- ONGC shall also ensure that good housekeeping standards are maintained to prevent hydrocarbons and other containments entering the storm water drainage systems;
- Careful consideration should be given and necessary controls exercised to minimize the amount of waste generated;
- The spent drilling fluid to be stored in impervious lined pit with sufficient free board to prevent any overflows. On completion of the drilling operation the waste drilling fluid to be solar evaporated; and
- The sanitary effluents should be treated in a septic tank system designed for the anticipated person equivalent loading and the treated sewage to be let out into soak away pits.



#### 4.3.9 Soil Erosion

The following mitigative measures shall be taken to reduce the impact of soil erosion:

- Minimize area extent of site clearance, by staying within the defined boundaries;
- Stockpile of topsoil wherever possible and applicable at the edge of site;
- Install and maintain effective run-off controls, including siltation ponds, traps and diffusion methods so as to minimize erosion; and
- Avoid uprooting trees or removing undergrowth where possible so as to retain land stability;

#### 4.3.10 Management of waste disposal sites within Drill site

ONGC will dispose the drill cuttings, drill mud and waste water generated during the drilling operations into the lined pits of various sizes and undertaking plantation within the drill site particularly on the reclaimed pits.

#### 4.3.11 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 along with all Personnel Safety Guidelines.

The well site supervisor shall carry out regular safety checks. All crew members would be reminded frequently of working safety aspects as part of work procedure. Should unsafe equipment or procedures be 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. The well site supervisor would maintain a separate mud material inventory and would ensure that accurate amounts of material used are entered in the Contractor's daily drilling reports.

Contractor would ensure that a document is posted in the doghouse showing "maximum back pressure held on casing" vs. "various mud densities" and would supply daily and weekly rig inspections by the company representative and the tool pusher. A detailed inspection would be carried out prior to drilling out the surface casing it would be ensured that all inspections are recorded in the tour book.

### 4.4 **Monitoring Environmental Performance**

Environmental performance should be monitored throughout the drilling programme. ONGC should develop specific environmental inspection / monitoring plans and environmental audits. The environmental inspection / monitoring program shall include all the phases of the proposed activity (namely pre-drilling,

drilling, testing and post drilling project activity). The wastewater from the drilling mud collection and recirculation pond should be tested.

The detailed monitoring plans / inspection and environmental audit should become a part of the operating procedures for the work programme.

#### **4.5 Emergency Response and Contingency Planning**

An emergency response plan will be in place for the drilling operations. These plans will define the responsibilities and resources available to respond to the different types of emergency envisaged. Training exercises will be held to ensure that all personnel are familiar with their responsibilities and that communication links are functioning effectively. The Disaster Management Plan (DMP) details the emergency response and preparedness plan to be implemented.

**TABLE-4.11  
SUMMARY OF ENVIRONMENTAL MANAGEMENT ACTIONS**

Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
1. Land take	1.1 Ensure that all necessary protocols are followed and legal requirements implemented: a) Ensure that appropriate legal requirements have been met with regard to land occupancy, land ownership or usage rights, notice and compensation etc; b) Establish and clearly document land take agreements with owners, users and state authorities.	ONGC, Land Acquisition coordinators  Land Acquisition coordinators	Check list of action items	Pre-deployment of topographic survey team or site clearance crew.
	1.2 Mark out site boundaries. Ensure that land take during drilling site construction is restricted to pre-agreed area	ONGC/Contractors	Site boundaries marked	After selection of precise site location and orientation. Prior to onset of site clearance.
2. Soil Erosion	2.1 Minimize area extent of site clearance, by staying within defined boundaries.	Contractor Supervisor	Site boundaries marked	Prior to onset of site clearance.
	2.2 Stockpile of topsoil wherever possible and applicable at the edge of site.	Contractor supervisor	Topsoil stockpile in place on site edge.	Site Construction. Duration of program up until demobilization.
	2.3 Install and maintain effective run-off controls, including siltation ponds, traps and diffusion methods so as to minimize erosion.	Drilling Site manager	Condition of siltation ponds. Rill or gully development in immediate off-site surroundings.	Site construction. Duration of program and beyond.
	2.4 Avoid uprooting trees or removing undergrowth where possible, so as to retain land stability.	Contractor supervisor	Trees to be preserved identified	Site clearance.
3. Habitat disturbance	3.1 Mark out site boundaries	Drilling Site manager	Clear boundary markers in place.	Prior to commencement of site clearance.
	3.2 Avoid uprooting trees and other plants where possible so as to	Contractor Supervisor	Trees to be preserved identified	Entire drilling campaign



Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
	facilitate subsequent re-growth.			
	3.3 For cleared areas, retain top soil in stockpile where possible on perimeter of site for subsequent re-spreading onsite during restoration	Contractor Supervisor	Topsoil stockpile in place on site edge.	Duration of programme until Demobilization or prior opportunity for revegetation of verges.
	3.4 All bulldozer operators involved in site preparation shall be trained to observe the defined site boundaries.	Contractor Supervisor	Maintenance of integrity of boundary markers.	Duration of site preparation.
	3.5 Hunting, fishing and wildlife trapping is forbidden. Removal or disturbance to nesting or breeding birds and animals, their eggs or young is strictly prohibited.	Contractor Supervisor	Awareness training	Entire drilling campaign
4. Fuels, Lubricants and Chemicals Management	4.1 Maintain strict inventory of all fuel, lubricants and chemicals brought to the drilling site.	Drilling Site manager	Up-to-date inventory in place.	-do-
	4.2 All fuels, lubricants and chemicals placed in controlled storage.	Contractor Supervisor	Periodic checking of Integrity of storage area, impervious liner; All drums and containers located within footprint of storage area.	-do-
	4.3 All used and unused lubricants and chemicals no longer required, to be stored in a secure paved area and disposed to authorized recyclers	Drilling Site Manager	Validity of authorization of the approved recyclers; Manifest and records to be maintained;	-do-
	4.4 Refueling operations to be undertaken over area with impervious flooring and surface drainage with oil traps.	Drilling Site Manager.	Paved facilities to be installed and training to concerned to be provided.	-do-
	4.5 Delivery of fuel to drilling site to be supervised.	Drilling Site Manager.	Detailed procedure in place and training to concerned provided.	-do-
	4.7 Adequate oil spill containment and clean-up equipment and materials on-hand and available to contain foreseeable oil spill.	Construction Supervisor/ Drilling Site manager	Facilities and inventories readily available and in good working order.	Entire drilling campaign
5. Waste and Effluent Management	5.1 Implement Drilling Waste Management Plan	Drilling site Manager.	Comprehensive Waste Management Plan in place and available at site.	Prior to site clearance.



Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
6. Soil Contamination	6.1 Impervious liners in place for a. Fuel, lubricants and chemicals storage area. b) cuttings pit; \$ stream side pump set station.	Contractor Supervisor	Evidence of protective measures in place. No visual sign of oil spills.	Daily throughout duration of programme.
	6.2 Effective bunds capable of containing 110% of the volume of the largest container within and enclosing all potentially contaminating materials. To be used for fuel lubricants and chemicals storage area.	Contractor Supervisor	Evidence of protective measures in place. Absence of visual evidence of contamination.	Daily throughout duration of programme.
	6.3 Non - contaminated and potentially contaminated run-off will be kept separate. Non-contaminated run-off will be routed to off-site areas via silt traps. Potentially contaminated surface run-off will be routed through oil traps	Drilling Site manager	Evidence of separate routes and effectively working silt traps. Oily water separation in good working order.	Duration of entire drill programme.
	6.4 Oil drip pans shall be used wherever there is significant potential for leakage including, but not limited to; • drill rig engine; • electric generator engine; • compressors, pumps or other motors; • maintenance areas; • fuel transfer areas.	Contractor Supervisor	Drip pans in place. Absence of visible signs of soil contamination.	Duration of entire drill programme.
	6.4 All spills/leaks contained, reported and cleaned up immediately: • oil absorbent /spill containment material deployed to contain large spills; • contaminated soil dug up, placed in drums and subsequently removed from site.	Contractor Supervisor	Written spill procedure in place.  Oil spills containment materials on-site (and always ready for deployment). Spill reporting procedure in place	Duration of entire drill programme.



Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
7. Water quality and other aquatic impacts.	7.1 No untreated discharge to be made to watercourses.	Drilling Site manager	Ensure no untreated effluent discharged on land or watercourse from the drilling site / campsite.	Duration of programme with particular emphasis during site layout design and site construction.
	7.2 Minimize suspended solids loads to watercourses by installing appropriate surface run-off drainage systems (eg silt traps)	Contractor Supervisor	Surface drainage systems in good working order.  Absence of visible erosion and gullies.  Absence of visible suspended solids loads in streams.  Results from water monitoring programme.	Duration of programme.
8. Noise and Vibration (Applies to Site preparation as well as drilling)	8.1 List of all potential noise / vibration generating machinery on-site identifying age of plant.	Drilling Site manager	Ensure that the drilling rig DG sets have acoustic hoods and noise dampers in place;  Mapping of noise generating equipments noise levels before commencement of drilling and once during the drilling operation;  Check the anti-vibration pads / other measures in place to attenuate transmission of machinery vibration	Prior to commencement of work by contractors at each drilling site.  During drilling operation
	8.2 Equipment maintained in good working order. Workers near noise source provided with noise protection equipment (ear muffs)	Contractor Supervisor	Written record of maintenance for all equipment.  Monitor effective use of personnel protective equipments	Prior to commencement of work by contractors at each drilling site.
	8.3 Implement good working practices to minimize noise.	Contractor Supervisor	No machinery running when not required.	Duration of entire drill programme.
	8.4 Acoustic mufflers in large engines (where practicable)	Contractor Supervisor	Mufflers in place.	Duration of entire drill programme.
9. Air Emissions	9.1 All equipment operated within	Drilling Site manager	N/A	Duration of entire drill



Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
	specified design parameters (site preparation and drilling phases)			programme.
	9.2 Any dry, dusty materials (chemicals, mud etc) shall be stored in original packings and loose storage avoided (wherever possible).	Contractor Supervisor	Absence of stockpiles or open containers of dusty material.	Duration of entire drill programme.
	9.3 Well testing (flaring) to be undertaken so as to minimize impacts of emissions: <ul style="list-style-type: none"> <li>• Duration of testing minimized by careful planning;</li> <li>• High combustion efficiency, smokeless flare/burner to be used.</li> </ul>	Drilling site Manager / Contractors supervisor	Check flare controls before flaring; Physical Inspection during flaring; Maintenance checklist of flaring equipment; Check firewall in place, where required and flare direction	Well testing.
10 Socio-Economic impacts	10.1 Well site to be developed to avoid any habitat and cultural / archaeological centers  10.2 Adequate dialogue with the local population and the authority while designing compensation packages, close monitoring on the type of land loss: <ul style="list-style-type: none"> <li>• Permanent</li> <li>• Temporary</li> </ul>	ONGC Land Acquisition Supervisor	Checklist of action items.  Continued dialogue with the local villagers and other stake holders	At the initial stage of well site planning
	Protection of traditional water structures provision of health and education services.  Loss of land and crop loss to be compensated Provide temporary employment generation opportunities, where feasible	ONGC Land acquisition supervisor	Project management plan should incorporate these aspects at the initial planning stage	All through drilling and post drilling operation  During site acquisition phase  During the site preparatory works



## 4.6 Waste Management Plan

The Waste Management Plan (WMP) covers disposal of all wastes with further reference to off-site disposal of those wastes, which cannot be dealt with on-site.

The objectives of the WMP are:

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

### 4.6.1 Classification of Waste

In general, wastes generated during the drilling activities can be categorized as follows:

- *Paper* - any paper waste generated as a result of drilling activities, inclusive of uncontaminated fluid, sacks, cement and food containers, office wastes, newspapers, packaging material, etc;
- *Wood* - waste pallets used for carriage of fluid and cement or packing crates;
- *Plastic* - shrink wrapping on fluid/cement, protective material, kitchen and domestic container wastes;
- *Inert Waste* - metal cans, glass jars, various containers, etc. which are not combustible and do not contain toxic or hazardous substances and are not under pressure;
- *Liquid Wastes* - any liquid wastes, chemicals or receptacles. This also includes small volumes of paints, solvents, lubricating oil, antifreeze, etc.;
- *Solid Wastes* - fluid, cement, or testing chemicals, containers holding or previously holding volumes of chemicals;
- *Waste Lead Acid batteries*: Spent batteries from equipment and DG set operations;
- *Contaminated Soils* - Soils contaminated by chemicals and oil;
- *Hydrocarbon Wastes* - waste oils, eg from oil changes or leakage from equipment or storage tanks;
- *Produced Hydrocarbons* - gas, condensate or oil produced during well testing;
- *Drill Cuttings* - drilled formation cuttings, consisting of shale, sands and carbonate ideologies; and
- *Drilling Fluids* - fluids used in the drilling or completion of the wells.

#### 4.6.2 Disposal Options

The following disposal options will be available on site. However, ONGC will 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* – ONGC will dispose off non-hazardous inert solid waste by compacting the waste to the smallest practical volume and final disposal at the designated site of MPCB;
- *Offsite Disposal* –Wastes which cannot be handled at the drilling site will be removed by ONGC to and designated authorized sites of MPCB;
- *Produced Hydrocarbon Flaring* - Hydrocarbons produced during well testing will be flared via a high efficiency burner system;
- *Cuttings* – All the Drilled cuttings generated will be disposed off into lined pits within the drill sites;
- *Sewage Treatment and Disposal* - A septic tank system with soak away pits will be constructed on the drilling site / camp site. Digested sludge, will be used as manure for green belt programme under restoration plan.

#### 4.6.3 Labelling of Waste

Any wastes, which cannot be dealt with on site, will be removed to a suitable location for further handling and/or disposal. All off-site transportation and disposal of hazardous waste (as per the Hazardous Waste Rules, 2000 Schedule I & II) shall be done after obtaining necessary authorization from MPCB.

Wastes will be clearly labelled according to:

- Non-hazardous wastes mentioning type of waste;
- Hazardous wastes as per Hazardous Waste Management & Handling Rules Form-8.

### 4.7 **Drilling Site Restoration Plan**

Upon completion of drilling the drilling rig and crew will demobilize from the site. All equipment and debris will be removed and the site will be returned to an acceptable condition including revegetation (re-forestation) as required.

Special care will be taken in sealing of the cuttings pit to ensure that there is no leaching of contaminants into the surrounding soils and that the fluid pit is buried to sufficient depth as not to interfere with existing land-use.

If a commercial discovery is made, the site will be restored to a standard acceptable depending on the requirements of the local authorities and consistent with future land-use.

Residual slurries in the waste and water pits will be buried in the PPE lined pits. This will constitute a secured landfill site. The residue in the pits will be covered with soil and impervious layer spread over this. One meter of topsoil cover will be placed the surface profiled to enhance the runoff of rain watered.