1.0 Introduction

Oil and Natural Gas Corporation Limited (ONGC) is a public sector petroleum company in India. It is a company contributing 77% of India's crude oil and 81 % natural gas production. It is the highest profit-making corporation in India. In order to meet the increasing demand of petroleum product, ONGC has proposed to carry out exploratory drilling in the awarded block CY-ONN-2004/2 in Cauvery Onshore area (Perambalur) along the coast in the state of Tamil Nadu to test the occurrence of hydrocarbons in the identified formation.

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

2.0 Project Description

Exploratory drilling is undertaken to establish the presence of hydrocarbons indicated by seismic survey and interpretation of data. Exploratory drilling is temporary and short duration activity and includes site preparation, well foundation, rig building, drilling and restoration of the well site. This activity takes approximately 3-4 months under normal conditions. Drilling rig is used for drilling the well and involves rotation of drill bit, attached to a long string of a drill pipe down the well. Drilling mud is pumped through the drill string, through the drill bit, which returns up the annulus between the drill string and bore. Drill mud is used to cool the drill bit while drilling, remove cuttings from the well, control formation pressures, suspend and release cuttings, seal permeable formations, maintain well-bore stability, minimize reservoir damage, cool and lubricate the bit etc. The drill cuttings are separated from the drilling mud in shale shaker and the fluid is re-circulated. If the presence of hydrocarbons is detected during drilling, production testing is normally conducted. The production testing is carried out to ascertain the reserves and economic viability.

3.0 Environment in the Block

The environmental baseline data was collected during the post-monsoon season 2007-2008 and primary data was collected along with the secondary data from various sources in public domain made available from published literature including discussion with various government departments and the project information is provided by ONGC.

The baseline status of ambient air quality was carried out in the block. While selecting ambient air quality monitoring stations due consideration was given to topography, terrain, human settlements, sensitive locations, general meteorological conditions, existing emission sources, industries, regional background and possible impact zones based on available information within the block area. The arithmetic mean and 98th percentile values of 24 hourly average samples for SPM varied between 97-151 $\mu g/m^3$ & 108-169 $\mu g/m^3$, RSPM in the range of 32-50 $\mu g/m^3$ & 35-58 $\mu g/m^3$, SO_2 in the range of 3-5 $\mu g/m^3$ & 4-6 $\mu g/m^3$ and NOx varied between 4-7 & 5-8 $\mu g/m^3$ respectively. Non-methane and methane hydrocarbons were monitored within the block area and varied between 0.3-0.6 ppm and 0.6-1.1 ppm respectively.

The background noise levels observed during daytime for residential and commercial areas were in the range of 46-54 dBA and 61-70 dBA and during night time, in the range of 38-44 dBA and 50-54 dBA respectively. In the sensitive areas the noise levels were observed to be 46-49 and 38-39 during day and night time respectively.

The baseline data for surface and groundwater was collected based on its use especially for drinking purpose by the villagers. There are, tube-wells and hand-pumps in villages. The monitored surface waters showed pH values 8.1-8.3 indicating water is in alkaline nature, TDS : 277-583 mg/l, turbidity : 1-12 NTU and hardness : 155-281 mg/l. Medium minerals content was observed in the samples collected from river. Nutrient values in the form of nitrate and phosphate was found to be less with organic load BOD : <3 mg/l and COD in the range of 19-93 mg/l respectively. Similarly groundwater of the study area showed high mineral content. The variations in the levels of various parameters are: total dissolved solids : 369-1426 mg/l, hardness : 170-520 mg/l, whereas chlorides, sulphates in the range of 42-195 and 10-72 mg/l respectively. Both surface and groundwater showed faecal contamination and need chlorination before used for drinking purpose.

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

The study area is dominated by natural vegetation and forest plantation. The forest have a large number of plant species which include 163 trees, 29 climbers and 156 shrubs. There are avenue plantation like *phylanthus emblica, Tamarandus indica, Albizia lebbek, pongamia pinnata* etc. The faunal diversity is very good in the study area. Mammals like Monkeys, Squirrels, Mongoose are common in the study area. Dominant birds observed in the study area are House Sparrow, House Crow, Myna, Kingfisher, Black drongo, Parakeet and Magpie robin. The agriculture is the main activity in the study area. The main crops grown are paddy, Maize sugarcane and cashew.

Demographic profile of this area consists of 55472 inhabitants in the area. Sex ratio in the region is 986 male/1000 female. Literacy rate is 54.41 %. Total main workers are 36.92 %. Primary middle and higher secondary schools and Primary Health Sub Centres are available in this area. Education facilities, medical and transportation and sanitary facilities are available in the area. Drinking water source is through handpumps, borewells and other allied sources.

4.0 Anticipated Environmental Impacts

The land requirement per well is about 150 m x 150 m and the environmental impacts during the construction stage to drilling phase is short term, temporary in nature and does not entail any displacement of people. The well head facilities will be located in such a manner avoiding settlements. The potential environmental impacts due to the proposed exploratory drilling activities can be exhaust gases from DG sets used for drilling; flaring of associated gas during production testing and the duration is for 3-4 days, disposal of drill cuttings and drilling mud, noise from the drilling operations and power generation units. The electricity requirement for proposed activities will be generated using DG sets. No existing resources/water sources (surface/groundwater) which are currently being used by the villagers for the purpose of obtaining drinking water, water for irrigation or other purposes will be tapped. Water will be supplied through tankers to the site.

5.0 Environmental Management Plan and Mitigation Measures

The land requirements for exploratory drilling is approximately 150 mx150 m and the land use pattern will not be affected as this is a short duration activity and of temporary nature. The land will be acquired from private/government lands. Crop and land compensation will be paid as determined by the revenue officials. The total water requirement will be met from tapping groundwater aquifer by drilling bore wells near the well site. If the local water quality does not meet the minimum quality requirement for use as make up water for drilling fluid/potable use, suitable arrangement for transportation of water will be made. Approximately 150 m^3 of spent drilling mud would be generated at each well site. Drilling mud is re-used as much as possible. At the end of drilling operations, the residual unusable mud is collected in lined pits and solar evaporated. The pit will be covered with soil for restoration. The domestic sewage will be treated in septic

tanks followed by soak pit system. The solid waste generation is limited to spent drill bits, packaging wastes and used containers, drill cuttings, waste oil and any contaminated soil during the drill rig movements and operations. The only hazardous waste generated in exploratory drilling operations is spent lube oil. The spent oil will be collected, stored and disposed as per the MoEF guidelines and in compliance to the Hazardous Waste (Handling & Management) Rules. All DG sets and flaring will be installed with adequate stack heights to ensure wider dispersion. The mud chemical storage area will be paved. Emission standards stipulated by CPCB and SPCB would be complied with. The noise level will not exceed 85 dB (A) beyond the boundary of the drill site. Personal protective equipment will be provided and their proper usage will be ensured for eardrum protection of the workers. The ecological studies are carried out during the study period, rich and diverse vegetation in the study will be taken care and maintained. Special care will be taken to project endangered and localized animals. Wherever necessary, wildlife habitat will be re-established or restored.

6.0 Project Benefits

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

- The commissioning of project would lead to improvement in transport facilities as loose or soft surface rural roads will be upgraded to facilitate movement of the drilling rig and supply vehicles.
- In case hydrocarbon reserves are found it will lead to all round prosperity of the region & nation

Environmental Management Plan

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

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

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

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

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

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

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

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

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

5.1 General Recommendations

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

5.1.1 Drilling Fluids

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

(A) Regulations

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

5.1.2 Drill Cuttings

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

5.2 Environment Management Plan

5.2.1 Air Environment

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

5.2.2 Noise Environment

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

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

5.2.3 Land Environment

Soils in the region have moderate infiltration rates amenable to groundwater pollution. Considering this fact and poor ground water quality, every precaution would be

taken to avoid spillages of chemicals on soils to avoid further deterioration of groundwater quality and danger to soil microbial populations in soils which are sensitive to hydrocarbon. Treated solid wastes, which have to be disposed on land, will be made on adequately prepared waste pits.

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

5.2.4 Water Environment

Wastewater generated during drilling operations would be around 10-15 m^3/d per operation. Wastewater characteristics would be of varied nature and likely to contain soil particulate matter along with organics. The effluents generated during drilling operations are recommenced to be collected in lined waste pit with a provision of three compartments. This will eliminate any possibility of wastewater spills from waste pits to surrounding areas.

5.2.5 Biological Environment

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

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

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

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

5.2.6 Socio- Economic Environment

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

- It must be ensured that the agricultural activity near the project sites must not get affected
- Required collaboration between project authority and local bodies is necessary for the smooth functioning of the project as well as for the progress of the region
- The facilities like education, medical, transportation, sanitation are poor in rural area. This provision needs to be strengthened under social welfare activity
- The medical facilities in the area are very poor. As such health camps for general health, eye check up, family planning, health awareness should be conducted for the rural people
- Special privilege should be given to dominant tribal population for employment, I.T.I. training for their economical upliftment

5.3 Waste Management Plan

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

The objectives of the WMP are :

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

5.3.1 Disposal Options

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

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

The details regarding waste classification and their disposal options are described in **Table 5.1**.

5.3.2 Waste Reduction, Reuse & Recycle

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

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

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

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

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

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

5.4 Waste Mud & Drill Cuttings Disposal Plan

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

5.4.1 Waste Generation at Drill Site

Drill Mud

It is estimated that approximately 700 m^3 of drilling fluid will be formulated during the course of one exploration well (for a well of approx. 1500 m) of the type to be drilled. During fluid or mud is basically a mixture of water, clay polymers and weighting material with all individual components being environmentally friendly. The mud system is being a closed loop the mud is re-circulated and mainly retained in the well. A small quantity of

residual unusable portions of mud retained in the mud tanks is disposed off at the end of drilling operations. The mud being inert material of bentonite and barite is filled in lined pits and dried. The dried mud is covered with excavated earth and native top soil.

Drill Cuttings

It is expected that approximately 150-200 m^3 of drill cuttings will be generated during the drilling of a well. Considering a specific gravity of the cuttings as the total weight will be 400 MT. It is planned to deposit the cuttings generated in the waste pit where they will be allowed to dry and finally they will be covered with topsoil.

5.5 Environment Protections and Reclamation Plan

- Construction activities will be coordinated in consultation with landowners to reduce interference with agricultural activities
- Top soil will be restored after the activities are over
- If required for rig stabilization the well site will be temporarily padded with granular fill
- The drill site would be provided with sufficient sanitary facilities
- Combustible wastes generated would be burnt in a controlled manner or disposed off in an approved dump site
- Hazardous materials such as petroleum, spirit, diesel lubrication oil and paint materials required at the site during construction activities would be stored as per safety norms
- To ensure that the local inhabitants are not exposed to the hazards of construction the site would be secured with manned entry posts
- It would be ensured that both gasoline and diesel powered construction vehicles are properly maintained. The vehicle maintenance area would be so located that the contamination of surface/soil/water by accidental spillage of oil/diesel will not take place and dumping of waste oil will be strictly prohibited
- All irrigation canals and ditches encountered by the proposed well site access and well site will be maintained in a fully functional state
- No Construction material debris will be left on site

5.6 Plans for Well Site Operation and or Abandonment

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

5.7 Drilling Program Safety Guidelines

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

The well site supervisor shall carry out regular safety checks. All crew members would be reminded frequently of working in a safe manner. Should unsafe equipment or

procedures are observed, operations would cease immediately and the hazard duly corrected.

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

Table 5.1
Classification of Wastes Generated during Proposed Drilling and their also Disposal Options

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