CHAPTER 2
THE PROPOSED DRILLING PROGRAMME

2.1 Key Well Information

Well Location Coordinates	MSC: X-3251236, Y-1119720 MSD: X-3259037, Y-1121300
Field Office	DULIAJAN
Ground Elevation	Not available as on date
Depth of Well	4600 Meters each
Planned Commencement of Drilling	MSC: October, 2008 MSD: March, 2009
Total Estimated Drilling Period	90 days each
Total Estimated Testing Period	15 days each
Type of hydrocarbon expected	Oil
Proposed Drilling Fluid	Water based mud
Anticipated Volume of Cuttings	1500 cubic meter
Anticipated water balance	a) Fresh water generation: 50 KLPD b) Water consumption in mud preparation including human consumption: 25 KLPD. c) Cooling water for all machineries: 05 KLPD d) Rest of the water will be used in washing of drill pipes, machineries and Mock drills. e) Recycling of wastewater will be done in permissible areas.

2.2 Well Objectives

Following the analysis of seismic survey data of the area, OIL is now planning to drill exploration wells at the locations MSC and MSD to determine the presence of hydrocarbons in a geological formation starting at a depth of around 1800m.

The objectives of the exploration well are

- To drill and evaluate the prospect of hydrocarbons in the area;
- To drill and evaluate the prospect without any damage to the environment;
- To determine the hydrocarbon potential of the designated prospect.

2.3 Regional Geological Setting

The study area is part of the Brahmaputra floodplain with a very gentle gradient from north to south. Average elevation is within 120 m of the mean sea level (msl). A number of south flowing rivers viz., Leko, Jonai Korong, Raiang, Rajakona and Barnesuti from east to west drain the area before deboucing into the Brahmaputra which marks the southern boundary of the area. Because of its proximity to the Brahmaputra and a number of active channel belts, the project area is characterized by typical floodplain geomorphology.

The whole study area is covered by recent alluvium composed of unconsolidated clay, sand, and occasional gravel. The subcrop stratigraphy is not well established. But extrapolation from the nearby wells drilled by OIL suggests a sequence of Alluvium, Dhekiajuli Beds, Namsang Formation, Tipam Group, Barail Group, Kapili Formation and Sylhet Formation in stratigraphically descending order expected to encounter in the study area and adjoining region. However, towards the northern part, at the foothills of the Arunachal, the sequence is not predictable. Although perceived structural lineaments have also been reported from the region buried under the Brahmaputra Alluvium their precise location has not been proved so far from geophysical data. A number of well known thrusts and faults have, however, been known to affect the Late Cenozoic rocks in Arunachal Himalaya bordering the Brahmaputra Alluvium in the north. The area has witnessed damage from recurring high magnitude earthquakes viz. 1897 and 1950 (M>8) besides being subjected to ongoing seismotectonic activities particularly the Himalayan seismicity. Evidence of co-seismic deformation and fault activation resulting in seismicity from the NE region in general calls for an intensive geophysical approach to delineate the faults and thrusts particularly in the foreland basin at the foothills of Himalaya which is occupied by a high density population and has been subjected to increased anthropogenic activities. This is more so in view of the evidence of continuous crustal deformation experienced by this part of the Indian lithospheric plate.

2.4 Hydrocarbon Play Elements

No fault seal analysis has been carried out but the report interprets fault seal as being successful even where throw is minimal (less than 10 m) or where sand-to-sand contact exists across the fault. Small (10-20 m throw) sub-seismic resolution faults are interpreted as compartmentalizing the gross structural closure into smaller segments, each with different fluid contacts. Hydrocarbon columns within individual fault compartments are never more than 120 m in gross thicknesses, however because of the compartmentalization, the lowest water contact is up to 500 m below the structural crest. On an average for the gross structure, the difference in relief between the water contacts in all the compartments and the structural crest is between 140-220 m, depending on the reservoir. These average gross hydrocarbon column thicknesses have been used as the column thicknesses for prospect volumetric calculations.

2.5 The Drilling Rig

The exploitation of hydrocarbons requires the construction of a conduit between the surface and the reservoir. This is achieved by the drilling process. The exploration well is proposed to be drilled using a Conventional Land Rig (Electric) equipped with a Top Drive System. This rig is suitable for deep drilling up to a depth of around 4600 m.

The Chartered Hired Rig to be utilized has the following key parameters:

- Draw works – 1500 HP
- Derrick Capacity (Gross Nominal) – 1,000,000 Lbs
- Pump rating – 1600 HP (2 nos)
- Total Tank Volume – 2200 bbls
- Drill pipe Size – 5”

The Rig including auxiliary equipments and Camp facilities comprise of around 100 trailer loads.

To support the drilling operation, the following systems and services are included at the rig package:

(i) **Portable Living Quarters** – to house essential personnel on site on a 24 hr basis. These units are provided with Bath/Washroom.

(ii) **Craneage** - cranes for loading/off loading equipment and supplies.

(iii) **Emergency Systems** - this includes fire detection and protection equipment.

(iv) **Environmental Protection** – Blow Out Prevention (BOP) system, wastewater treatment unit, cuttings handling equipment.

2.6 Activities prior to Drilling

2.6.1 Site Survey

The locations, MSC and MSD, in Jonai were selected by OIL's drilling department based on geological data available and the seismic data acquired. A preliminary site survey was already undertaken by the Oil drilling team. The suitable drilling locations were selected based on the physical (terrain and access) and technical suitability. It is decided to drill a vertical well. Detailed drill site and access road survey and alignment have already been done. The sequence of events involved between release of location and drilling of the exploration well is given below:

- Release of drilling location - accomplished
- Site survey and access road alignment - accomplished
- Land acquisition - accomplished
- Assam State Pollution Control Board permission – Permission to establish has been obtained. Permission to operate to be obtained prior to commencement of drilling.
- Road and site design and construction – access road construction work are in place.
- Mobilizing the drilling rig to the site – to be completed
- Drilling the Well – expected to be spudded in for MSC: Third week of Oct, 2008 and for MSD: First week of Mar, 2009.

2.6.2 Road and Site Construction

The construction phase will consist of the following works:

(a) The existing roads will be used. No clearing of forest is therefore involved or is required to be done. If necessary, the existing road will be developed by widening, etc.

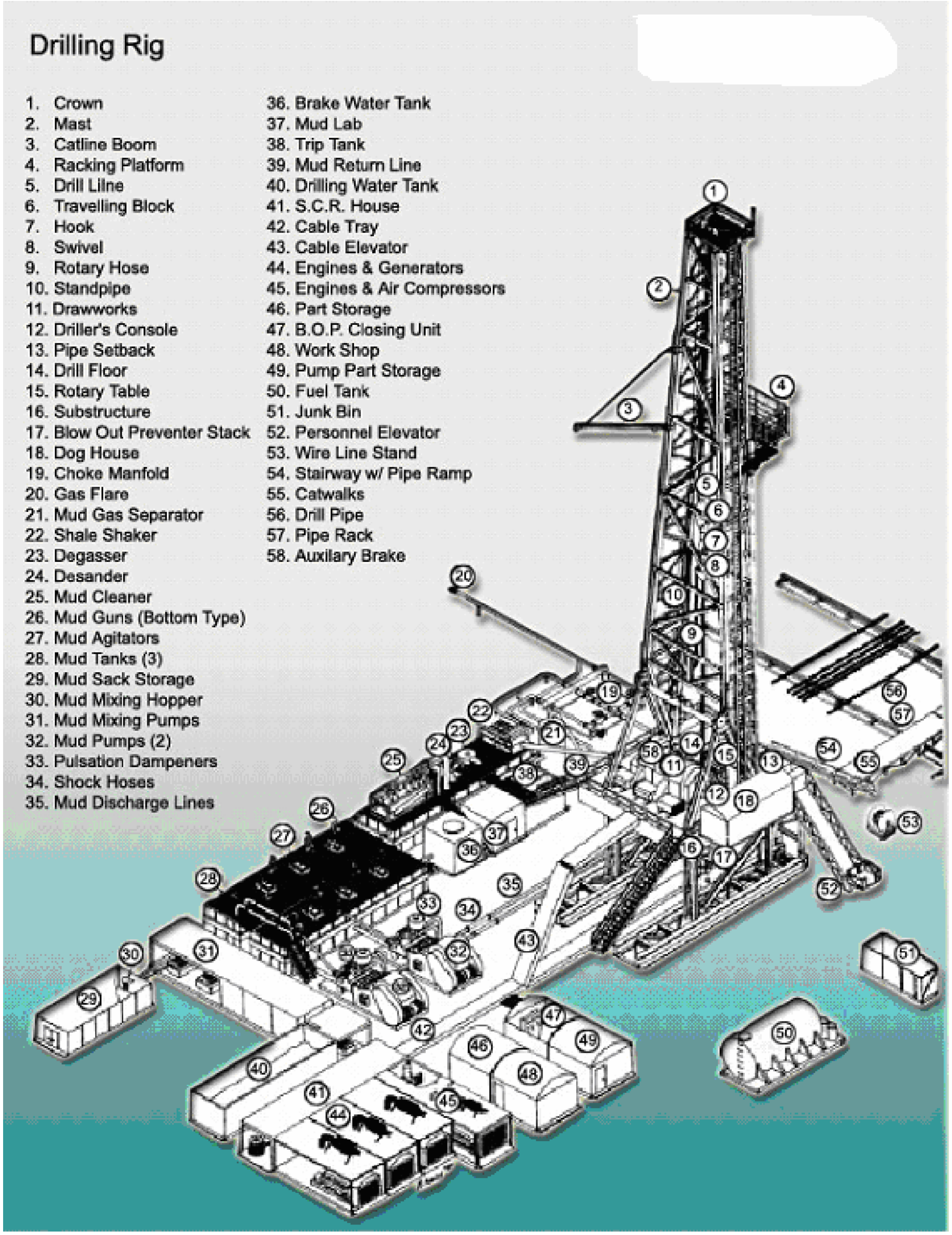

Figure 2.1. Typical Land Drilling Rig

(b) The ground is relatively flat in the area. The vegetation varies from place to place. While it is clear of vegetation at some places, it is covered with thick bush to heavily overgrown trees at other places. The work may require clearing of the small bushes and some trees near the drill sites. However, forest clearing will be kept to the minimum and will be confined to that absolutely required. Deviations off the track for meeting various requirements will be kept to the minimum.

(c) Construction of a flat rectangular/square drilling site (pad) of 150 M X 150 M (approximate) at site to facilitate drilling and testing of hydrocarbons will be required. The tree cover at the site mainly comprises of small trees which may have to be removed, but felling will be limited to those in critical positions, others will not be felled and the rig equipment will be stationed around them.

2.6.3 Well Construction

Wells are drilled in sections, with the diameter of each section decreasing with increasing depth. Before commencing the actual drilling, large diameter pipe (Conductor) is lowered into a hole and cemented/grouted. Conductor pipes provide a conduit for the return fluid during drilling next section and also prevent unconsolidated material falling into the hole and potential washout problems. Typical depths of such pipes are 150 m.

The lengths and diameters of each section of the well are determined prior to drilling and are dependent on the geological conditions through which the well is to be drilled. Once each section of the well is completed, the drill string is lifted and protective steel pipe or casing lowered into the well and cemented into place. The casing helps to maintain the stability of the hole and also helps reduce fluid losses from the well bore into surrounding rock formations.

2.6.4 Proposed well profile

The profile of the proposed well is given in Table 2.1. It is anticipated that the well will be drilled vertically.

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Table 2.1 Proposed Well Profile

Hole Size (inch)	Casing Size (inch)	Depth of Shoe (meters) (Below Ground Level)	Section Length (metres)
26	20	150	150
17.5	13 3/8	1800	1800
12.25	9 5/8	3700	3700
8.5	5 1/2	4600	4600

2.6.5 Drilling Fluids

During drilling operations a fluid known as drilling fluid (or 'mud') is pumped through the drill string down to the drilling bit and the fluid returns through the space between the drill pipe casing annulus to the surface, back into the circulation system after separation of drill cuttings /solids through solids control equipment. Drilling fluid is essential to the operation. It performs the following functions:

- The hydrostatic pressure generated by the drill fluid's weight controls the down hole pressure and prevents formation fluids from entering the well bore.
- It removes the formation cuttings from the bottom of the hole and carries them to the surface and when circulation is interrupted it suspends the drill cuttings in the hole and prevents them from settling.
- It lubricates and cools the drill bit and string.
- It deposits an impermeable cake (filter cake) on the wall of the well bore effectively sealing and stabilizing the formations being drilled.

The drill fluid is recycled and maintained in good condition throughout the operation. The drilling fluid circulation system is illustrated below in Fig. 2.2.

The drill fluid and suspended cuttings are processed on the rig through screens called "shale shakers" to maximize recovery of the drill fluid. The recovered drill fluid is then passed through a desander to remove sand particles and, if necessary, subsequent treatment is provided by a centrifuge or desilter. This additional equipment removes fine colloidal solids too small to be removed by the conventional equipment, which if allowed to build up can make the fluid too viscous. The drilling fluid then passes to the mud tanks from where it is again pumped down the hole. The cuttings and sand recovered from the mud are stored and kept in a cutting pit. A variety of products are added to adjust the mud properties to ensure that the following functions are met:

Fluid loss control. The layer of fluid on the wall of the well bore retards passage of liquid into the surrounding rock formation. Bentonite as well as naturally occurring additives such as starch and cellulose are added to the drilling fluid to ensure the following properties are met:

Lost circulation. Naturally occurring fibrous, filamentous, granular or flake materials are used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include groundnut shells and mica.

Lubricity. Normally the drilling fluid is sufficient to lubricate and cool the bit. However, under extreme loading, other lubricants are added to prevent the drill string from becoming stuck.

pH control. Caustic and lime are used to control the alkalinity of the fluid to a pH of 9 to 10. This ensures the optimum performance of the polymers in the fluid and controls bacterial activity.

Pressure control. Barite is generally used as a weighting agent to control downhole pressure.

Two types of drilling fluid are currently used in drilling operations:

(a) Water based Fluids: water forms the continuous phase of the fluid (up to 90 % by volume) and

(b) Low toxicity Oil based Fluids: base oils refined from crude form continuous phase of the fluid.

The wells in the present work will be drilled using **water based drilling fluids**, which are known to have lesser environmental effects when compared to other fluid types. The tentative mud program for the well is given in Table 2.2. The hole section-wise use of chemicals is presented in Table 2.3.

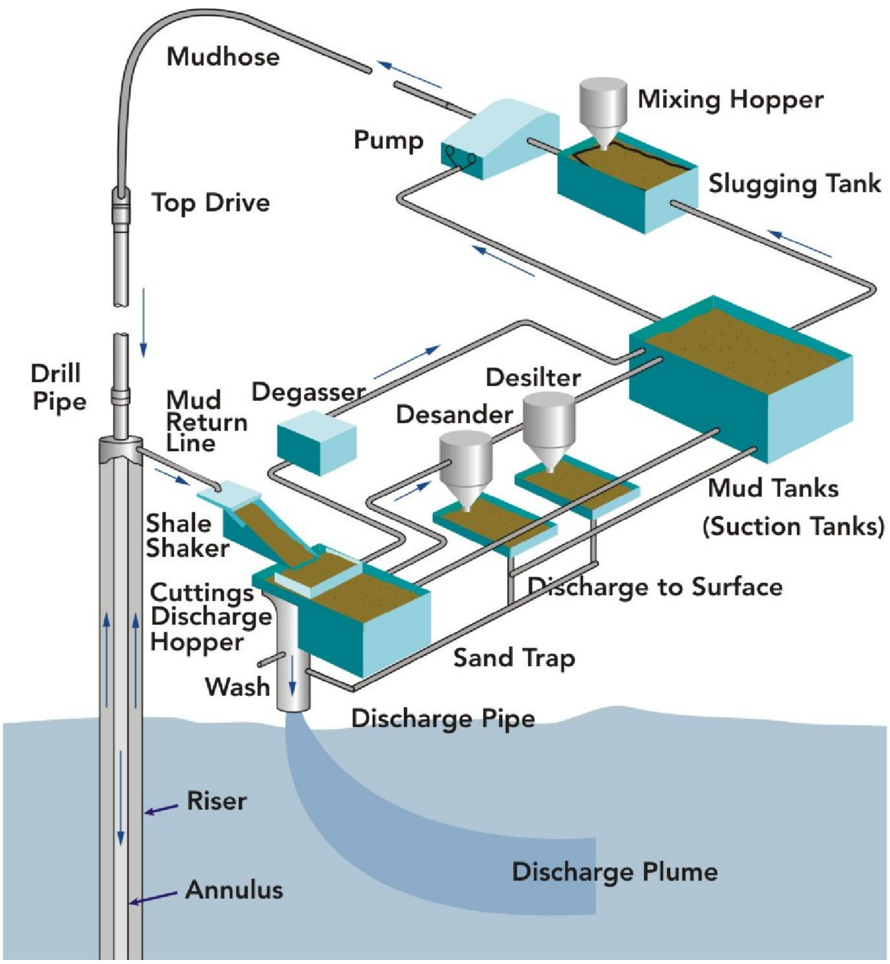

Figure 2.2. Typical Drill Fluid Circulation System

Table 2.2. The Mud programme for the Well

	Hole Depth m	Casing Depth m	Mud Type	Drilling Fluid Formulations
		30" @ +/-30 m		Products
	26" Hole to 770 m.	20" Csg. @ 770 m.	Bentonite-PAC Mud	Freshwater Soda Ash Caustic soda API Bentonite PAC regular Xantham Gum Barite
	17-1/2" Hole to 2050m	13 3/8" Csg @ 2050 m.	KCl/PHPA-Glycol	Freshwater Soda Ash Caustic Soda PAC regular PAC LV PHPA Xanthan Gum KCl Barite Glycol
	12¼" Hole to 3500 m	95/8" Csg @ 3500 m.	KCl/PHPA-Glycol	Freshwater Soda Ash Caustic Soda PAC regular PAC LV PHPA Xanthan Gum KCl Barite Glycol
	8-1/2" Hole to 4200 m	7" Liner @ 4200 m	KCl/PHPA-Glycol	Freshwater Soda Ash Caustic Soda PAC regular PAC LV PHPA Xanthan Gum KCl Barite Glycol

Table 2.3 Hole Section wise Drilling Fluid Chemical Usage

Chemical and formulation names	Chemical function group	Chemical label code	Estimated use (tonnes/gallons
914 mm (36") Hole-Pre set			
660 mm (26") Hole			
Barite	Weighting Chemical	PLO	51.30 Tonnes
Bentonite	Viscosifier	PLO	28.5 Tonnes
Biocide	Mud Bacteria Control	PLO	55 Gallons
Calcium Carbonate	LCM	PLO	3 Tonnes
Drilling Detergents	Emulsifier	PLO	220 Gallons
Soda Ash	Inorganic	PLO	40 Tonnes
Caustic Soda	Inorganic	PLO	1.83 Tonnes
Sodium Bicarbonate	Inorganic	PLO	0.25 Tones
PAC regular	Filtrate Control	PLO	1.18 Tonnes
Xanthan Gum	Rheology Control	PLO	0.15 Tonnes
445 (17.5'') Hole			
Barite	Weighting Chemical	PLO	118.2 Tonnes
Biocide	Viscosifier	PLO	55 Gallons
Calcium Carbonate F/M/C	LCM	PLO	2.25 Tonnes (Total 3 grades)
Caustic Soda	Inorganic	PLO	0.65 Tonnes
Defoamer	Viscosifier	PLO	55 Gallons
Glycol (Low Temp)	Inorganic	PLO	3630 Gallons
KCl	Inorganic	PLO	105 Tonnes
KwikSeal M	LCM	PLO	0.5 Tonnes
Modified Starch	Filtrate Control	PLO	1.25 Tonnes
PAC Low vis	Filtrate Control	PLO	1.25 Tonnes
PAC regular	Filtrate Control	PLO	4 Tonnes
PHPA(100%)	Encapsulating Polymer	PLO	2.63 Tonnes
Soda Ash	Inorganic	PLO	0.33 Tonnes
Sodium Bicarbonate	Inorganic	PLO	0.25 Tonnes

Table 2.3 Hole Section wise Drilling Fluid Chemical Usage (continued)

Chemical and formulation names	Chemical function group	Chemical label code	Estimated use (tonnes/gallons
311 (12.25'') Hole			
Barite	Weighting Chemical	PLO	104.5 Tonnes
Biocide	Mud Bacteria Control	PLO	55 Gallons
Caustic Soda	Inorganic	PLO	0.125 Tonnes
Citric Acid	Amine inhibitor	PLO	0.25 Tonnes
Defoamer	Viscosifier	PLO	55 Gallons
Glycol (Mod Temp)	Inorganic	PLO	2035 Gallons
KCl	Inorganic	PLO	13.75 Tonnes
Modified Starch	Filtrate Control	PLO	0.625 Tonnes
PAC Low vis	Filtrate Control	PLO	0.625 Tonnes
PAC regular	Filtrate Control	PLO	0.625 Tonnes
PHPA(100%)	Encapsulating Polymer	PLO	0.7 Tonnes
Soda Ash	Inorganic	PLO	0.075 Tonnes
Sodium Bicarbonate	Inorganic	PLO	0.25 Tonnes
Xanthan Gum	Viscosifier	PLO	0.3 Tonnes
216 mm (8.5'') Hole			
Barite	Weighting Chemical	PLO	104.5 Tonnes
Biocide	Viscosifier	PLO	55 Gallons
Caustic Soda	Viscosifier	PLO	0.125 Tonnes
Citric Acid	Viscosifier	PLO	0.25 Tonnes
Defoamer	Viscosifier	PLO	55 Gallons
Glycol (Mod Temp)	Inorganic	PLO	2035 Gallons
KCl	Inorganic	PLO	13.75 Tonnes
Modified Starch	Viscosifier	PLO	0.625 Tonnes
PAC Low vis	Viscosifier	PLO	0.625 Tonnes
PAC regular	Viscosifier	PLO	0.625 Tonnes
PHPA(100%)	Viscosifier	PLO	0.7 Tonnes
Soda Ash	Viscosifier	PLO	0.075 Tonnes
Sodium Bicarbonate	Inorganic	PLO	0.25 Tonnes
Xanthan Gum	Rheology Control	PLO	0.3 Tones

PLO = PLONOR Chemicals considered to pose little or no risk to the environment (PLONOR) (*OSPAR, May 1999*). All of the above water based drilling chemicals are PLONOR and have therefore not been assessed using the CHARM calculator.

2.7 Cementing Program

Cementing is a necessary aspect of drilling oil and gas wells. Cement is used to

- Ø Secure/support casing strings
- Ø Isolate zones for Production purposes
- Ø To solve various hole problems
- Ø Isolate the potable water from contamination

Cementing utilizes Portland Cement (API Class G Oil Well Cement) with various additives in small quantities as retarders, density adjusters, dispersants, fluid loss additives, friction loss additives, to control retrogression etc. Detailed cementing program for the proposed wells with exact quantities of chemicals is not yet worked out but a tentative outline-cementing plan is given in Table 2.4.

Table 2.4 Outline Cement Program

Hole size	Casing size	Type	Interval m TVD	Cement height m TVD	Slurry weight lbs/cubic foot	Excess allowed on gauge hole
26”	20”		Up to Surface	150 m	114	100%
171/2”	13 3/8”	Lead Tail	1800 M (total cemented portion)	1440 m 360 m	102 110	20%
121/4”	9 5/8”	Lead Tail	2000 M (total cemented portion)	1600m 400 m	102 114	10%
81/2”	7”		1000 M (total cemented portion)	1000 m	118	30% *

(Proposed Well depth: 4600Mts)

* Actual cement volume in 8 1/2” hole will be based on calliper + 10%.

2.8 Well Evaluation

Well Logging

Between the drilling operations for different zones, logging operations will be undertaken to provide information on the potential type and quantities of hydrocarbons present in the target formations.

Technicians will do well logging. There are many different well logging techniques including electric, sonic and radioactive logging. Logging instruments (sensors) are attached to the bottom of a wire line and lowered to the bottom of the well. They are then slowly brought back, the devices reading different data as they pass each formation and recording it on graphs, which can be interpreted by the geologist, geophysicist and drilling engineer. There are no emissions to the environment associated with wire line logging operations. The radioactive source required for well logging operations will be kept in specially designed containers.

Well Testing

Normally, in the event that hydrocarbons are found in sufficient quantities, as determined by electric wire line logs, a temporary drill stem test string may be run and the well fluids flowed to surface and processed using a surface well testing package, involving the oil and associated gas being flared to atmosphere.

2.9 Completion of Drilling

On completion of activities, the well will be diverted to the Oil Collecting Station for production (if the well evaluations indicate commercial quantities of hydrocarbons) or will be killed and permanently abandoned. In the event of a decision to suspend the well, it will be filled with a brine solution containing very small quantities of inhibitors to protect the well. The well will be sealed with cement plugs and some of the wellhead equipment (Blind Flange) will be left on the surface (Cellar).

If the well is abandoned it will be sealed with a series of cement plugs, all the wellhead equipment will be removed, leaving the surface clear of any debris and the site will be restored to its natural state to the extent possible.