

CHAPTER 3
PROJECT DESCRIPTION

CHAPTER 3**PROJECT DESCRIPTION****3.1 INTRODUCTION:**

Oil India Ltd. (OIL) is proposing to carry out exploratory drilling and testing of 6 exploratory wells within AA-ONN-2004/1 block area for full assessment of oil and gas production potential from the block. The proposed drilling and testing of 6 exploratory wells are expected to cost nearly Rs. 150 crores @ Rs. 25 crores per well and will be carried out sequentially in next 2 years commencing from December, 2008. The block has an estimated original oil in place (OOIP) of nearly 34 MMT approx. and estimated gross ultimate recovery (GUR) of nearly 10.2 MMT (approx.).

3.2 BLOCK AA-ONN-2004/1:

Block AA-ONN-2004/1 is located essentially in Sibsagar district in Assam. The total area of the block is 144 sq. km. The block coordinates are as follows:

POINTS	LATITUDE (N)	LONGITUDE (E)
A	26 ⁰ 56'16.29"	94 ⁰ 26'49.25"
B	26 ⁰ 59'56.46"	94 ⁰ 30'18.10"
C	27 ⁰ 00'00.00"	94 ⁰ 34'11.16"
D	26 ⁰ 59'13.36"	94 ⁰ 34'59.74"
E	26 ⁰ 58'25.00"	94 ⁰ 31'10.10"
F	26 ⁰ 56'10.00"	94 ⁰ 31'12.50"
G	26 ⁰ 56'19.17"	94 ⁰ 37'25.48"
H	26 ⁰ 54'18.48"	94 ⁰ 36'22.45"
I	26 ⁰ 54'53.18"	94 ⁰ 35'18.18"
J	26 ⁰ 52'30.00"	94 ⁰ 33'42.72"
K	26 ⁰ 51'45.94"	94 ⁰ 35'02.78"
L	26 ⁰ 50'51.65"	94 ⁰ 34'34.43"
M	26 ⁰ 49'46.23"	94 ⁰ 33'51.66"
N	26 ⁰ 49'24.15"	94 ⁰ 33'42.75"
O	26 ⁰ 49'13.63"	94 ⁰ 32'52.72"
P	26 ⁰ 50'51.81"	94 ⁰ 31'30.90"
Q	26 ⁰ 51'20.45"	94 ⁰ 32'57.27"
R	26 ⁰ 52'05.45"	94 ⁰ 30'59.09"
S	26 ⁰ 50'10.90"	94 ⁰ 29'37.27"
T	26 ⁰ 50'01.77"	94 ⁰ 29'23.61"
A	26 ⁰ 56'16.29"	94 ⁰ 26'49.25"

The block can be easily approached by road (national highway NH 37) from Dibrugarh in Assam. Dibrugarh is also connected directly by air to Delhi via Guwahati. Nearest railway station from the block is Amguri, located at a distance of merely 2.5 km WSW of Point O of the block area. Amguri railway station lies at a distance of 129 km from New Tinsukia and 386 km from Guwahati on Guwahati-New Tinsukia Section of NF railway.

Total block area of 144 sq. km is a flat plain covered with paddy fields. The rivers Dikhow and Jhanji along with their tributaries flow through the block area. Rivers are perennial in nature but the nullahs in the block area are nearly dry in winter and have fordable rain water during rainy season which starts from mid April and extends to mid October. River Brahmaputra flows at a distance of 2 to 3 km from north-west boundary AB of the block.

3.3 PRODUCTION SHARING CONTRACT (PSC):

As per the PSC entered between Government of India and OIL & Shiv-Vani Oil & Gas Exploration Services Limited, four (4) exploratory wells are to be drilled in seven (7) years starting 2007-14.

3.4 JUSTIFICATION AND BENEFITS OF THE PROJECT:

For assessing oil/gas production potential and estimation of recoverable reserves, geological survey, geochemical survey and 2-D seismic survey have already been carried out by ONGC and OIL. Earlier ONGC has also drilled 8 wells in the block area (refer Section 1.1 and Fig. 1.2 in Chapter 1) which were found to be dry and, therefore, abandoned. OIL is now planning to carry out exploratory drilling/testing at 6 more locations in next 2 years commencing December, 2008 for obtaining more precise estimates of expected total reserves, likely maximum recovery and techno-economic viability of oil/gas production in the block area.

On completion of proposed exploratory drilling and testing, if oil and gas production is found to be commercially viable from the estimated OOIP of nearly 34 MMT (approx.), then oil/gas production phase will commence and more production wells may be drilled, if considered necessary, to produce GUR amount of nearly 10.2 MMT (approx.) in next few years. Production of oil/gas will generate additional revenue for the Assam State as well as Government of India in terms of royalty, taxation, cess and profit petroleum. Furthermore, any oil/gas production will be an import substitute and would save foreign currency reserves of Government of India and enhance energy security.

Assam's economy is presently characterized by high rate of poverty, low per-capita income, low capital formation, inadequate infrastructure facilities, geographical isolation and communication bottleneck, inadequate exploitation and use of forest and mineral resources, low progress in industrial field and high unemployment problem. Industrial sector is not able to open sufficient employment opportunities despite government's effort for developing a comprehensive base for industrialization. On the other hand, agriculture sector has become stagnant and not ready to absorb growing demand for employment.

Oil/gas production from the block will, therefore, assist in the economic development of this less developed area of Assam, due to increase in oil/gas revenue as well as generating some direct and indirect employment for unskilled and semi-skilled persons. Oil production, if found to be commercially viable will also result in overall infrastructure development and increase in business opportunities.

3.5 **DRILLING OF EXPLORATORY WELLS:**

3.5.1 Introduction

The exploitation of hydrocarbons requires the construction of a conduit between the surface and the reservoir. This is achieved by the drilling process. OIL is planning to drill 6 new exploratory wells within the block area to assess more accurately the commercial viability of oil and gas production from the block AA-ONN-2004/1. Drilling operations will be carried out upto a depth of about 4200 m. On the basis of available Geoscientific data and findings of exploratory testing of 8 wells drilled earlier by ONGC, OIL has tentatively fixed the coordinates of following four locations:

Location No.	Name	Latitude, N	Longitude, E
LOC-1	Amguri-1	26 ⁰ 53'35.94"	94 ⁰ 29'18.79"
LOC-2	Amguri-2	26 ⁰ 53'45.59"	94 ⁰ 29'10.85"
LOC-3	Amguri-3	26 ⁰ 50'31.45"	94 ⁰ 32'16.51"
LOC-4	Amguri-4	26 ⁰ 50'46.35"	94 ⁰ 32'39.69"

The locations of these 4 exploratory wells proposed to be drilled by OIL are shown in Fig. 1.2 in Chapter 1. The locations of other 2 wells within the block area are not yet finalized and will be based on more detailed analysis of available data and findings of drilling/testing of these 4 wells. It may be noted that the exploratory drilling/testing at the proposed 6 locations will be carried out sequentially and may require nearly 4 months at each location. Therefore, identification of exact coordinates of LOC-5 and LOC-6 will be necessary to commence drilling only after December 2009. Furthermore, with further analysis of available data and findings of exploratory testing of new wells drilled by OIL, some changes in exact coordinates of other remaining wells proposed to be drilled are quite likely since finding of an optimal location for drilling of an oil/gas well is a continuing process.

The lithological detail in the block area at the proposed drilling locations is expected to be as under:

Stratigraphic Description		Depth, m
•	Alluvium	0 – 250
•	Alluvium/Loose Sand	250 – 1500
•	Clay, Shale, Sandstone, Bands of Coal	1500 – 3000
•	Sand, Shale	3000 - 4200

The typical flow of events in planning and executing an exploratory well drilling activity comprises of the following steps:

- Data interpretation (based on 2D & 3D seismic surveys, exploratory drilling etc), for fixing of the well locations;
- Site Selection;
- Site Acquisition and Site Preparation;

- Pre-drilling Activities (mobilizing & rigging up of drilling rig)
- Well Drilling
- Well Evaluation and
- Well Site Restoration

3.5.2 Site Selection and Acquisition:

The exploratory / appraisal well sites will be identified based on the study and interpretation of the stratigraphy, seismic data and findings of exploratory testing of wells that has already been drilled in the area. The actual location of the well that will be drilled in each segment would be finalized by Exploration Department of OIL after giving due consideration to following major environmental factors also:

- At a reasonable distance (minimum 500 m) from any settlement, river or stream;
- At a reasonable distance (minimum 500 m) from State/National Highway;
- At a safe distance from any radio transmitter or overhead electrical lines;
- Without affecting drainage either by avoiding or by rerouting
- Not in any wildlife sanctuary / protected forest/national park.

All practicable means shall be taken to minimize or avoid detrimental effects on the surrounding environment by virtue of the construction of the location or the operation of the drilling rig. The exploratory well drilling would be a short duration activity.

3.5.3 Site Acquisition and Preparation:

Site acquisition and preparation activities will consist of the following:

- A. Use of existing road wherever suitable – Up-gradation and strengthening of the existing roads wherever required to facilitate drilling rig movement. No clearing / minimum clearing of roadside vegetation will be ensured for this work. A compensatory roadside plantation will be taken up through the Forest Department for any clearing of vegetation. As the existing road will be developed by widening/strengthening, thus it will be necessary to add support base material, replacing and strengthening of old culvert pipes, etc.
- B. Construction of new road - A route survey will be undertaken to identify most suitable path to the drilling site. Wherever existing road is not available new alignment will be identified. In case any approach road falls in forest land necessary Forest Clearance under the Forest Conservation Act, 1980, shall be obtained.
- C. Construction of a drilling site (pad) to facilitate drilling and testing of oil and gas well may require discontinuation of the agricultural activities in the identified piece of land. In case any forest land is to be used for construction related to drill site necessary Forest Clearance under the Forest Conservation Act, 1980, shall be obtained. Optimum design of the

drill site will be developed considering environmental and safety considerations such that minimum possible land is used for developing the drill site. Necessary compensation to the landowner(s) will be provided for procurement of land.

- D. Designing roads with sharp curves, blind spots, steep grades in or near streams and valleys will be avoided.
- E. Topsoil will not be used for road construction as well as site development. Top soil (top 30cm) will be scrapped from the drill site area as well as any new area to be brought under construction and will be stored appropriately with necessary cover so that the same is used for reclaiming the drill site later as a part of the drill site restoration or will be used to develop plantation in the nearby wastelands.

3.5.4 Drilling Rig and Support System:

The choice of the rig normally depends on the depth and the geological formations likely to be encountered. OIL has selected a 2000 hp diesel electric rig to execute the drilling operation in the block. The rig to be utilized has the following major equipment and specifications:

- **DRAW WORKS**

- Input HP rating minimum 2000 HP nominal depth rating 5500 m (approximately) with 5” drill pipe.
- Draw works will be operated by minimum two DC motors.

- **MUD PUMP**

Two triplex mud pumps equivalent to minimum input horse power of 1600 each. Power transmission is driven by 2 DC motors.

- **MAST**

Self elevating mast with minimum clear height of 147 feet. It will have a hook load capacity (derrick capacity) of 1,000,000 lbs (1000 KPS).

- **SUB-STRUCTURE**

Rotary capacity will be approximately 1,000,000 lbs and set back capacity 550,000 lbs. Combined capacity of hook load and setback will be minimum 800,000 lbs.

- **ROTARY SWIVEL**

Swivel will have a minimum dead load rating of 500 T with 5000 psi working pressure.

- **POWER PACK**

Engines minimum 4 (four) numbers turbocharged, after cooled, air start, diesel driven, 1010 hp@1500 rpm. Generators – 1500 kVA (each), 600 V, 1500 rpm, 0.7 PF, 50 Hz.

- **SCR SYSTEM**

One RIGHILL electrical SCR system

- **TRAVELLING BLOCK AND HOOK**

Unitized traveling block and hook assembly of 500 T capacity with 6 sheaves grooved suitable for drill line and with minimum 12 line operation.

- **DRILL PIPES**

A total of 6000 m of 5” OD drill pipe consisting of 19.5 PPF Grade ‘G’ flash/friction welded, tapered or square shoulder, in range 2 length.

- **DRILL COLLARS**

Suitable size and numbers of Drill Collars to be used.

- **BOP CONTROL UNIT**

Proper BOP (Blow Out Preventer) system will be used for the drilling operation to contain any unexpected pressures from the well.

- **TOTAL TANK VOLUME**

A mud system having an active capacity of 220 m³ and gross capacity of about 400 m³, including reserve capacity.

- **SUPPORT SYSTEM**

- **Portable Living Quarters** – to house essential personnel on site on a 24 hour basis. These units are provided with Bath/Washroom.
- **Crane-age** – cranes for loading/off loading equipment and supplies.
- **Vehicle Requirement for Interlocation Movement (ILM)** - The rig components including auxiliary equipment, camp facilities, etc. comprise about 50 trailer loads.]

- **Emergency Systems** – this includes fire detection and protection equipment. MBBS Doctor will be there for emergency medical attention, round the clock.
- **Environmental Protection** – Blow Out Prevention (BOP) system, wastewater treatment unit, drill cuttings handling equipment.

Plate 3.1 shows a typical drilling rig and associated system.

3.5.5 **Pre-Drilling Activities:**

Pre-drilling activities involve mobilization of drilling rig and associated equipment onto the location on completion of drilling location preparation. This will be followed by the rig building process, which would involve assembling of various rig parts and equipment for the well drilling. Once the drilling rig is assembled, thorough rig inspection will be carried out to check equipment working capability and quality standards including compliance to HSE requirements.

3.5.6 **Well Drilling:**

The drilling rig will carry out drilling with a standard water based drilling fluid. The well site once drilled will undergo exploratory production testing and the rig will be moved to next location. The drilling campaign shall continue till adequate results of the reservoir characteristics and production potential are collected for estimating the developmental activities by drilling about 6 proposed new exploratory wells. Additional wells may be drilled at a later stage, if considered necessary.

The drilling operation involves simultaneous data logging of the stratigraphy. If sufficient evidence about the well location is found having trapped hydrocarbons, a well test will be performed to establish the oil and/or gas flow potential of the various zones of interest. In case the well test results in encouraging yield, further exploratory/appraisal wells will be drilled at identified locations within the prospect area for determining the extent and quantum of the total and recoverable reserves.

Well spudding is the start of drilling activity. Top-hole section will be drilled to a desired depth based on well design. After drilling top-hole section, it will be cased with a pipe called "Casing". The casing provides support to the drill hole wall and secures the hole-section. Other than this, it isolates problematic hole-sections such as loose zones, shale sections, over pressurized formations, etc. After running casing, the space between hole wall and casing (annulus) will be cemented. This process of drilling and casing the hole-section continues until the final well depth (target) is achieved.

A well drilled for oil is not simply a hole drilled from surface to total depth, but it is several concentric holes. The smallest is at the maximum depth and each is often lined with steel casing, which is held in place by placing cement in the annulus between it and hole wall, at predetermined regular intervals. When required, the casing prevents collapse of hole and/or uncontrollable

flow of fluids into or out of the well bore. Well profile proposed by OIL for a drilling depth of 4200 m is as under:

Hole Size (mm)	Casing Size (mm)	Depth Range (meters below ground level)
660 (26")	508 (20")	0 – 250
445 (17.5")	337 (13 ³ / ₈ ")	250 - 1500
311 (12.25")	244 (9 ⁵ / ₈ ")	1500 - 3000
216 (8.5")	139.7 (5.5")	3000 - 4200

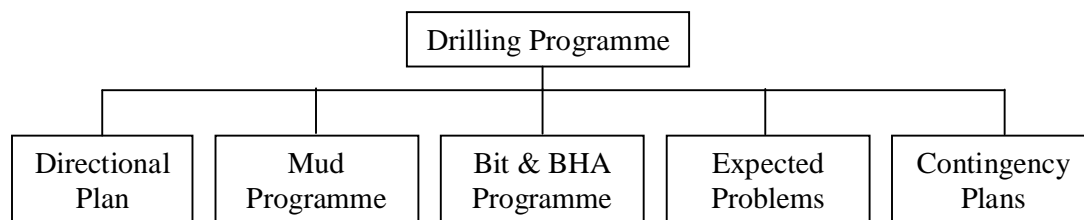
Needless to say that both the casing and cementing will have perforations at appropriate depths for recovery of oil and gas. OIL will employ drilling contractor for routine drilling of wells. However, a number of related services must be performed in order to properly drill the borehole and complete the exploration well, whether it is dry or producer. These are provided by international service companies whose contracts are separate from drilling contractor as indicated in flow diagram given in **Fig. 3.1**.

After the well is spudded, routine drilling consists of continuously drilling increments of drill pipe, making connections (adding to the drillstring of another joint or stand of drill pipe), and continuing until it is the time to change the drill bit. The bit must be changed when it is worn or a formation is encountered for which the particular bit being used is not suitable. Changing the bit is accomplished in an operation called "tripping". A round-trip includes coming out of the hole, changing the bit, and going back to the hole.

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 hole unconsolidated material falling into hole and potential washout problems. Typical lengths of such pipes are 12 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.

Success of drilling programme is contingent of many sub-programmes/plans as indicated below:



Completion of well involves perforations at appropriate depth levels having oil/gas bearing strata through casing and cementing so that oil/gas can flow in to the well. A tubing generally of 2⁷/₈ inch diameter is placed at the centre of bore hole for withdrawal of oil/gas to the surface.

3.5.6.1 Drilling Fluid Plan:

During drilling operations a fluid known as drilling fluid (or 'mud') is pumped through the drill string down to the drilling bit and returns between the drill pipe casing annulus up to surface back into the circulation system after separation of drill cuttings / solids through solids control equipment as shown in **Plate 3.2**. Drilling fluid is essential to the drilling operation. It performs the following functions:

- Removes drilled cuttings from the bottom of the hole and transports the cuttings back to the surface, where they are separated from the mud and discarded (in effluent pits).
- Lubricates and cools the drill bit and string.
- Forms a layer (wall cake) on the sides of the hole, which seals the walls and prevents mud from entering the formations.
- Keeps the drill cuttings suspended if drilling is interrupted.
- Counters natural formation pressures, preventing the uncontrolled flow of oil, gas, or water into the borehole.

An **environment-friendly water-based mud (WBM)** system will be used for drilling of the proposed wells.

The drilling fluids circulation system consists of several items of equipment as shown in Plate 3.2. The mud pump takes in mud from the mud pits and sends it out through a discharge line to a standpipe. The standpipe is a steel pipe mounted vertically on one leg of the derrick. The mud is pumped up the standpipe into a flexible reinforced rubber hose called the Kelly hose. The Kelly hose would be connected to the swivel. The mud goes down the Kelly, drill pipe and drill collars and exits at the bit. The mud then does a sharp U-turn and heads back up the hole in the annulus. The annulus is the space between the outside of the drill string and the wall of the hole. Finally, the mud leaves the hole through a steel pipe called the mud return pipe and falls over a vibrating screen like device called the shale shaker.

The shale shakers will be high speed, linear motion shakers and will discharge the cuttings into a solids catchments trough below. The more efficient the shale shakers are the less drilling fluid will be associated with the cuttings and the quicker the cuttings will be able to dry out, which is the reason why high speed linear motion shale shakers would be used. An air driven jetting system will be installed in the header boxes so that accumulated cuttings can be periodically flushed up and over the screens and into the cuttings catchments trough. When dumping of whole mud would be required (i.e. cement jobs or changing out the mud system), the returns will be diverted straight to the waste mud pit, not the cuttings catchments trough. A high power wash gun will be

placed at the shakers to help clean them, to avoid large volumes of wash down water.

The function of the cuttings catchments trough is to provide a brief initial containment of the cuttings, as well as allowing liquids to drain off into the waste mud pits. The cuttings catchments trough will be waterproof and rectangular and located below the shale shakers, with the width designed to be slightly wider than the bucket of the rubber-tired end-loader. It will be composed of a flat cement floor, with thick vertical walls of brick or cement 80 to 100 cm high on both long sides, and on one of the short ends.

The bricked short end would be securely constructed, as the end-loader pushes up against this wall to help scoop up the drill cuttings. The other short end incorporates a ramp to allow the end loader to enter and descend to the floor and scoop up the cuttings and other solids for disposal in the cuttings collection field. This ramp will also contain the cuttings within the cutting catchments trough and not allow them to escape onto surrounding areas. The cuttings catchments trough will have two drainage ditches; both with 'V' or 'U' shaped bottoms, to allow drainage of liquids from the trough, to the waste mud pits. The drainage ditches will be formed of cement, with an upstream, end screen, to filter out large solids, and a closing gate. The ditches will not be flat bottomed because this shape readily accumulates solids while V and U shaped ditches are to some extent, self-cleaning. Ditches would be preferred to pipes, since the latter are more difficult to clean out when solids accumulate inside, except in vehicular traffic areas.

Handling equipment will include a rubber-tired end-loader with a bucket mounted at the front for scooping up drill cuttings from the cuttings catchments trough. The tires of this vehicle will be sufficiently wide so that the loader does not get mired down if rain soaks the location. This end-loader will collect the cuttings from the cuttings collection trough, remove them to the cuttings collection field and dump them there to be dried out by the sun. There will also be two separate areas where the end-loader can discharge cuttings to the cuttings disposal field, so that the cuttings can be more evenly spread over the field allowing for faster drying.

The solids control tanks will have agitators installed to prevent solids from settling out there. When required, these tanks can be processed through the hydro-cyclones (including de-sander and de-silter) and centrifuge to clean out the drilled solids from drilling mud. When dumping through the dump valves of the solids control tanks, the mud will flow directly to the waste mud pits.

Two triplex mud pumps will be provided to pump the mud tanks nearly dry and move waste fluids between the waste pits and the solar drying beds. This pump will also be useful to empty mud tanks and transfer mud to either the centrifuge or to the mud waste pit. If a de-sander is installed, the underflow will be capable of being directed either to the solids catchments trough or the waste mud pit. If a mud cleaner is installed, the solids from the screen will be directed to the cuttings catchments trough.

The whole process by which the drilling fluid will be reused during the drilling operation is commonly known as a “closed loop system.” This system is ideal for drilling operations in sensitive environments as it cuts down immensely on the total water consumption for the formulation of drilling mud, saves on the consumption of chemicals and reduces waste generation. **Plate 3.2** shows the schematic layout of the drilling waste management settings for the exploratory wells in block AA-ONN-2004/1.

Various chemicals will be used during the drilling phase as components of drilling fluid (mud). At the planning stage, an estimate of the potential usage for every chemical will be made. The proposed mud policy of OIL for drilling of 6 exploratory wells in the block is as follows:

Hole Size	Depth, mt.	Csg. Size	Mud Type	SG	PV	YP	GEL	API F/L, cc	pH
26"	250	20"	Bentonite Suspension	ALAP	ALAP	20-25	>8		8.5-9.5
17½"	1500	13¾"	Partially Treated WBM	1.1-1.18	ALAP	20-25	>8	<15	9.0-9.5
12¼"	3200	9¾"	PAC MUD	1.1-1.18	ALAP	15-20	6-8	10-8	9.0-9.5
8½"	4300	5½"	XC-PAC MUD	1.18-1.20	ALAP	15-20	5-6	7-5	9.0-9.5

Abbreviations: SG = Specific Gravity, PV = Plastic Viscosity, YP = Yield Point
API = American Petroleum Institute, F/L = Fluid Loss/

It may be noted that a typical WBM may contain nearly 75% water and 25% clay plus chemicals by weight.

Some of the typical chemicals which are planned to be used for the drilling campaign are as follows:

Chemicals	Unit	Quantity Required in Different Stages				Total Requirement	Chemical Characteristics
		26"	17½"	12¼"	8½"		
- Barytes	MT		50	150	150	350	Inert
- Bentonite	MT	45	45	40	20	150	Clay
- Caustic Soda	KG	500	1000	1250	750	3500	
- CMC (H)	KG	500	2500			3000	Bio-degr
- Guar Gum	KG		1500			1500	Bio-degr
- CFLS CL 20	KG			2500	2500	5000	
- PAC (SL)	KG			500	1500	2000	
- CMC (SL)	KG			2000	1500	3500	Bio-degr
- CMC (L)	KG		3500	1250		4750	Bio-degr
- PAC (R)	KG			2500	1500	4000	Bio-degr
- Resinex	KG				4000	4000	
- Magcoasphasol	KG				4000	4000	
- XC-Polymer	KG			500	800	1300	Bio-degr
- Linseed Oil	KL			12	8	20	Bio-degr
- EP-Lube	KL			6	4	8	Eg-oil lubricant
- Drilling Det	LIT			500	1500	2000	

The above list of drilling material requirements may vary considering situations encountered during drilling. During the operation chemical usage will be monitored and efforts will be made to conserve or reuse chemical as much as technically possible.

To overcome specific well problem, the mud is made up through the addition of specific mud components to adjust the mud properties to ensure that following functions are met:

- **Fluid loss control:** The layer of fluid on the wall of the bore retards passage of liquid into the surrounding rock formation. Bentonite as well as naturally occurring additives such as starch and cellulose are added.
- **Lost circulation:** Naturally occurring fibrous, filamentous and granular or flaky 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.
- **Shale Inhibition:** Potassium assists in the hydration of shale which in turns prevents their sloughing into the well bore. This potassium ion is normally introduced to the mud via potassium chloride (KCl). In these wells, to minimize any impact on the environment, potassium sulphate will be used.
- **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 down-hole pressure.

The essential ingredients of the WBM are all low toxicity materials, rated either as Grade **E** products (according to the new OCNS grading system), or Grade **O** (according to the former OCNS system). These are lowest two toxicity categories. A variety of other products will be available for various contingencies. Thinners such as chrome free ligno-sulphonates (CFLS) and lignin compounds may be used to control rheology. Citric acid may be used to reduce pH after drilling. As detailed above various Lost Circulation Materials may also be used to reduce the circulation loss of WBM to drilled formations. There is a low level of risk that the drill pipe becomes stuck in the well. Currently a number of **freeing agents** (defoamers, surfactants or emulsifiers) are available that would normally be mixed in diesel and pumped into the well around the stuck section of the drill pipe. This is a contingency procedure and these products will be replaced with more environmentally acceptable products, wherever possible. Oily muds and cuttings will not be discharged into WBM effluent pit and will be kept separate for proper disposal. In the

event of hydrogen sulphide (H₂S) being detected at any stage in the well, remedial methods will include pumping into well of calcium hydroxide, sodium hydroxide or iron oxide in the form of Fe₃O₄.

In order to prevent the ingress of formation fluids into drilling mud, drilling mud pressure is kept 200 to 500 psig (14 to 35 kg/cm² g) above the hydrostatic pressure of formation fluids.

3.5.6.2 Drilling Equipments and Logistics:

Standard, Diesel Electric 1500 HP/2000 HP rotary drilling rig and associated ancillary equipments is proposed to be used for drilling of 6 exploratory wells in the block by OIL. Mast cellar of the rig will occupy nearly 5 m x 5 m and overall exploratory well plinth will be nearly 186 m x 110 m (2.94 hectares) including camp site, Flave system, etc. Close to the rig, tanks for recycling of the drilling mud, appropriate waste disposal facilities and suitable storage facilities for chemicals and diesel fuel will be constructed. **Fig. 3.2** shows a typical plan of drilling rig site of OIL. **Plate 3.1** shows a typical drilling rig and associated facilities.

3.5.6.3 Blow Out Preventors (BOPs):

Well control procedures will be conducted as per API 6A and API RP 53 standards. Well control occurs in two forms, namely, primary and secondary.

Primary: Aimed at preventing the influx of formation fluids by maintaining sufficient down hole pressure. This will be achieved by using drilling mud as indicated in Sub-section 3.5.6.1.

Secondary: This is applied when primary control has failed and fluids have entered the well bore from a formation. The aim of secondary control is to safely discharge the fluids at the surface while preventing further influx down the hole. This is achieved by using blow out preventors (BOPs). A BOP stack is usually formed of three or more separate hydraulically operated preventors, of which there are two main types:

- Annular; and
- Ram type.

The BOP stack arrangement is selected depending on the expected well pressure. Once assembled, the stack is placed on the high-pressure riser and tested and then placed on well mouth before commencement of drilling. Typical onshore drilling BOP stack is shown in **Fig. 3.3**.

3.5.7 Well Evaluation:

3.5.7.1 Well Logging:

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

Technicians employed by a specialist logging Service Company 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 sources required for well logging operations will be kept in specially designed container, if used.

3.5.8 Well Testing:

In the event that hydrocarbons are encountered in sufficient quantities, as determined by electric wire line logs, exploratory testing of well is undertaken. During testing, pressure control Christmas tree at well head is installed to test the well in a controlled manner. The main purpose of exploratory testing of oil/gas from the exploration/assessment location is to determine the quality and quantity of oil/gas and commercial viability of production. This is done by bringing a controlled flow of well fluids to the surface from which the following properties are established: well potential; formation pressure and temperature; and reservoir permeability, etc.

If an oil well is found to be commercially viable but well pressure is not sufficient for it to be self flowing, then artificial lifting devices may be used to pump oil from the well to the surface. If oil well is self flowing, oil will flow to the surface through the central tubing due to well pressure and no submersible pump will be necessary. Flow of formation fluid (oil/gas/water) to surface is controlled by placing nozzle (called Bean) of appropriate diameter at the top of the well and oil along with other formation fluids will be sent directly to the temporary production testing facilities constructed near the exploration well through piping system.

In the event when a well is found to be dry, that is, no oil/gas is found or the production is not commercially viable, the well will be plugged and abandoned.

Fig. 3.4 shows the general steps involved from well drilling to oil/gas production.

Exploratory testing will involve pumping of recovered oil/gas along with formation water. H₂S scavenging chemicals (caustic soda solution or calcium hydroxide or iron oxide slurry), if H₂S is detected, and defoaming chemical solution, if required, will be injected in the recovered oil/formation water mixture after pressure reduction through choke and sent to Separator. Three phase separation will take place in the Separator. Hydrocarbon gases will be sent from the top of the Separator to Knock-out Drum in which liquid droplet

entrapped in gases leaving the Separator will be recovered while gases leaving the Knock-out Drum will be flared in a well designed Flare Pit. Formation water collected at the bottom of the Separator will be mixed with de-emulsifier and sent to Formation Water Tank. Liquid hydrocarbons collected at the top of the Formation Water Tank will be recovered while waste water will be sent to polylined Effluent Pit.

Recovered oil from Separator will be first collected in a Test Tank and then sent to Oil Storage Tanks.

Fig. 3.5 shows the process flow diagram of initial production testing for oil/gas from exploratory/assessment drilling location.

3.5.9 Well Site Restoration:

On completion of drilling, the rig will be demobilized which will involve the dismantling of the rig and residential camp, and transporting out of the project site.

A drill site restoration plan will be prepared as a part of post drilling operations for the following two scenarios:

3.5.9.1 Economic Quantities of Hydrocarbon are Found:

In the event that economic quantities of hydrocarbons are found, the well will be shut in with a wellhead / X-mas tree in place, but all other equipment and materials will be removed from the site. The steps to be taken are mentioned below:

- All empty/discarded drums will be sent to base camp at Duliajan, decontaminated by cleaning and sold to recyclers.
- Solid waste, i.e., Drill Cuttings shall be spread on land for drying and then disposed off in the well site HDPE lined secured pits, in line with EP Rules, 2005 (Amendment).
- Fuel and lubricants will be transferred to the other drilling sites for further use.
- Water supply and effluent discharge hoses and associated equipment will be removed.
- The access road(s) would be either left behind or restored to original condition based on the needs of the local authorities/land owners.

At the end of well testing at each drilling site, the HDPE Lined Secured Pits for Drill Cuttings and Drilling Mud will be covered with a top HDPE liner of 1500 microns. The pit will then be backfilled with minimum 300 mm layer of local top soil, which was collected and stored during drill site development (refer Section 3.5.3 E) and/or is available in the vicinity at a shortest distance from the project site and compacted.

3.5.9.2 Economic Quantities of Hydrocarbons are not found:

In the event that economic quantities of hydrocarbons are not found, the well will be declared dry and plugged. A full abandonment plan will be implemented for the drilling sites in accordance with the applicable Indian regulations (OISD and Oil Mines Regulations) and good industrial practice. The actions outlined in Sub-section 3.5.8.1 would apply to decommissioning upon abandonment as well, but abandonment would be more permanent. The following steps will be taken to restore the area.

- § The well head and all casing string will be cut off to a minimum depth of 3 m below ground.
- § All concrete or steel installations would be removed to at least 3-m below ground level and debris disposed off as per regulatory requirement.
- § In the unlikely event that soil is found contaminated, measures would be taken to remove or treat appropriately all contaminated topsoil to promote its remediation.
- § All fencing and access gates will be removed.

Plugging requirement of abandoned wells as per Oil Mines Regulation, 1984 are as follows:

1. When it is intended to abandon a well.
2. All permeable formations shall be isolated with cement;
3. A cement plug of minimum length of 50 metres shall be placed at the bottom of the well;
4. A cement plug of a minimum length of 50 metres shall be placed across the shoe of surface casing;
5. The celler or pit around the well shall be filled up and the land shall be restored to the original level; and
6. Cased wells may be abandoned by placing a bridge-plug above the top of perforations capped with three-metre cement plug.
7. Every abandoned well shall be clearly identified at site.

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

If due to certain reasons, another well(s) is/are required to be drilled within the existing drill site, for any of the above-mentioned scenarios, the dried waste from the existing secured pits will be transferred to the new smaller capacity secured pits as required. They will then be covered with a 1500 micron top liner and backfilled with minimum 300 mm local top soil. By transferring of the waste to the new secured pits the existing higher capacity pits can be used for the containment of the waste from the new well.

3.6 **REQUIREMENTS OF MANPOWER, TIME, WATER, POWER, FUEL AND CHEMICALS FOR DRILLING AND TESTING**

3.6.1 **Manpower Requirement:**

Under normal operation, the project work force will consist of nearly 65 persons distributed as follows:

Location	Manpower		Total
	Technical	Non-Technical	
• Base Office (Duliajan)	5	--	5
• Camp Site	20	10	30
• Well Site	20	10	30
Total	45	20	65

At any one time there will be nearly 30 persons at the well site camp and will be accommodated at the temporary camp/area facilities near the well site and almost an equal number will be on duty for rig operations. Only minimum number of essential shift persons will stay on duty at drilling site during night-time. About 4 vehicles will be required during drilling and testing operations for movement of men and material as detailed below:

Sl. No.	Vehicle	Number	Purpose
1.	Ambulance	1	Standby at site for emergency.
2.	TATA Sumo or equivalent	1	For meeting domestic requirements at the camp site personnel.
3.	Truck	1	For transporting cement, chemicals, etc to well site as and when required from base camp godown.
4.	Trailer	1	For transporting casing pipes, tubulars, other heavy equipment to well site from base camp godown.

3.6.2 **Time Requirement:**

Time required for actual drilling and completion of one well upto a depth of 4200 m will be nearly four months (120 days) including assessment testing period of 5 to 10 days for each exploratory well indicating promising presence of hydrocarbons. In addition, 15 to 20 days will be required at each well site for rig building before commencement of drilling, dismantling after completion of drilling and intersite movement of drilling rig. Nearly 50 vehicle loads may be required for transporting drilling rig, associated equipments and material. Expected date of commencement of drilling is December, 2008 and drilling of 6 wells will be carried out sequentially.

3.6.3 Water Requirement and Water Balance:

The water requirement during drilling of exploratory well will be small and is likely range from 30 to 50 klpd with an average of 40 klpd. Water usage and water balance are as follows:

Item	Inflow		Loss klpd	Outflow	
	Amount klpd	Basis		Amount klpd	Disposal
• WBM Make-up	10.0	Assumed	5.0	5.0	Effluent Pit
• Fire Water Make-up/Equipment/Floor Washing and Other Uses	20.0	Assumed	7.5	12.5	Effluent Pit
• Domestic	4.0	For 40 persons @ 100 lpd per person	1.5	2.5	Waste Water & Sewage Disposal Facilities/Soak Pit
• Storage and Other Losses	6.0	Assumed @ 15%	6.0	--	--
Total	40.0		20.0	20.0	

Water requirement during production testing period will be very small and may not exceed 10 klpd. 200 m³ of water will be stored in overhead rectangular steel tanks for smooth and unhampered operations.

Water for drilling and testing will be supplied from tube wells within the drill site. In view of fairly high rainfall in the area and fairly limited use of water for domestic, agricultural and industrial use, availability of water is assured throughout the year.

3.6.4 Power Requirement:

Drilling rig and associated system will have a minimum of 4 DG sets of Cummins make each of 1010 hp (or 750 kW) to meet the total power requirement including drill site domestic requirement during drilling. A 50 kW DG set will be used to meet power requirement during assessment testing of well in the absence of power availability from rig Gen Set.

3.6.5 Fuel and Chemical Requirement:

High speed diesel (HSD) requirement will be nearly 3 to 5 klpd during drilling and 1 to 2 klpd during well testing for the operation of drilling rig and to meet other industrial and domestic power requirement at drilling/testing site as well as for vehicles used for transport of personnel and material. Diesel will be stored at drilling site in covered MS tanks of 10 to 20 kl capacity. Only low sulphur (<0.1%) HSD will be used.

Various chemicals that are likely to be used during the drilling phase are listed in Sub-section 3.5.6.1. At the planning stage, an estimate of the potential usage for every chemical will be made. During the operation chemical usage will be monitored and efforts will be made to reduce or conserve chemical usage as much as technically possible. Bentonite and barite will be stored in sheds while expensive chemicals required in smaller quantities will be stored in godowns.

The supplies during well drilling and testing include all fuels and oils, chemicals for drilling mud, spare parts for the rig and vehicles, and food and other supplies for the residential camp. Fuels, oils, and chemicals will be unloaded in designated areas with impermeable floors (either concrete or covered with an impermeable material) and lined by dykes or walls to prevent soil and water contamination from spills.

3.6.6 Material Supply System:

Supply of materials, such as, diesel fuel, drilling chemicals, provisions and other supplies to the drilling site will be made by road transport. Fresh water for drilling and general use will be provided from tube well source and water will be stored in MS tank. Road tankers will be used for supply of diesel fuel to storage facilities at drilling site. Provisions and other supplies to drilling site will be made by Tata Sumo or jeep. Road transport will also be used for supply of materials and transport of personnel to drilling sites.

3.7 Normal Operational Pollution Sources:

During drilling and testing of oil/gas at exploratory/assessment locations as in most industrial processes, it is unavoidable that there will be the requirement for the discharge of waste materials to the environment. These discharges need to be controlled to reduce adverse impact on the surrounding environment. The sources and types of wastes that will be generated by the drilling and testing programme are described in following sub-sections. Where possible the description includes quantification of the discharge expected. Any assumptions made are also indicated in the text.

3.7.1 Drilling Discharges:

Drilling operations directly generate three forms of waste, drilling materials, liquid effluents and solid wastes. The solid wastes and liquid effluents include drill cuttings of rocks and used or spent drilling mud. Drill cuttings produced using WBM will be collected in HDPE lined solar drying pit for further drying and later disposed off in HDPE lined cutting disposal pit on completion of drilling and testing operations. Wasted water based mud (WBM) will be discharged directly into the HDPE lined mud pit as an unusable liquid during and after completion of drilling operations. Nearly 75 to 100 m³ of wasted WBM and nearly 170 to 200 m³ of drill cuttings are expected to be produced at each well. Any diesel based mud, if used during drilling for freeing of drill pipes if stuck in the well, as well as oil containing drill cuttings from oil bearing stratum using WBM, if any, will be centrifuged and bioremediated, if

necessary, to reduce oil content to less than 1% before disposal in HDPE lined drill cutting disposal pit.

Some cement waste may also be generated during cementing of casing during drilling at the exploratory well site and the same will be used as landfill.

3.7.2 Drainage Discharges:

Drainage discharges will occur from a variety of sources on the rig. These include:

- Clean rig floor area drains;
- Machine area floor drains;
- Bunded areas beneath lubricating oil storage;
- Bunded areas beneath fuel or chemical storage; and
- Overflow drains in diesel fuel tank system.

3.7.3 Waste Water Generation During Production Testing:

Waste water generated at the well site during exploratory production testing programme of 5 to 10 days for each exploratory/assessment well will be the formation water which will be treated in the nearest Formation Water Clarification Unit. And treated effluents meeting the on-shore discharge standards will be discharged underground in water disposal wells at a controlled rate in necessary. Formation water production rate is likely to be extremely small or negligible during 5 to 10 days of assessment testing at each well site showing existence of hydrocarbons containing strata.

3.7.4 Domestic Waste Water:

Domestic wastewater will be generated by general use by work force during drilling and testing operations at the exploratory well site. As part of the site preparation stage, a drainage and sewerage system will be constructed for the camp and the rig. The sewerage system will consist of soak pits for the collection and treatment of wastewater from the camp kitchen, laundry, and showers. Soak pits will be constructed in such a manner so as to avoid any seepage in any surface or ground water source.

Sewage from toilets will go into septic tanks from where, after being treated, the wastewater will go into a soak pit and the semi-solid waste will be collected from the septic tanks periodically and transported to a nearest municipal drain, if required.

3.7.5 Gaseous Emissions:

Gaseous emissions from the drilling rig operations will be dominated by exhaust gases from the diesel driven power generators. These emissions will include SPM, CO₂, NO_x, SO₂, CO and unburnt hydrocarbons (UHC). It may be noted that nearly 3 to 5 klpd of HSD with low sulphur content (<0.1%) will be consumed during drilling operation (Sub-section 3.6.5) and only 1 to 2 klpd

of HSD will be consumed during testing operation. Exhaust emissions will be discharged from stacks of appropriate heights (5 m or more) for adequate natural dispersion from DG sets.

Gaseous hydrocarbons produced from the exploratory well during testing will be directed to the flare pit resulting in release of NO_x, CO₂, and SO₂. Flare gas quantity will depend upon the extent of gaseous hydrocarbons generated during approximately 5 to 10 days period of assessment testing of oil and gas at each exploratory/assessment location. In case an oil well has associated gas, about 10000 m³/d of natural gas is likely to be flared for about 3 to 4 days at one well. Depending on the efficiency of the multiheader flare burner and the quality of the gas, flare emissions may also contain a small amount of UHC and particulate matter, which may sometime produce a black smoke plume.

Minor gaseous releases may occur from venting of the tanks, such as, test tank, oil storage tank, formation water tank. Small methane releases may also occur in association with water based mud sediments and it will be released to the atmosphere. Unless significant quantity of methane is released, even on a calm day, it will not constitute a viable combustion hazard because lower flammability limit for methane in air is 5%.

3.7.6 Noise:

Sources of noise at the drilling site include rotating equipments such as, rotary table, pumps, reciprocating compressors, diesel powered generators, piping sources, coolers and the flare. Noise level at the periphery of the drilling well plinth will not exceed 75 dB (A) and will decrease rapidly on moving away from the well site. The rig itself has a built in shock absorbing system that prevents propagation of any vibration produced by rotating equipments. DG sets will have noise control enclosure as per regulatory requirement. Vehicular traffic is expected to generate temporary noise level of less than 70 dB(A) at about 10 m distance.

3.7.7 Heat Generation:

The drilling process will generate heat at the bottom of the well bore which will be dissipated to the WBM. Information on the amount of heat that will be generated during the drilling work is not known, but the same is unlikely to have any noticeable effect in area surrounding the drilling rig and mud tanks.

3.8 TREATMENT AND DISPOSAL STRATEGY FOR POLLUTANTS

3.8.1 Drilling Discharges:

The accumulation of drilled cuttings at the drilling site is unavoidable in any drilling operation using WBM. Rock/drill cuttings generated during drilling will be lifted with drilling mud and brought to surface where they will be separated from the drilling fluid. This process is not completely effective and the cuttings will retain a thin coat of mud. The cleaned cuttings from using WBM will be further dried in HDPE lined Solar Pit. Oil containing drill

cuttings, if any, will be centrifuged and bioremediated, if necessary, to reduce oil content to less than 1% before disposing in HDPE lined drill cutting disposal pit. On completion of drilling, the drill cuttings (approximately 170 to 200 m³) will be placed in polylined impervious effluent pit, covered with polythene sheet and then with compacted cover of soil and capped as per regulatory pit closure protocol. However, attempt is always made to use these cuttings for plinth/road maintenance, land fill, etc. also.

On completion of drilling, the total quantity of wasted or used WBM collected in the effluent pit at each well site may have upto about 75 to 100 m³ total volume. Since the climate of the area is humid, rainfall is moderate to heavy except during November to March, solar drying may not be always possible. Since it is non-toxic, it will be disposed off in HDPE lined mud pit. Pits will be constructed of sufficient capacity to provide safe storage and prevent contamination of surface and ground water as shown in **Fig. 3.2**.

3.8.2 Drainage Discharges:

The drainage discharges may be contaminated in some manner by oils or chemicals. These discharges will be routed to the nearest Waste Water Clarification System for treatment and treated effluents meeting onshore discharge limits will be discharged underground in abandoned wells at a controlled rate.

3.8.3 Waste Water Generated From Exploratory Production Testing:

Formation water separated in Separator during recovery of oil and gas during 5 to 10 days of assessment testing at each well site will be treated in the nearest Waste Water Clarification System and treated effluents meeting the on-shore discharge standards will be discharged underground in water disposal wells at a controlled rate (refer Sub-section 2.5.1 in Chapter 2) for treated water, if required.

3.8.4 Waste Water Clarification System:

Wastewater from drilling rig drainage discharges will be sent to a settling pit, where suspended solids in wastewater will settle. The supernatant will be carried to the second pit for further settling of suspended solids. Formation water separated in separator during testing operation will be sent directly to second pit as it will not have much suspended solids. Sufficient retention time will be provided for separation of suspended solids and subsequently, the supernatant of the second pit will be taken into the skid mounted treatment systems, which consists of coagulation, flocculation and oil removal. At the last stage the treated water is passed through a filtration section. Most of the treated water will be reused in washing and in process operations, whereas the remaining treated water will be used for dust suppression and gardening within the drill site as shown in **Fig. 3.6**.

3.8.5 Domestic Waste Water:

Domestic waste water disposal for residential facilities at the well site will be treated and handled in a well designed drainage and sewerage system.

3.8.6 Used Oil:

Spent oil generated from oil changes or leakage from equipment or diesel storage tanks, used lubricating oil (from engine oil changes) is designated as hazardous and shall be sold only to MoEF/SPCB approved recyclers.

3.8.7 Gaseous Emissions:

The exhaust gases from diesel driven power generators and diesel-powered equipment on the rig will be discharged through stacks of appropriate heights (5 m or more) to achieve adequate natural dispersion. Only low sulphur (<0.1%) HSD will be used.

Gaseous hydrocarbons produced during assessment testing will be flared in a multiheader flare pit at a distance of about 100 m from well centre. Ground flare will be properly designed and will be surrounded by heat resistant wall as shown in **Figs. 3.7** and **3.8**.

Small methane releases from drill cuttings and mud sediments at the WBM recirculation tank will rise to surface and will readily transfer to the atmosphere without constituting a viable combustion hazard.

3.8.8 Noise:

The built-in shock absorbing system in rig will reduce vibration and noise from rotating equipment to ensure that noise level at the periphery of drilling location plinth does not exceed 75 dB (A). DG sets will also have noise control enclosure as per regulatory requirement.

3.8.9 Heat Generation:

Natural heat losses from recirculating WBM will rapidly dissipate the heat generated due to drilling operation to a large mass of WBM.

3.8.10 Other Solid Wastes:

A number of operational and non-operational solid wastes will be generated as a part of the proposed drilling and assessment testing programme and may include domestic garbage, scrap food, packaging materials and special hazardous wastes. All solid wastes will be collected and appropriately segregated for proper disposal.

Hazardous wastes may include such items as spent batteries, waste oil and chemicals, empty chemical drums and fluorescent tubing. These will be sent to

base camp at Duliajan & disposed off in accordance with approved safe procedures.

All biodegradable waste (food & kitchen waste) at the drilling site will be collected and disposed off into two small humus pits (each of 2 m x 2 m x 1.5 m) within the drilling site area away from common use by rig crew members. The humus pits will be covered with soil on daily basis to avoid any odour nuisance due to decomposition and check any contact with the flies or insects.

3.8.11 Potential Accidental Events:

Due to strict observation of necessary safety requirements, chances of accident occurring are negligible. However, in all aspects of hydrocarbon exploration, there is always a risk of non-routine or accidental events occurring which may lead to an unwanted emission or impact.

During drilling operation of an oil well, following two major hazards can occur which can create danger to life at and around the drilling site:

- Occurrence of blow out
- Occurrence of sour gas (H₂S)

Blow out is defined as uncontrolled sudden violent escape of well fluids from the well as a result of the following:

- Formation fluid entry into the well bore;
- Loss of containment due to mal-operation (e.g. during wire lining); and
- Wellhead damage (e.g. by fires, storms, dropped objects, etc.).

Blow out followed by ignition can be extremely hazardous close to a well site. During drilling operation, sour gas (H₂S) may also be released from the well along with gaseous hydrocarbons, mostly methane. Since H₂S is a toxic gas its release from the well may result in toxic hazard close to the well site. However, it is known that crude oil/gas in Assam is sweet in nature, that is, there is no presence of H₂S in produced oil/gas.

Oil spill of diesel fuel is also likely from a number of sources, such as:

- Storage facilities at the drilling site and
- Diesel transfer operations from road tanker to a storage tank.

A brief account of these hazards and general safety measures likely to be adopted during drilling and initial testing of the exploratory well is presented in Chapter 6 of this report.

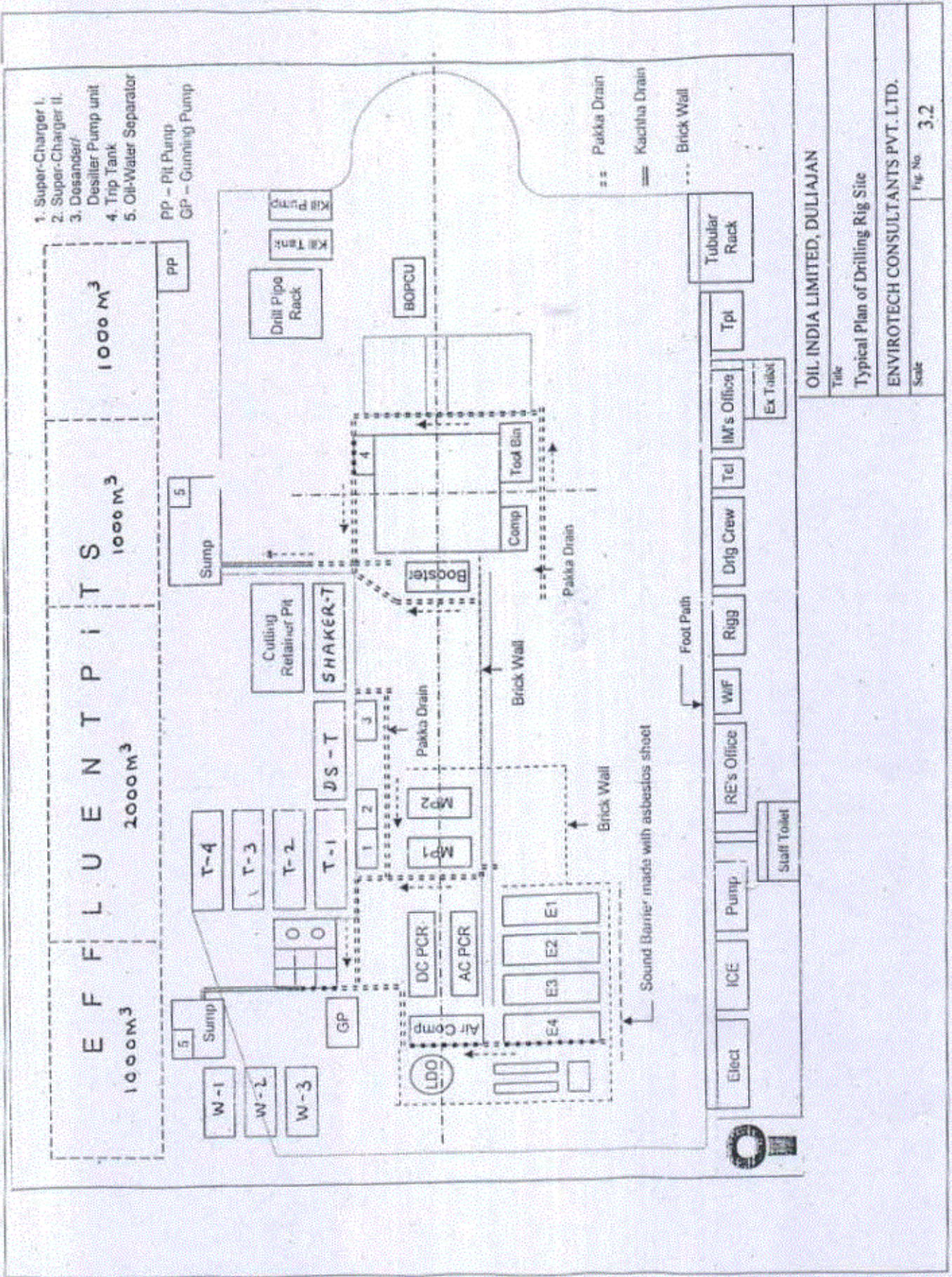
3.9 ANALYSIS OF ALTERNATIVES

3.9.1 Site Alternative:

The precise location of a drill site is dependent upon the characteristics of the underlying geological formations. If the formation permits, there may be several possible site options to drill which may give a degree of flexibility in the choice of the site. However, in most cases the area from which the prospect can be drilled is restricted to an area of less than 300 m diameter and the proposed exploratory drilling locations are/will be based on complete analysis of seismic survey data and other relevant information by OIL.

3.9.2 Technical Alternatives:

The approach followed in executing the exploratory drilling and assessment testing programme has been to adopt cost effective and environment friendly drilling and testing programmes and equipments. WBM will be used for drilling which has minimum impact on environment.



1. Super-Charger I.
2. Super-Charger II.
3. Dosander/ Desilting Pump unit
4. Trip Tank
5. Oil-Water Separator

PP - Pit Pump
GP - Gunning Pump

== Pakka Drain
= Kachhua Drain
--- Brick Wall

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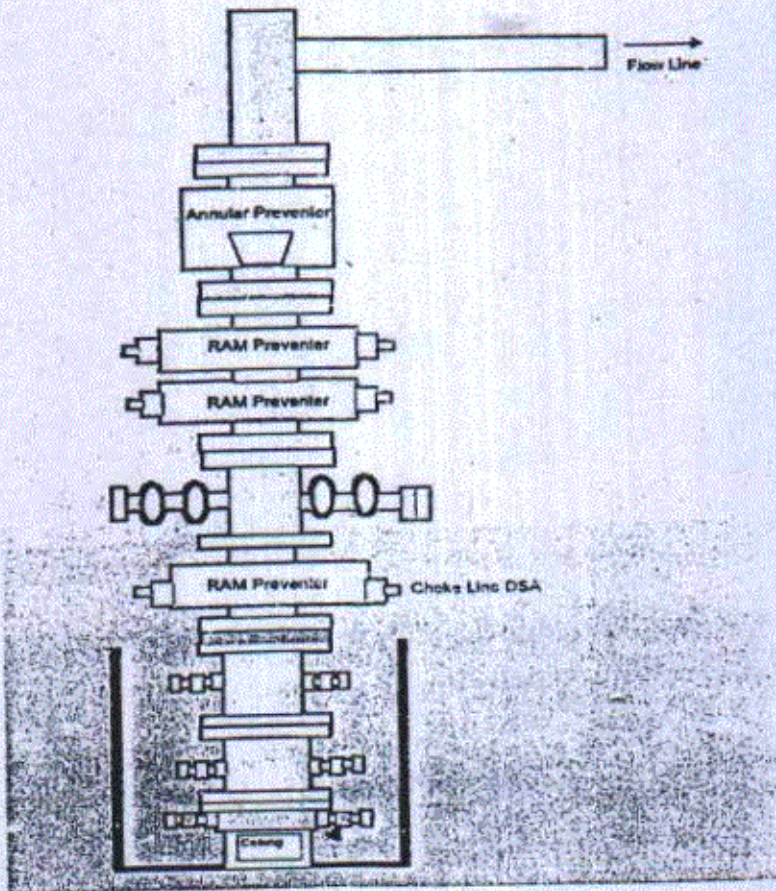
Title

Typical Plan of Drilling Rig Site

ENVIROTECH CONSULTANTS PVT. LTD.

Scale

Fig. No. 3.2



OIL INDIA LIMITED, DULIAJAN

Title

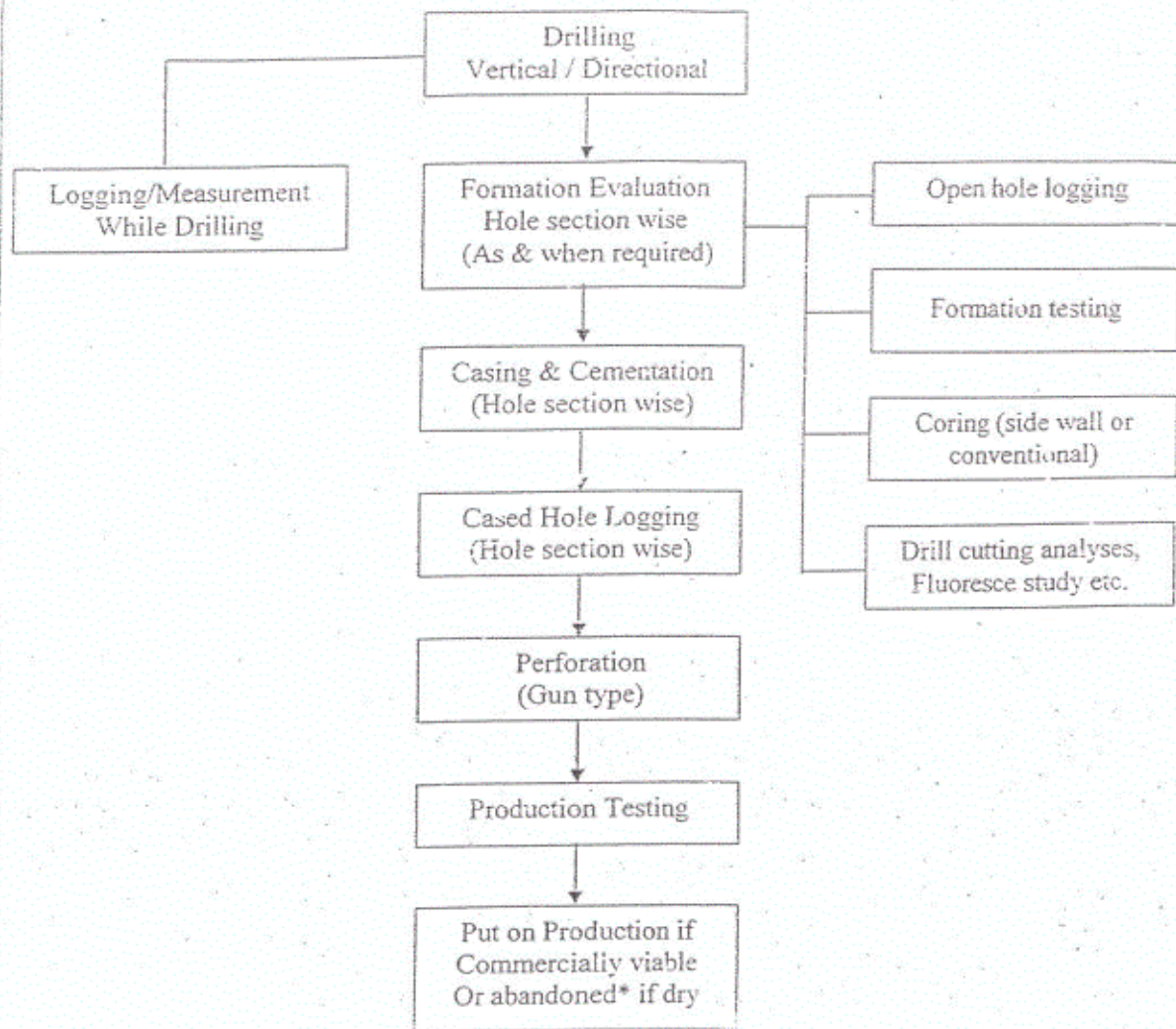
Typical Onshore BOP Stack

ENVIROTECH CONSULTANTS PVT. LTD.

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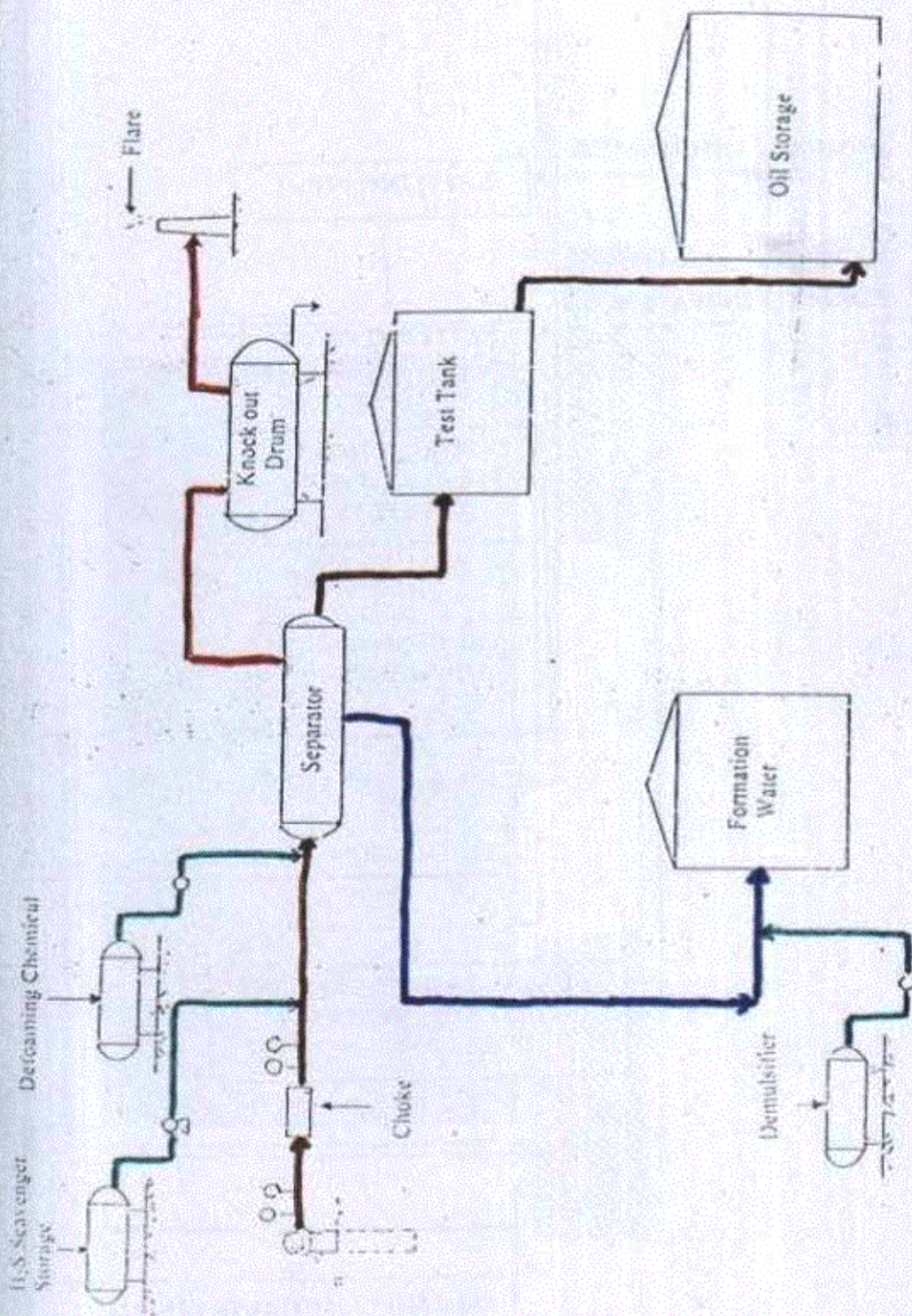
Fig. No.

3.3



* Well may be abandoned considering various drilling and sub-surface hazards also.

OIL INDIA LIMITED, DULIAJAN	
Title	
GENERAL STEPS FROM DRILLING TO PRODUCTION	
ENVIROTECH CONSULTANTS PVT. LTD.	
Scale	Fig. No. 3.4



LEGEND

GAS

OIL

WATER

CHEMICALS

OIL INDIA LIMITED, DULAJAN

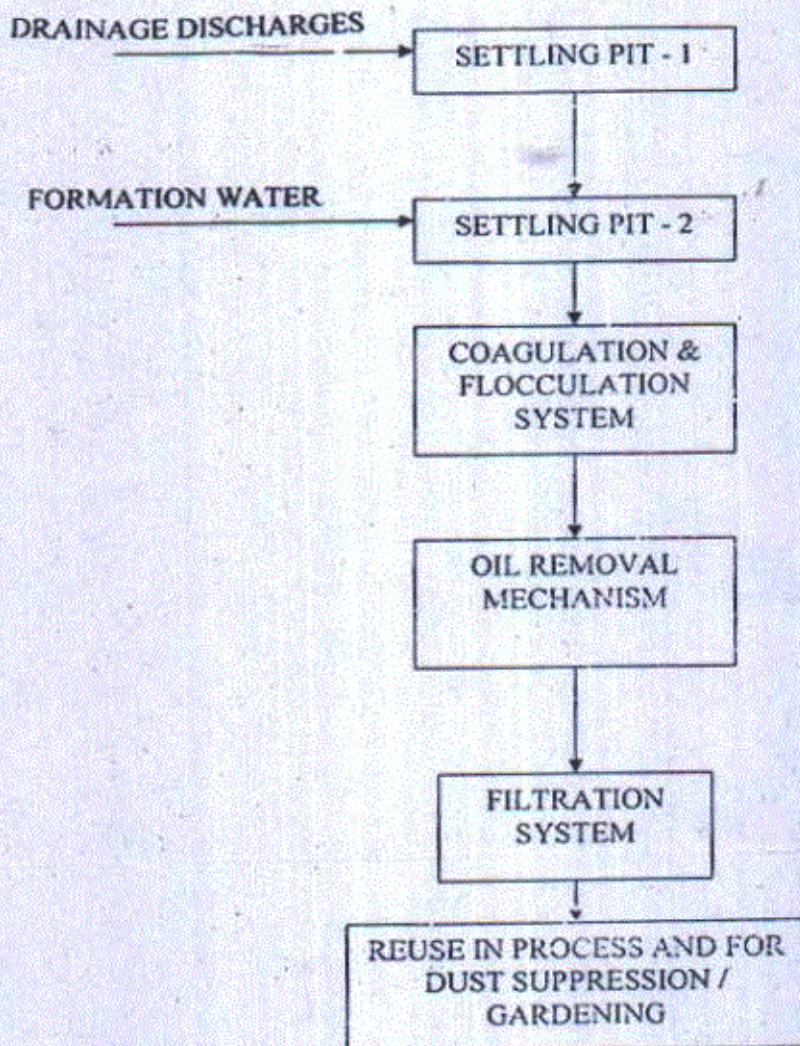
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Process Flow Diagram For Production Testing
For Hydrocarbons

ENVIROTECH CONSULTANTS PVT, LTD.

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Fig. No. 3.5



OIL INDIA LIMITED, DULIAJAN

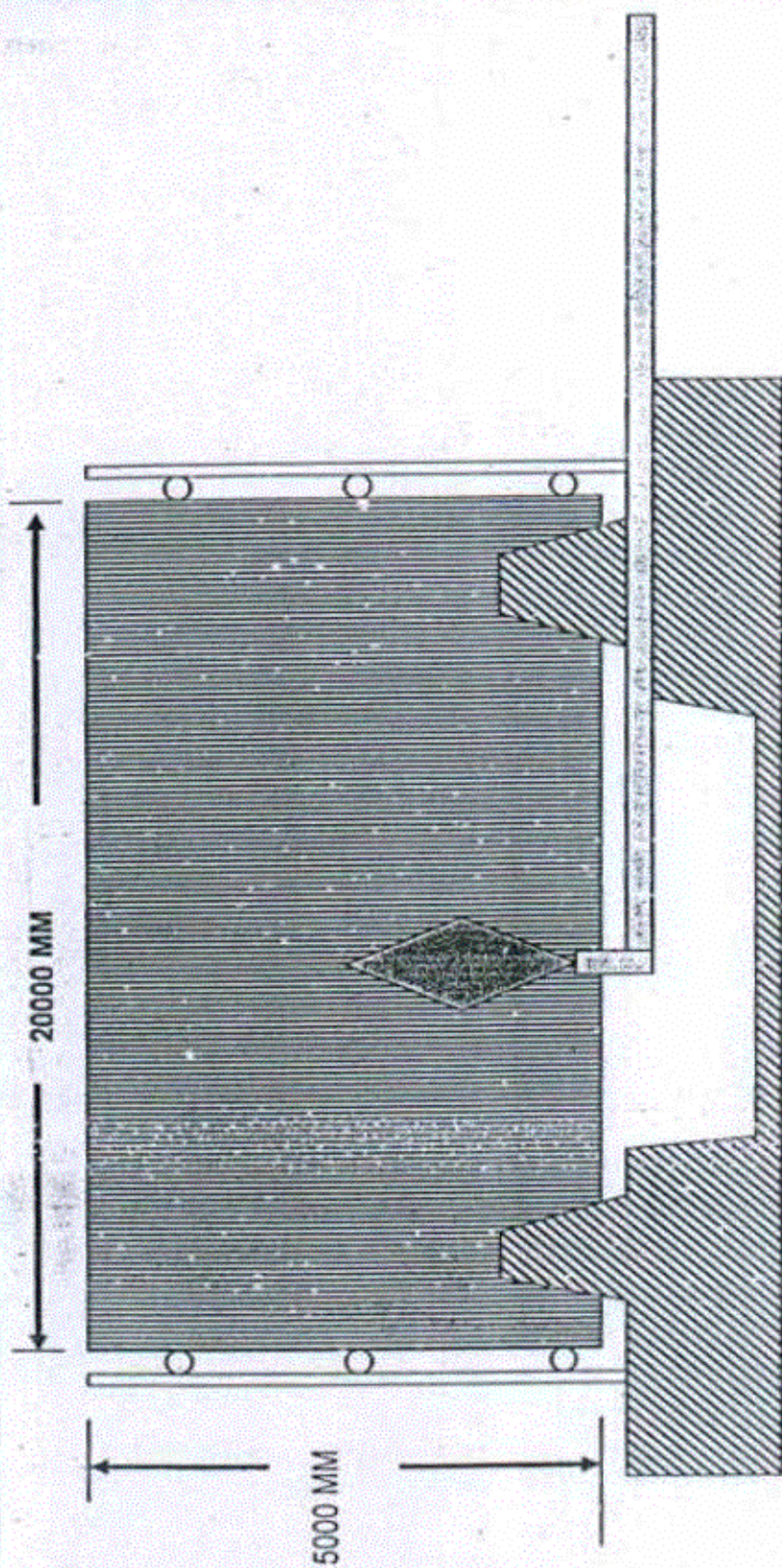
Title

Waste Water Treatment and Disposal

ENVIROTECH CONSULTANTS PVT. LTD.

Scale

Fig. No. 3.6



OIL INDIA LIMITED, DULIAJAN

Title

Sectional Elevation of Flare Pit

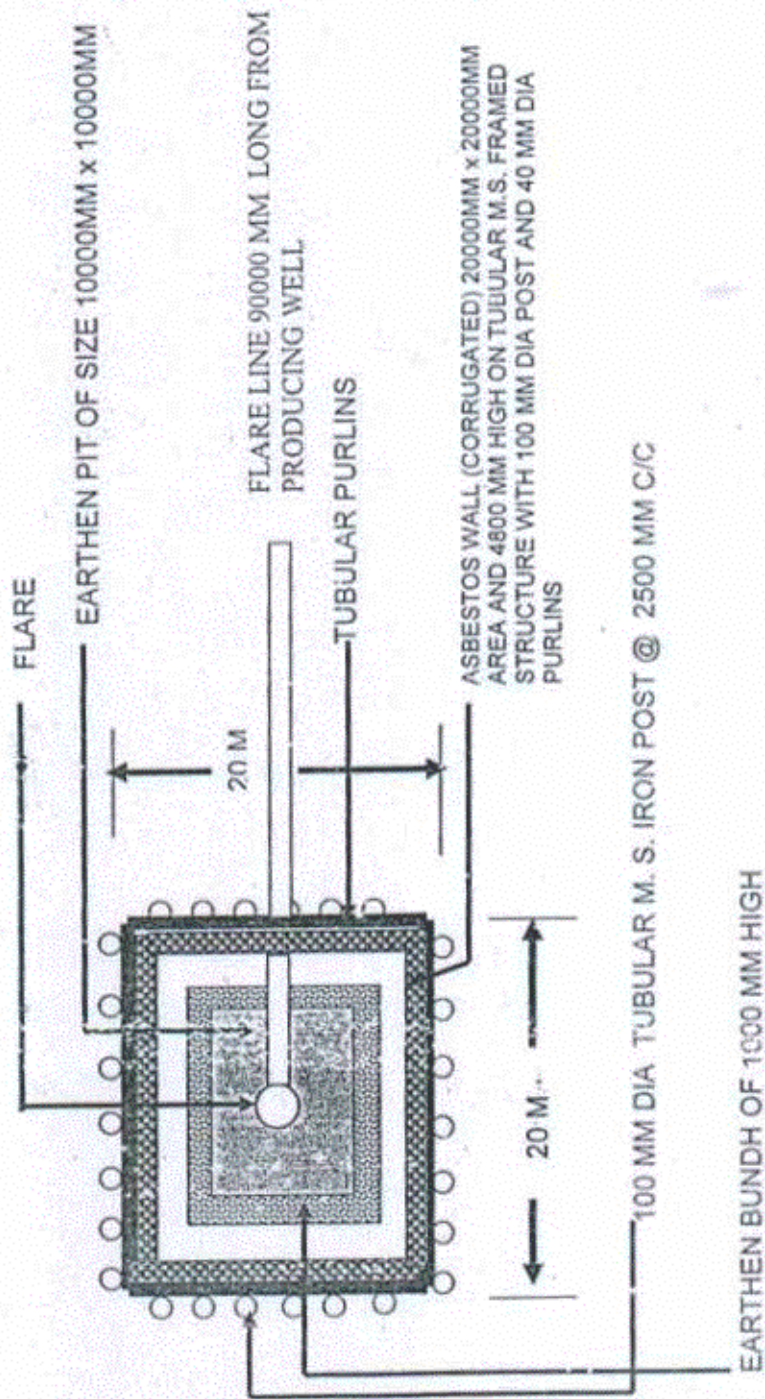
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Fig. No.

3.7



OIL INDIA LIMITED, DULIAJAN

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Lay-Out Plan of Flare Pit

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Fig. No.

3.8

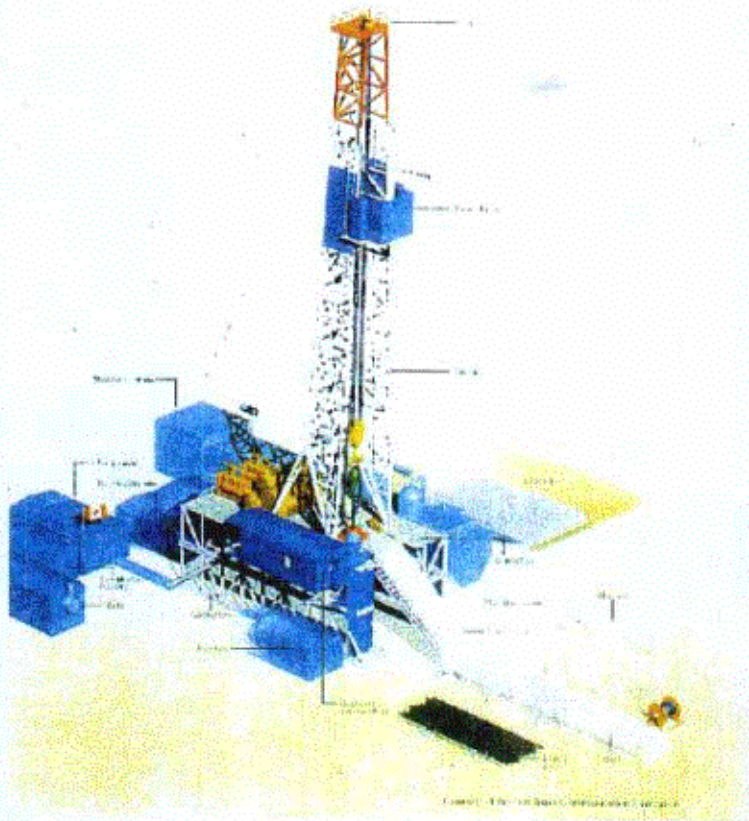


PLATE 3.1 DRILLING RIG AND ASSOCIATED FACILITIES

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Title

DRILLING RIG AND ASSOCIATED
FACILITIES

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Scale

Plate No.

3.1

DRILLING OF WELLS

Recycling of Drilling Fluid (Mud)

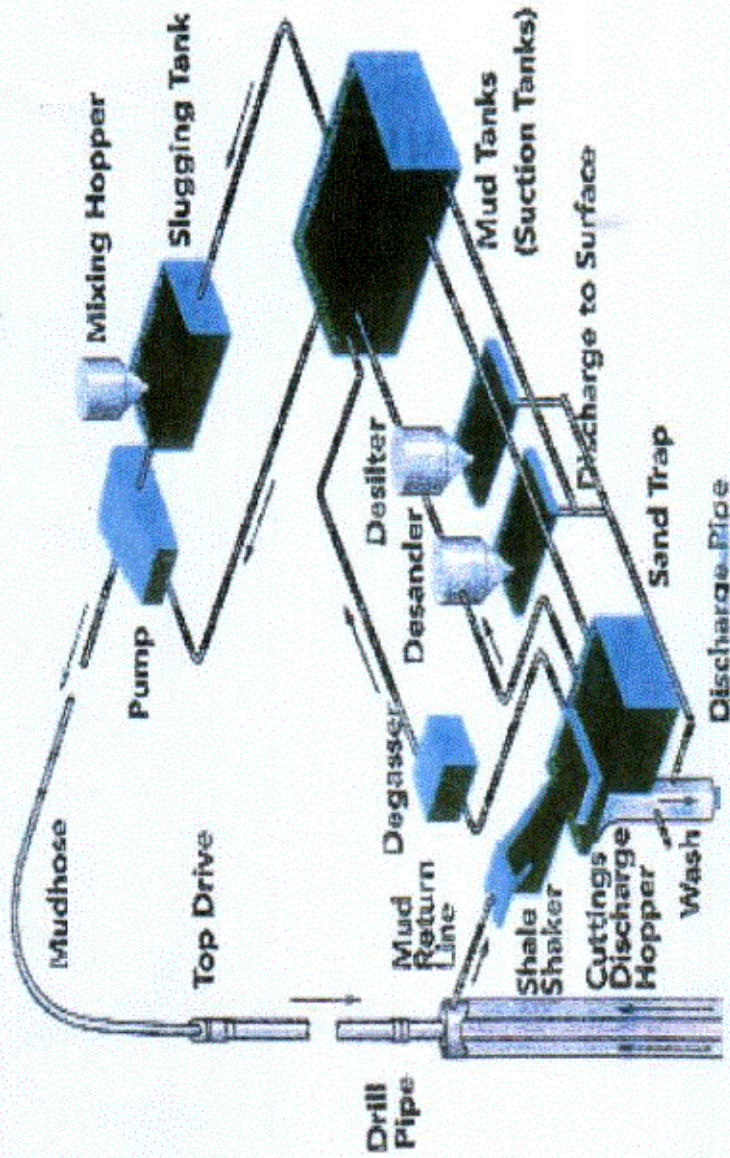


PLATE 3.2 : MUD TREATMENT AND HANDLING SYSTEM

OIL INDIA LIMITED, DULAJAN	
Title	MUD TREATMENT AND HANDLING SYSTEM
ENVIROTECH CONSULTANTS PVT. LTD.	
Scale	Plate No. 3.2