Pre-Feasibility Report

For

Onshore Oil and Gas Exploration & Appraisal in Block AA-ONHP-2017/15 in Lakhimpur, Dhemaji, Jorhat, Dibrugarh, Sibsagar Districts of Assam and West Siang District of Arunachal Pradesh

VEDANTA LTD. (CAIRN OIL & GAS)

March, 2019

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1. Executive Summary

Vedanta (erstwhile Cairn India Limited merged with Vedanta Limited w.e.f. April 11, 2017, pursuant to NCLT order dated March 23, 2017) is a globally diversified natural resources company with interest in Zinc, Iron Ore, Aluminium, Copper, Power and Oil & Gas. Vedanta Ltd. (Cairn Oil & Gas) is the operator of the Onshore AA-ONHP-2017/15 block. The block covers an area of 1367 Sq.Km in Lakhimpur, Dhemaji, Jorhat, Dibrugarh, Sibsagar district of Assam and West Siang district of Arunachal Pradesh. Vedanta Ltd. (Cairn Oil & Gas) has been allocated AA-ONHP-2017/15 block by MoP&NG, Govt. of India under the Revenue Sharing Contract (RSC) for exploration and exploitation of hydrocarbons. A Revenue Sharing Contract (RSC) was signed between the Government of India (GoI) and Vedanta Ltd on 1st October 2018.

1.1 Project Details

1.1.1 Proposed facilities

Vedanta Limited (Cairn Oil & Gas) proposes to carryout seismic survey, exploratory including appraisal well drilling and setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) and early production in the block AA-ONHP-2017/15.

1.1.2 Justification of the project

The demand for petroleum has recorded a considerable increase over the last few years. There is a considerable increase in consumption of petroleum products due to the development activities in the country in the last few years. During the year 2016-17, the consumption of petroleum products in India was 194.60 MMT with a growth of 5.37% as compared to consumption of 184.67 MMT during 2015-16. The consumption of petroleum products during April-November, 2017 was at 134.60 MMT i.e. an increase of 3.40% over 130.17 MMT in April-November, 2016. The crude oil production for the year 2016-17 is at 36.01 Million Metric Tonnes (MMT) as against production of 36.94 MMT in 2015-16, showing a decrease of about 2.53%. Whereas Natural Gas production during the year 2016-17 is at 31.90 Billion Cubic Meters (BCM) which is 1.09% lower than production of 32.25 BCM in 2015-16. Import of crude oil during 2016-17 was 213.93 MMT valued at 470159 crore as against import of 202.85 MMT valued at 416579 crore in 2015-16 which marked an increase of 5.46% in quantity terms and 12.86% in value terms as compared to the import of crude oil during 2015-16.

Import of Crude Oil during April-November, 2017 was 144.72 MMT valued at 3,42,673 crore which marked an increase of 9.31% in quantity terms and 15.32% in value terms as against the imports of 143.81 MMT valued at 2,97,161 crore for the same period of last year. Therefore, India is largely dependent on import of petroleum goods to meet its requirements. Facing an environment of increasing consumption, static reserves, increasing imports and increasing costs of crude as well as decreasing value of the Indian Rupee vis-à-vis the US Dollar, it follows that any accretion of hydrocarbon reserves in the country, is welcome.

Vedanta's proposed exploratory and appraisal drilling could possibly result in the discovery of hydrocarbon and in that case, would help in reducing India's dependence on imports.

1.2 Site Analysis

1.2.1 Climate

The district is located near the foothills of Arunachal Pradesh; it exhibits difference in temperature, rainfall, fog, wind etc. The climate of the district is per-humid characterized by high rainfall. Mild summer and winter and falls under cool to warm per humid thermic-agro ecological sub-zone.

1.3 Water and power requirements

1.3.1 Water Requirement

A. Water Requirement during Seismic Survey

A total of 20-30 m3/day of water will be required during the seismic operation. The water requirement is for domestic needs of the temporary campsite and will be sourced locally through approved authorities.

B. Water requirement during Exploratory and Appraisal well drilling

The most significant requirement of water for drilling activities is for mud preparation. The other requirement would be for engine cooling, floor / equipment / string washing, sanitation, fire-fighting storage / make-up and drinking. During the drilling activity, about 20-30 m3 per day water will be required for domestic consumption and 25-50 m3/day for drilling operation like engine cooling, floor / equipment/string washing, firefighting storage / make up etc. The water requirement for the water based drilling mud (WBM) preparation is envisaged to be of 600-1000m3/well and 150-300m3/well will be required for preparing the synthetic based drilling mud (SBM). The water will be sourced locally through approved authorities.

C. Water requirement during early Production

The water requirement for the oil and gas processing will be sourced locally through approved authorities or through extraction of ground water. In case of extraction of ground water, permission (NOC) will be obtained from CGWA/ CGWB (Central Ground Water Authority/ Board) of from State Govt.

1.3.2 Power requirement

A. Power requirement during seismic Survey

The power requirement in campsite is 2*350 KVA. The required power supply will be provided either from state grid or from diesel generators.

B. Power requirement during Exploratory and Appraisal well drilling

The power requirement of drill rig is 3*1000 KVA, 2*350 KVA for drilling camp site and 2* 100 KVA for the radio room respectively. The required power will be met by DG sets.

C. Power requirement during early Production

The power requirement will be met through state electricity grid and/ or installation of Diesel/ Gas Engine Generator(s) using produced gas.

1.4 Pollution control measures

1.4.1 Pollution Control measures during Seismic Operations

A. Air Emissions and Control Measure

Transient airborne dust raised by construction activities (e.g. preparation of seismic cut lines and moving vehicles and equipment) and emissions from vehicles & machinery.

B. Noise Emissions and Control Measure

Noise emissions that could be released during the seismic operations will include those generated by blasting of shot holes, field machinery (Bulldozer and support vehicles) and generators and work yard at the camp site. Adequate noise control measures will be taken.

C. Wastes treatment and disposal

The non-hazardous wastes like domestic wastes, plastics, and paper and disposal options include, compaction and removal from site and burying (especially for biodegradable material), or a combination of these activities.

D. Waste Water Generation:

Domestic waste water of 15-25 m3/day is envisaged and will be treated suitably.

1.4.2 Pollution Control measures during Drilling Operations

A. Air Emissions and Control Measure

The emissions to the atmosphere from the drilling operations shall be from the diesel engines, and power generator and temporary from flaring activity (during testing). Adequate air emission control measures will be taken.

B. Noise Emissions and Control Measure

The source of noise generation during this phase of operations would be the operation of rig and diesel generator sets. The expected noise generation at source is due to operation of rig. Besides, certain pumps are expected to be in operation during this phase, for mud circulation. The noise generation work however is transient and limited to the drilling period only. Appropriate control measures will be taken to minimise exposure of noise to drill personnel.

C. Waste treatment and disposal

Hazardous waste:

Drill cuttings of 250-750 tons/well will be generated during the drilling phase with water-based mud (WBM) whereas the amount of drill cutting generated during drilling with synthetic based mud (SBM) will be of around 500-1500 tons per well. This will be stored in well-designed HDPE line pit. It shall be tested for its hazardous constituents (Oil and Grease).

Spent / Residual drilling mud of 250-500 tons per well, sludge containing oil and other drilling waste will be around 250-500 tons/well is envisaged.

Used /waste Oil – During the drilling approx. 1-2 ton per well will be generated. Noncombustible waste/ non-hazardous waste/ scraps will be generated and the same will be disposed suitably.

Non-Hazardous waste:

Domestic food waste of 25-30 kg/day per well will be generated at site, which will be segregated at source (Organic / Inorganic) and disposed accordingly.

All kind of waste will be disposed in accordance with the requirement of CPCB/SPCB.

D. Waste water Treatment:

Domestic waste water of 15-25 m3/day per well shall be generated and the domestic waste water will be treated suitably.

1.4.3 Pollution Control measures during Early Production

The produced water will be treated to achieve MoEF/ CPCB/ SPCB specification (discharge standards) and will be disposed off. The treated effluent (produced water) will be disposed off using either a nearby down hole disposal well (by reinjection in abandoned well) or other available & suitable onshore disposal medium or solar/ mechanical evaporators depending on feasibility.

1.5 Project schedule and cost estimate

Vedanta Ltd (Cairn Oil and gas) has planned to carry out seismic data acquisition, exploration and appraisal well drilling in the AA-ONHP-2017/15 Block in next 10-12 years.
The cost of the project is estimated is given below:

1) Physical Surveys Cost estimated to be approximately INR 16 Crore.
2) Average Cost per well for exploratory & appraisal well is estimated to be INR 16 Crore.
3) Average cost of each EPU (Early Production Unit)/ QPU (Quick Processing Unit) is estimated to be INR 44 Crore.

1.6 Employment Generation

The seismic surveys and drilling operations are expected to take about 6 to 8 months to complete and will require a crew of approximately 300 to 500 persons. And most of the workforce will be from local/ nearby area. During the site preparation for drilling, approximately 30-35 workmen will be employed per drill site. During the drilling phase, about 50 workmen per shift will be working on site. This will include technical experts, who will be responsible for various drilling related activities and some technical manpower engaged are either from Vedanta Limited or contractor's crew as applicable. It is anticipated that, at any given time, there will be 80-100 (approx.) personnel working on site including technical staff, drilling crew, security staff etc.

1.7 Rehabilitation and Resettlement

For exploration and appraisal activities, the project does not envisage any R & R of the project, since the land requirement would be very less and on short term and temporary lease and away from the settlements. If the identified lands are of private landowners then land lease mode will be applied and in case of govt. land, land allotment from Govt. to be applied. Initially temporary short-term lease will be taken for 3 - 5 years for exploration purpose and in case of commercially viable discovery of hydrocarbon resources; the land lease would be converted into long term lease up to life of the project.
For sites selected having settlements if any, Resettlement & rehabilitation (R&R) plan will be developed and implemented as per the applicable State/ Central Govt. policy. Compensation to affected landowners for any loss of land, Cairn will ensure the livelihood of local community, if any affected by the proposed land take, are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities.

2. Introduction of the project

2.1 Identification of the project

Vedanta Ltd (Cairn Oil & Gas) has been awarded the AA-ONHP-2017/15 hydrocarbon block under the OALP (Open Acreage Licensing Policy) by MoP&NG, Govt. of India. RSC (Revenue Sharing Contract) has been signed between Vedanta Ltd and MoP&NG on 1st October, 2018 for the exploration and exploitation of hydrocarbons. Vedanta Ltd (Cairn Oil & Gas) proposes to carry out exploration (including seismic surveys, exploratory and appraisal well drilling) and early production of oil and gas in the block. In case of discovery (ies), the exploratory and appraisal wells will be tested for extended duration by flowing hydrocarbons to ascertain the reservoir parameters and to assess the quality and commercial viability. Moreover, in case of commercially viable discovery (ies) of hydrocarbons in the block and having established the size of the hydrocarbon field (s), field will be immediately brought into production using one or more of the successful exploratory/ appraisal wells by setting up of temporary and mobile Early Production Units (UPUs)/ Quick Production Units (QPFs) for the processing of produced well fluid.

2.2 Brief description of nature of the project

The proposed project is green field in nature. The proposed project is oil and gas exploration (including appraisal) and early production.

2.3 Need for the project and its importance to country and region

India is largely dependent on import of petroleum goods to meet its requirements. Facing an environment of increasing consumption, static reserves, increasing imports and increasing costs of crude as well as decreasing value of the Indian Rupee vis-à-vis the US Dollar, it follows that any accretion of hydrocarbon reserves in the country, is welcome.

Vedanta's proposed exploratory drilling project could possibly result in the discovery of hydrocarbon and subsequent development and production would help in reducing India's dependence on imports. Consequently, the need for the project is evident. The proposed project would also contribute to the state Governments in the NE region in terms of royalty through the mining lease. Additionally the proposed project would generate direct and indirect employment in the region.

2.4 Demand-supply Gap

As on 1.4.2017, In-place hydrocarbon volume of 10454 million tonnes of oil and oil equivalent gas could be established through exploration by ONGC, OIL and Private/JV companies. So, about 75% of resources are under "yet to find" category. Out of 10454 MMT of oil and oil equivalent gas of In-place volumes, the ultimate reserves which can be produced are about 4017 MMT of oil and oil equivalent gas since inception. The balance recoverable reserves are of the order of 1787 MMT of oil and oil equivalent gas.

2.4.1 Production and Consumption

The crude oil production for the year 2016-17 is at 36.01 Million Metric Tonnes (MMT) as against production of 36.94 MMT in 2015-16, showing a decrease of about 2.53%. Whereas Natural Gas production during the year 2016-17 is at 31.90 Billion Cubic Meters (BCM) which is 1.09% lower than production of 32.25 BCM in 2015-16. The demand for petroleum has recorded a considerable

increase over the last few years due to the development activities in the country in the last few years.

During the year 2016-17, the consumption of petroleum products in India was 194.60 MMT with a growth of 5.37% as compared to consumption of 184.67 MMT during 2015-16. The consumption of petroleum products during April-November, 2017 was at 134.60 MMT i.e. an increase of 3.40% over 130.17 MMT in April-November, 2016

Therefore, India is largely dependent on import of petroleum goods to meet its requirements. Vedanta's proposed exploratory drilling project could possibly result in the discovery of hydrocarbon and in that case, would help in reducing India's dependence on imports.

2.4.2 Imports

Import of crude oil during 2016-17 was 213.93 MMT valued at 470159 crore as against import of 202.85 MMT valued at 416579 crore in 2015-16 which marked an increase of 5.46% in quantity terms and 12.86% in value terms as compared to the import of crude oil during 2015-16. Import of Crude Oil during April-November, 2017 was 144.72 MMT valued at 3,42,673 crore which marked an increase of 9.31% in quantity terms and 15.32% in value terms as against the imports of 143.81 MMT valued at 2,97,161 crore for the same period of last year.

2.5 Import versus indigenous production and export

India imports more than 80% of the petroleum products of its daily requirement.

2.6 Domestic Markets

The Oil & Gas produced if there is commercially viable discovery and subsequent development will be utilized for domestic purpose only. There is enough demand in domestic market.

2.7 Employment generation

The seismic surveys are expected to take about 6 to 8 months to complete and will require a crew of approximately 300 to 500 persons. And most of the workforce will be from local area. During the site preparation for drilling, approximately 30-35 workmen will be employed per drill site. During the drilling phase, about 50 workmen per shift will be working on site. This will include technical experts, who will be responsible for various drilling related activities and some technical manpower engaged are either from Vedanta Limited or contractor's crew as applicable. It is anticipated that, at any given time, there will be 80-100 (approx) personnel working on site including technical staff, drilling crew, security staff etc. In case of commercial discovery of oil and gas additional manpower will be employed for building of production facilities and laying of pipelines.

3. Project Description

3.1 Type of project

The proposed project is a green field project. There is no interlinked and inter-dependent project.

3.2 Location with co-ordinates

The block AA-ONHP-2017/15 is located in Lakhimpur, Dhemaji, Jorhat, Dibrugarh, Sibsagar district of Assam and West Siang district of Arunachal Pradesh. It encloses an area of 1367 Sq. Km. and is

bounded by the points having following coordinates Table-1. A map of the area is shown in Figure 1.

Figure-1: Location map of block AA-ONHP-2017/15 with state and district boundary

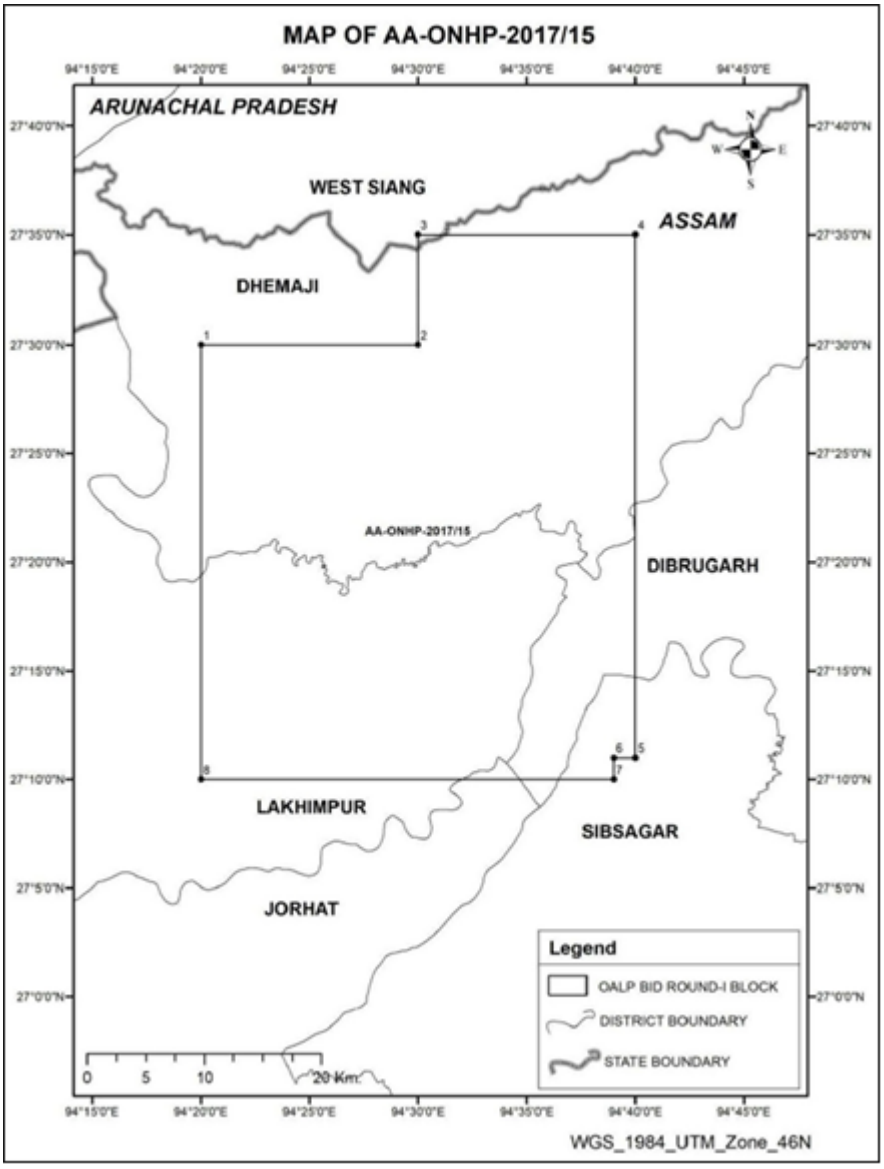


Table-1: Apex Co-ordinates of Block AA-ONHP-2017/15 boundary (as per RSC)

Points	Longitude	Latitude
1	94° 20'	27° 30'
2	94° 30'	27° 30'
3	94° 30'	27° 35'
4	94° 40'	27° 35'
5	94° 40'	27° 11'
6	94° 39'	27° 11'
7	94° 39'	27° 10'
8	94° 20'	27° 10'

The block area covers total of 1367 Sq. Km out of which 1366 Sq. Km falls under Lakhimpur, Dhemaji, Jorhat, Dibrugarh and Sibsagr district of Assam and the remaining 1 Sq. Km falls in the West Siang district of Arunachal Pradesh. The map of the block with block co-ordinates is presented as Figure-2 and the detailed co-ordinates are given in Table-2A and 2B.

Figure-2: Area map of block AA-ONHP-2017/15 falling under different state boundary

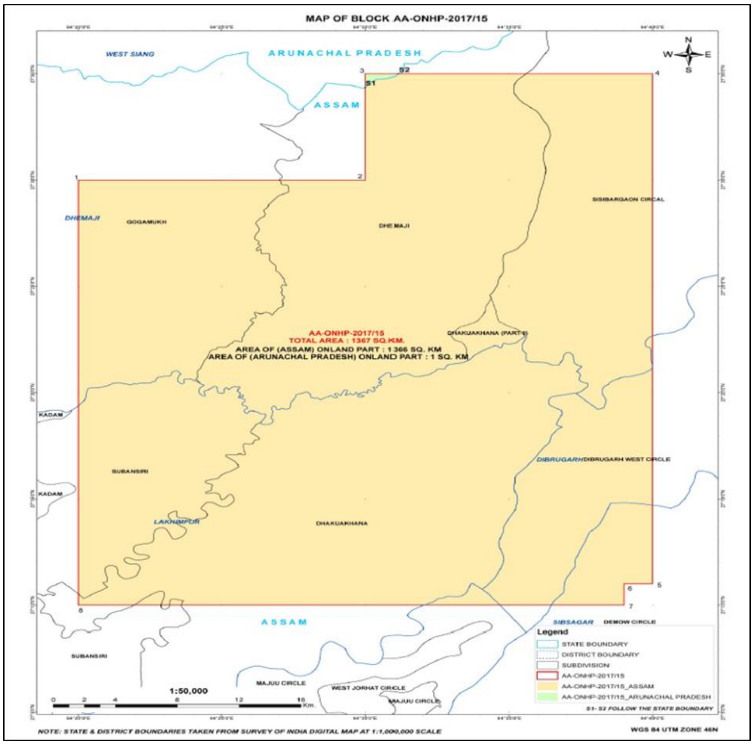


Table-2A: Co-ordinates of Block AA-ONHP-2017/15 within state of Assam

Points	Longitude	Latitude
1	94° 20'	27° 30'
2	94° 30'	27° 30'
S1	94° 30'	27° 34' 22.04"
S2	94° 31' 7.58"	27° 35'
4	94° 40'	27° 35'
5	94° 40'	27° 11'
6	94° 39'	27° 11'
7	94° 39'	27° 10'
8	94° 20'	27° 10'

**S1- S2 FOLLOW THE STATE BOUNDARY*

Table-2B: Co-ordinates of Block AA-ONHP-2017/15 within state of Arunachal Pradesh

Points	Longitude	Latitude
S1	94° 30'	27° 34' 22.04"
S2	94° 31' 7.58"	27° 35'
3	94° 30'	27° 35'

**S1- S2 FOLLOW THE STATE BOUNDARY*

3.3 Details of alternate site considered and the basis of selecting the proposed site

The block is allocated by the Government of India under the Revenue Sharing Contract (RSC). Vedanta Ltd. - Cairn Oil & Gas is the Operator for this block. Drilling locations are proposed based on geo-scientific information and alternate sites cannot be considered for the proposed project facilities due to the following reasons:

The location is within the existing RSC boundary of the field/block. The locations of wells are selected considering the drilling configuration (reach to reservoirs).

3.4 Size / magnitude of operation

The proposed onshore oil and gas exploration, development and production project is expected to carry out

1. 2D and 3D Seismic data acquisition
2. Drilling of 20 exploratory (including appraisal) wells
3. Setting of facilities Quick Production Units (QPUs)/ Early Production Units (EPUs) for oil & gas processing and early production of up to 8000 BOPD of crude oil and 1.6 MMSCFD of associated natural gas.

3.5 Project description with process details

3.5.1 2D & 3D Seismic survey:

Seismic surveys are a primary tool utilized during the exploration of hydrocarbons over land and water. A seismic survey is conducted by creating an energy wave commonly referred to as a 'seismic wave' on the surface of the ground/ over water along a predetermined line, using an energy source. This wave travels into and through the earth strata, where it is reflected and refracted by various

subsurface formations, and returns to the surface where receivers called geophones are used to detect the waves and convey them to a recorder for analysis. Seismic waves can be induced by the following methods: small explosive charges, primarily dynamite, set off in shallow holes known as 'shot holes'; or by large 'Vibroseis' trucks equipped with heavy plates that vibrate on the ground or air guns for water based surveys. By analyzing the time it takes for the seismic waves to reflect off subsurface formations and return to the surface formations can be mapped and potential oil or gas deposits identified. 2D/3D surveys are acquired by laying out energy source points (vibroseis or dynamite charges) and receiver points (geophones) in a grid over the area to be surveyed. The receiver points - to record the reflected vibrations from the source points - are laid down in parallel lines (receiver lines), and the source points are laid out in parallel lines that are approximately perpendicular to the receiver lines. The spacing of the source and receiver points is determined by the design and objectives of the survey. In case of 2D seismic survey, the receiver points, to record the reflected vibrations from the source points, are laid down in between the receiver lines.

To estimate the thickness and seismic velocity of the weathered zone as well as the sub-weathering velocity, Seismic 'upholes' (drill holes (20–50m in depth)) placed at regular intervals (3–5 km) along exploration seismic lines. These data are then used in computing time corrections to a nominal seismic datum, which is a fundamental step in computer processing of seismic field data. The upholes will be drilled by a small truck-mounted rig usually using compressed air to lift soil cuttings, adding water occasionally to lift gravelly material. Apart from soil, ground sandstone and water, no chemicals will be added to the drilling fluid only small quantities of bentonite clay if required during backfilling to seal off any encountered groundwater. Once recordings have been made, the majority of the cuttings will be returned to the hole. The cuttings present no risk to the environment in toxicity terms. Excess cuttings at each Uphole, if any, are placed on top of the Uphole and will integrate into the soil over time.

3D seismic surveys are generally conducted in a similar way to 2D seismic surveys but with the variation of setting up six or eight geophone cables side by side at the same time at a distance in most cases of about 100 to 400 metres apart. Several "shots" from calculated positions along and between the receiver lines are taken, before the cables are moved up and the process repeated. 3D seismic surveys must be conducted over a large area in order to provide sufficient data for accurate interpretation of the subsurface geology. The data collected can later be combined into a single data set for processing and analysis, provided there is sufficient overlap of the areas covered by the surveys. Computer analyses of the recorded seismic waves provide a profile of the underlying rock strata and offer the basis for identifying potential hydrocarbon traps.

3.5.1.1. Seismic Survey Objective, Scale and Extent

The objective of the proposed seismic survey is to identify and delineate potential prospects, in sufficient detail to be able to, at a later and different stage, test one or more by drilling.

The seismic data acquisition exercise (Recording) will take approximately 6 to 8 months. It should be noted that while there are pre-determined seismic line transects based on analysis of pre-existing data, the actual locations of the seismic transects may be varied prior to and/or during the seismic

data acquisition exercise. The seismic survey operation will be constrained along the seismic survey lines and to the base and fly camps, as well as to the access roads to these areas.

3.5.1.2. Personnel and Facilities

The project requires a base camp to be constructed within the survey area. Base camps range in size and are constructed to accommodate 200 to 500 persons depending on the size of the project. There will, in addition, be small, mobile fly camps that will be serviced from the main base camp. A mobile fly camp is used to extend the operational reach of the seismic line crews during operations. Mobile fly camps rang in size from 50 to 100 persons. Thus, the base camp will support the crew, and "fly camps" will accommodate smaller-sized groups of personnel in outlying areas, and will be set up as and when required. Such campsites will be located away from community settlements. A fully equipped and staffed ambulance will be on standby in case of accidents or emergencies, and will be supported by a fully equipped and staffed clinic that will be located in the base camp.

3.5.2.1. Location & Description of Drilling of Exploration and Appraisal wells

The locations for the drilling of wells will be fixed once the detailed interpretation of the acquired seismic survey is over. However, the wells will be strictly confined within the acquired block itself. Since the exact drilling locations are yet to be determined, the details of the block location are provided herewith. The acquired exploratory block AA-ONHP-2017/15 is located in Lakhimpur, Dhemaji, Jorhat, Dibrugarh, Sibsagar district of Assam and West Siang district of Arunachal Pradesh. The tentative drilling locations are presented in satellite image and Survey of India toposheet (Figure-2A and 2B). The proposed coordinates of the exploratory and appraisal wells are given in the Table 4. The proposed well depth may vary from 1750m to 5000m due to the subsurface structural configuration and the depth of occurrence of the primary reservoirs. Typically estimated drilling duration is 60-90 days/well. In general, exploratory and appraisal well testing duration is about 30 days/well. However, depending on the need, based on nature of the reservoirs, the exploratory and appraisal wells will be tested for longer (extended) durations to ascertain the reservoir parameters. Water Based Mud (WBM) will be used as drilling fluid for initial sections, shallower sections where massive shale not encountered. The deeper and difficult to drill geological formations will be drilled using Synthetic Based Mud (SBM) as drilling fluid.

*Figure-2A**. Proposed well Locations in Block AA-ONHP-2017/15 on satellite map***

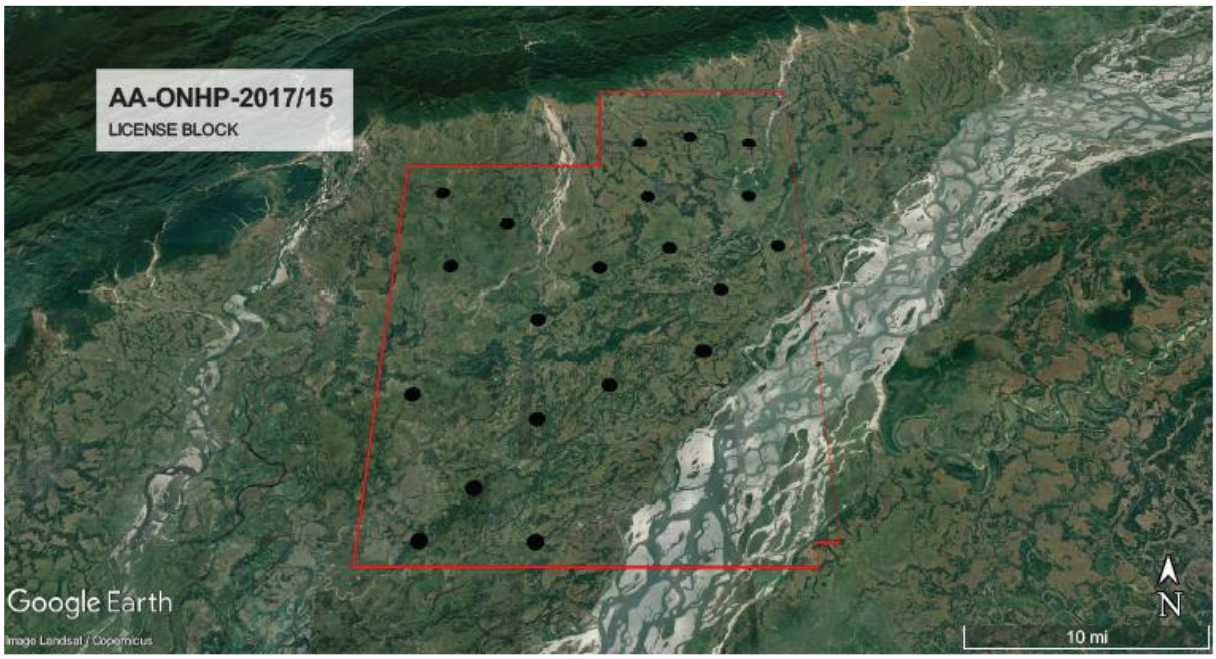


Figure-2B: Proposed well Locations in Block AA-ONHP-2017/15 on Survey of India Toposheet

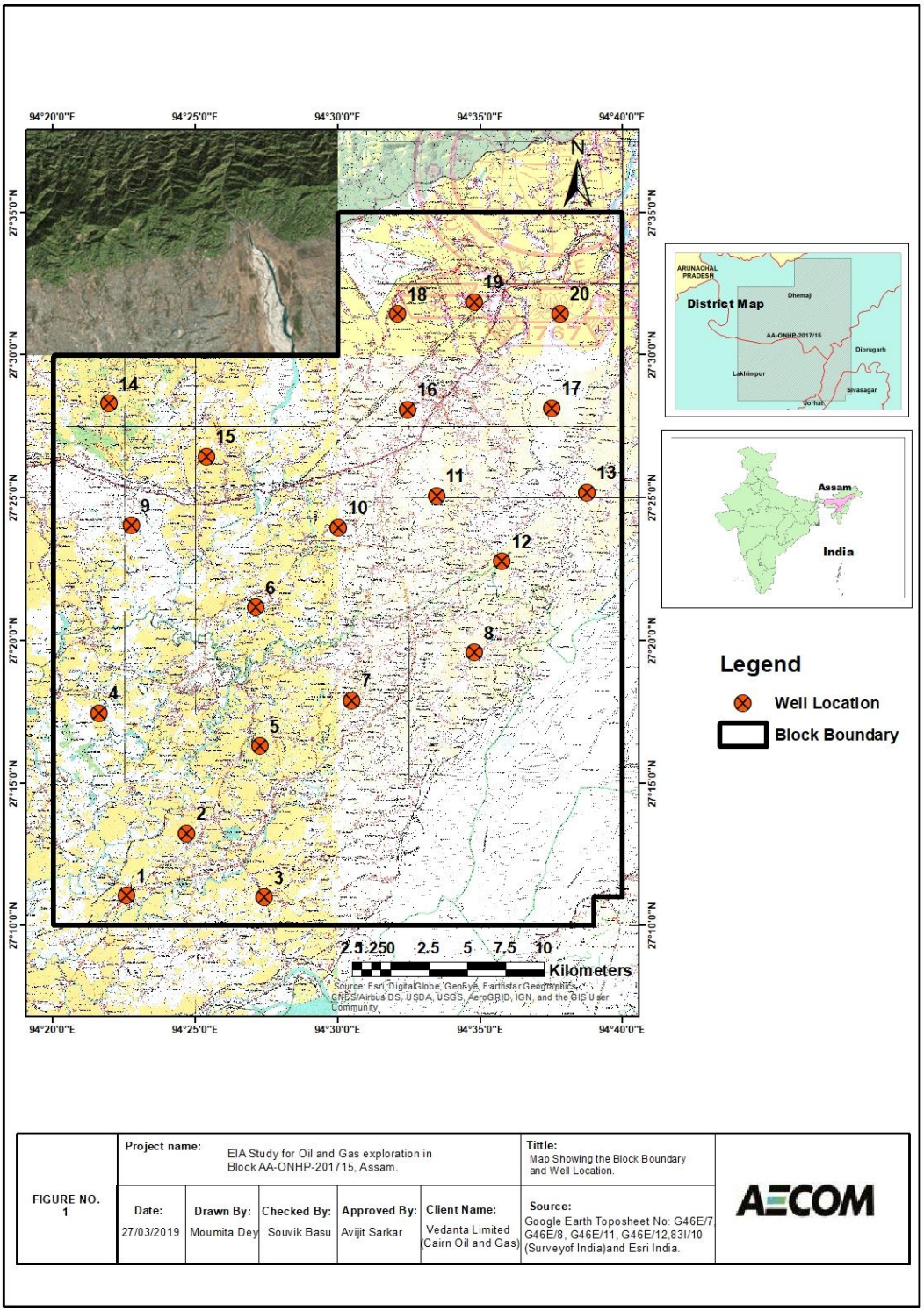


Table-4: Proposed well co-ordinates to be drilled in block AA-ONHP-2017/15

Well No	Latitude	Longitude
1	27°11'2.86"N	94°22'35.64"E
2	27°13'13.91"N	94°24'42.05"E
3	27°10'59.46"N	94°27'26.13"E
4	27°17'26.77"N	94°21'37.30"E
5	27°16'17.35"N	94°27'17.59"E
6	27°21'9.46"N	94°27'8.42"E
7	27°17'53.80"N	94°30'30.82"E
8	27°19'34.57"N	94°34'49.45"E
9	27°24'2.21"N	94°22'45.10"E
10	27°23'57.70"N	94°30'1.93"E
11	27°25'4.30"N	94°33'28.90"E
12	27°22'46.30"N	94°35'47.69"E
13	27°25'11.22"N	94°38'45.67"E
14	27°28'18.97"N	94°21'58.02"E
15	27°26'26.67"N	94°25'23.38"E
16	27°28'5.87"N	94°32'28.55"E
17	27°28'9.31"N	94°37'32.77"E
18	27°31'27.27"N	94°32'7.88"E
19	27°31'52.70"N	94°34'48.07"E
20	27°31'27.49"N	94°37'49.72"E

Note: Actual geographical surface coordinates of exploratory and appraisal well locations will be within 2000m radius of the proposed coordinates.

3.5.2.2. Exploratory & Appraisal well Drilling Process

Exploration & appraisal wells will be drilled using an Electric Land Rig of around 1200-1500 HP capacity, equipped with a Rotary/Top Drive System.

To support drilling operation, the following systems and services will be included at the rig:

- Portable Living Quarters – to house essential personnel on site on a 24 hr basis. These nits are provided with Bath/Washroom.
- Crane-age - cranes for loading/offloading equipment and supplies.
- Emergency Systems - it includes fire detection and protection equipment.
- Environmental Protection – Blow out Prevention (BOP) system, wastewater treatment unit, cuttings handling equipment.

Additionally, there will be other ancillary facilities like Drilling mud system, ETP, Cuttings disposal, Drill Cementing equipment etc. and utilities to supply Power (DGsets), water, fuel (HSD) to the drilling process and will be set up as a part of the project.

The following shows the various phases of the drilling activities and model of drilling process respectively.

1. Site selection after prospect Identification
2. Temporary land acquisition on lease
3. Site and access road preparation
4. Drilling activities

5. Well testing
6. Complete the well and suspend for production in case of hydrocarbon find
7. Decommissioning & closure of wells in case no success

The model drilling process is followed in forthcoming sections and a represented in Figure-5.

Figure-5: A typical model onshore drilling process

The various activities involved as a part of the drilling of exploration wells are described in detail in the subsequent sections.

Site Selection

The exploration history of the area exhibits the potential presence of the oil and gas in the region. The exact location of the wells has not been finalized and the seismic data interpretation of the seismic survey would decide the exact locations of the drilling well.

Land acquisition

An area of about 300m X 300m would be taken on temporary lease basis for the construction of well pad / drill site etc for exploratory and appraisal wells. For the preparation of suitable access roads connecting to well pads, laying of infield interconnecting pipelines, OHL and laying pipelines for utilities in future, a width of 30m RoU (approx.) will be required. Wherever needed, infield interconnecting pipeline will be laid.

Site & Access road preparation

The internal village roads will be strengthened for transportation of machineries, equipments and drilling crew members. Additionally strengthening of the existing approach road to the site can be

done if required for transportation of drilling rig & associated equipment. In general, movement of drilling rig and ancillary equipment would involve around 20-25 truck load for approximately one and half years. A provision will be kept for parking of these cars within the developed site or its nearby area.

Site preparation will involve all activities required to facilitate the operation of the drilling rig and associated equipment and machineries. At the initial stage, the drilling site will be elevated to about 2.0 m from the existing ground level with minimal clearance of existing ground vegetation. The loose top soil will be removed by using mechanical means like bulldozer and saved at a nearby place for later use during site restoration. Levelling and compaction will be done with the help of graders and mechanical rollers. The land filling materials and rubbles will be required for the purpose of site preparation in sufficient amount. All such materials will be procured by Vedanta through contractors and it will be ensured that they source the materials from government approved borrows and quarries. Subsequently, the proposed well site & campsite will be duly fenced using chain link and barbed wires.

Platforms for drill pad and all other heavy equipment systems or machinery, cast in-situ Reinforced Cement Concrete (RCC) will be used for the construction of foundation system. The rig foundation will be of 20m X 20m in size and will have an elevation of 0.6 m. For making the foundations of main rig structure, cast in-situ bored under- reamed piles of specified lengths will also be used. The elevated structures will have proper garland drains for storm water with sufficient gradient, made of brick masonry, to take care of surface runoff water.

Specially designed pit of an impervious HDPE liner of 1-1.5 mm thickness will be provided as part of the site development for disposal of drilling waste in the form of spent drilling mud and cuttings. In addition to that, a cuttings pit of 28m X 24m for disposal of drill cuttings and two waste pits of 17m X 12m for disposal of drilling mud and rig wash water will be provided.

A Campsite of size 100 x 50m, elevated to the height as that of the drilling site (approx.2.0 m), will be set up adjoining the well site. Local earth and rubble will be used as the fill material. The surface will have a 150mm thick WBM layer. Proper surface gradients and brick masonry drains will take care of the run-off water, where as separate septic tanks and soak pits will be provided along with the labour camp for disposal of domestic waste water.

Though the rig and related equipment will be directly brought to site, spares, mud preparing chemicals and other materials will be stored at a warehouse near to the site and will be received to the site from that intermediate storage area. The rig equipment will however be transported directly to the drilling site during mobilization and will be de-mobilized directly from the site. The materials will be intermittently supplied from warehouse to the drilling site, during the operations - with some stock at the drilling site itself.

Drilling Activities

Drilling Rig Type

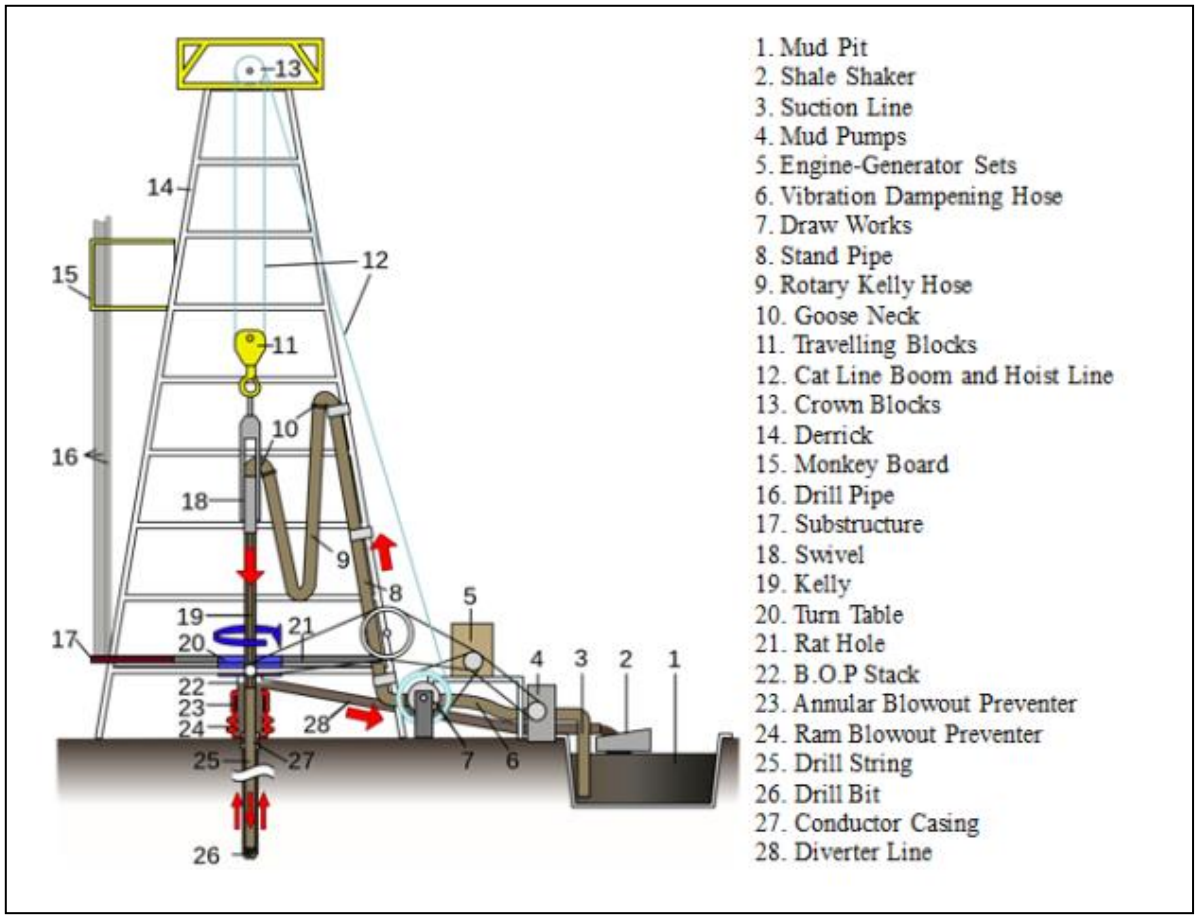
The proposed drilling shall be carried out by using a standard land rig or a “Mobile Land Rig” with standard water based drilling fluid treatment system. This rig will be suitable for deep drilling up to the desired depth of 5000 meters (TVDSS) as planned for the project. (Table-5) The typical configuration of a Drilling Rig is shown in the Figure 6. Additionally, there will be other ancillary facilities like Drilling mud system, ETP, Cuttings disposal, Drill Cementing equipment etc. and utilities

to supply power (DG sets), water, fuel (HSD) to the drilling process and will be set up as a part of the Project. The details of the drilling rig are as follows.

Table-5: Specification of the Drilling Rig

Type of Rig	Electrical Rig
Drilling mud composition	Water based mud in shallower section and synthetic based mud in deeper section
Power generator type & nos.	AC – SCR Type.
Details of solids handling systems on rig	Shale Shakers - 1200 GPM Capacity Desander – 1200 GPM Capacity Desilter – 1200 GPM Capacity

Figure-6: Typical configuration of a Drilling Rig



Drilling Operation

Wells will be drilled in sections, with the diameter of each section decreasing with increasing depth. Before commencing the actual drilling, large diameter pipe (Conductor) will be 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 hole and potential washout problems. The lengths and diameters of each section of the well will be determined prior to the starting of the drilling activities 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. "Casing" provides support to hole wall and secures hole section. Other than that, it isolates problematic hole sections such as loss zones, shale sections, over pressurized formations etc. After running casing, 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.

Mud System and Cuttings

During drilling operations, the drilling fluid (or mud) is pumped through the drill string down to the drilling bit and returns at the drill pipe–casing annulus up to surface back into the circulation system after separation of drill cuttings /solids through solids control equipment. The primary function of drilling fluid is to ensure that the rock cuttings generated by the drill bit are continuously removed from the wellbore. The mud must be designed such that it can carry the cuttings to surface while circulating, suspend the cuttings while not circulating and drop the cuttings out of suspension at the surface. The drilled solids are removed at the surface by mechanical devices such as shale shakers, de-sanders and de-silters. The hydrostatic pressure exerted by the mud column prevents influx of formation fluids into the wellbore. The instability caused by the pressure differential between the borehole and the pore pressure can be overcome by increasing the mud weight. Hydration of the clays can be overcome by using non aqueous based muds, or partially addressed by treating the mud with chemicals which will reduce the ability of the water in the mud to hydrate the clays in the formation. Water based mud will be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations will be drilled using synthetic base mud (SBM). Synthetic base mud unlike oil based mud (OBM) is biodegradable but can be re-used. At the end of drilling a well almost the entire amount of the SBM is collected for re-use in next drilling operation. SBM systems promote good hole cleaning and cuttings suspension properties. They also suppress gas hydrate formation and exhibit improved conditions for well bore stability compared to most WBM. WBM typically consists of water, bentonite, polymers and barite. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation. The mud to be used will be continuously tested for its density, viscosity, yield point, water loss, pH value etc. The mud will be prepared onsite (drill location) using centrifugal pumps, hoppers and treatment tanks.

During drilling activity, cuttings will be generated due to crushing action of the drill bit. These cuttings will be removed by pumping drilling fluid into the well via triplex mud pumps. The mud used during such operation will flush out formation cuttings from the well hole. Cuttings will be then separated from drilling mud using solids-control equipment. This will comprise a stepped system of processes consisting of linear motion vibrating screens called shale shakers, hydro-cyclones (including de-sanders and de-silters), and centrifuges to mechanically separate cuttings from the mud.

Figure 7 Flow chart for drilling mud & solid discharge, Figure 8 indicates a typical view of drill cutting separation & Treatment system

Figure 7: Flow chart for drilling mud & solid discharge

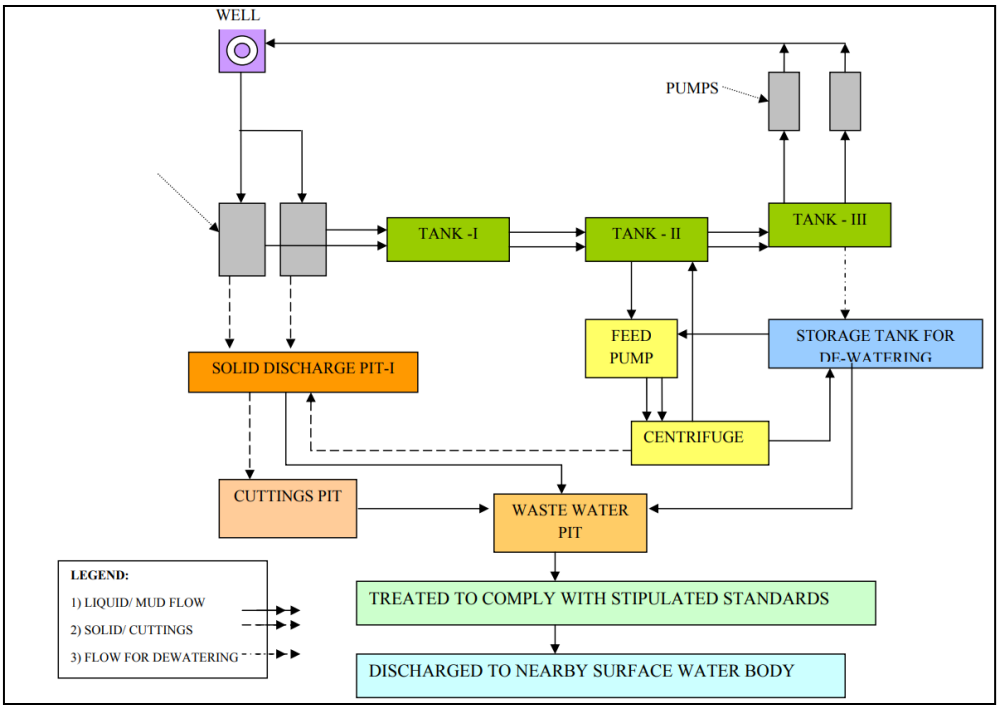
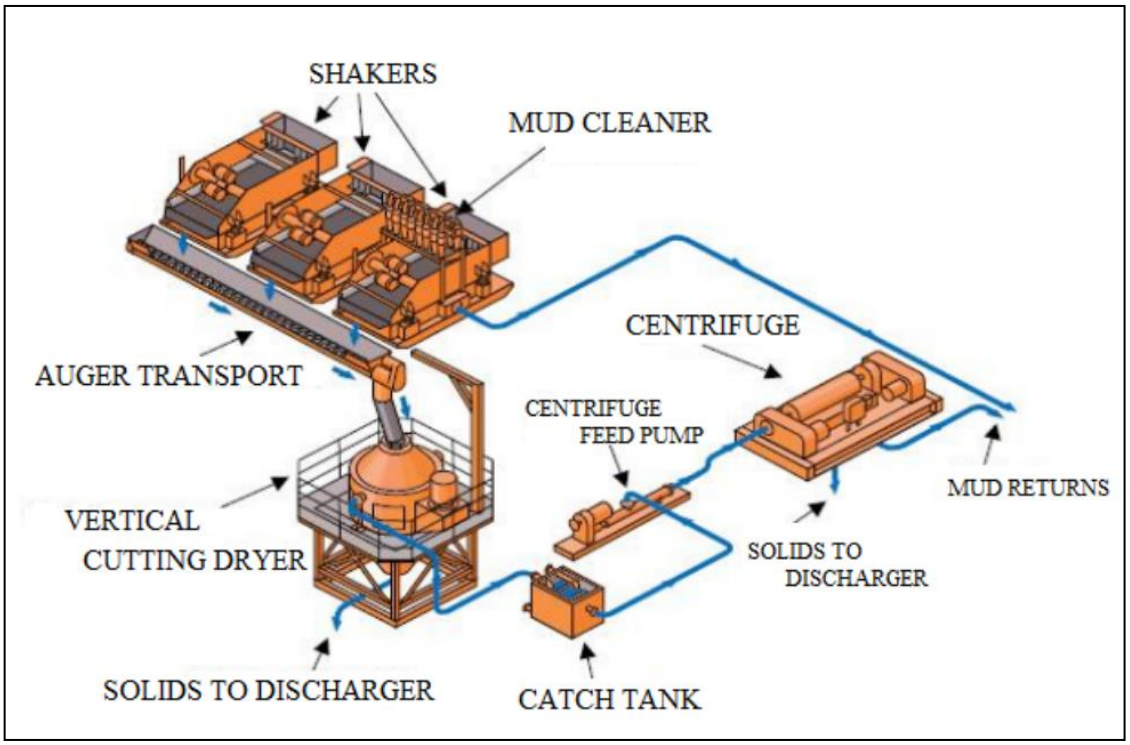


Figure 8: A typical view of drill cutting separation & treatment System



Cementing

Cementing is a necessary aspect of exploratory and appraisal drilling oil and gas wells. Cement is used to fulfill the following works:

- Secure/support casing strings
- Isolate zones for production purposes

Cementing generally utilizes Portland cement (API Class G Oil Well Cement) with various additives in small quantities as accelerators/retarders, density adjusters, dispersants, fluid loss additives, anti-gas migration additives etc.

Well Evaluation

During the drilling operations for different zones, logging operations will be undertaken to get 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 by different well logging techniques including electric, sonic and radioactive techniques. Logging instruments (sensors) are attached to the bottom of a wire line and lowered to the bottom of the well and they are then slowly brought back. The devices read different data as they pass each formation and record it on graphs, which will be interpreted by the geologist, geophysicist and drilling engineer. No emissions to the environment or any environmental harm is associated with wire line logging operations. The radioactive source required for well logging operations will be kept in specially designed container. In this drilling procedure, once the drilling is over, the well evaluation will be done by using electric wire line logs to assess the potential of the reservoir. This typically involves sampling the reservoir formation and pressure points during logging operations and reduces the requirement to flow hydrocarbons to the surface, significantly reducing the atmospheric emissions associated with the testing operation. Normally, in the event that hydrocarbons are encountered 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 being stored and trucked off the site and associated gas being flared to atmosphere.

Hydraulic Fracturing – for Tight Rock Reservoirs of Hydrocarbons

Hydraulic fracturing is used in tight rock reservoirs with low permeability, such as shale (i.e., the conductivity or ability of hydrocarbons to flow in the formation is low because of the small pore size in the rock). The goal of hydraulic fracturing in tight reservoir (shale) formations is to enable a well to produce the resource or to increase the rate at which a well is able to produce the resource. Hydraulic fracturing may be conducted in wells with low permeability formation and low pressure. Wells requiring hydraulic fracturing and numbers of stages of hydraulic fracturing per well will depend on seismic data acquired & interpreted and data acquired during the drilling phase of the project.

Hydraulic fracturing is a common technique used to stimulate the production of oil and natural gas by creating fractures or cracks that extend from the well hole into the rock formations. This is accomplished by injecting fluid, which is usually a mixture of water and high viscosity fluid additives, under extremely high pressure. The pressure of the water will then exceed the strength of the rock, causing fractures to enlarge. After the fractures take place, a “propping agent” known as proppant

(which is usually sand) is injected into the fractures to keep them from closing. This allows the hydrocarbon to move more efficiently from the rock to the well. A single well may require up to 15,000 m^3 of water which may vary depending on the fracking requirements. For the hydraulic fracturing in a well, proppant mass of 150,000 – 200,000 lbs per stage and fluid volume of 2500 bbls – 4000 bbls per stage will be required.

Fracturing effluent generated will be discharged in the HDPE lined pits at the drilling well sites. Additional land will be procured wherever required. For effective recycling and reuse of the frac fluid, effluent treatment plant (ETP) will be installed, thus raw water required for fracturing will be minimized.

Well Testing & Flaring

During the exploration and appraisal drilling, where a hydrocarbon formation is found, initial well test (generally about one month of duration) will be carried out to establish flow rates, formation pressure and other parameters. However, depending on the need based on the nature of the reservoirs, the exploratory and appraisal wells will be tested for longer/extended durations to ascertain the reservoir parameters. In case hydrocarbons are detected in the well, the quantity and quality will be tested. The fluids & gases coming out from the well will be flared. The flaring will be intermittent and last only for few days and it will not pollute environment. However, for flaring all the flaring guidelines for onshore wells will be followed and the design, size and location of flaring stack will be decided based on surrounding habitations and the flaring guidelines. Extremities of flare lines will be located at least 90 m from roads, public works, processing units or tanks. They will be at least 50 m from a well, gas/oil separator, site drainage or other possible source of ignitable vapours. It should be ensured that a flare line will be:

- ✓ Equipped with a pilot flame or other ignition device to ensure continuous Ignition of vented gas; and
- ✓ Equipped with a guard to protect the flame from being extinguished by the wind.

The zones expected to be Gas bearing will be identified based on the wire line log data and same will undergo testing to confirm the same. Approximately duration of the test flaring is around six hours per day and for four days during developmental drilling. Temporary test separators with facilities for flow metering will be provided which will separate oil, gas and water.

The crude oil produced during the well testing at appraisal stage will be collected and sent to nearby refineries and /or approved waste oil recyclers.

Completion of Drilling

On completion of activities, the well will be either plugged and suspended (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, by leaving the surface clear of any debris and the site will be restored.

Decommissioning & closure of wells

After the completion of the drilling activity, partial de-mobilization of the drilling rig and associated infrastructure will be initiated. As discussed earlier, well testing may be carried out immediately after the drilling is completed. The complete de-mobilization of the facilities at site will happen once well-testing completed successfully. This will involve the dismantling of the rig, all associated equipment and the residential camp, and transporting it out of the project area. It is expected that demobilization will take approximately 20-25 days and will involve the trucking away of materials, equipment and other materials from the site to bring it back to its original condition. It is estimated that about 50 truckloads will be transported out of site during this period. If no indication of any commercially viable amount of oil or gas is encountered either before or after testing, the well will be declared dry and accordingly will be plugged of and abandoned, and the site will be restored in line with regulations and good industry practice. The following steps will be typically involved to restore and rehabilitate the area:

- The wellhead and all casing string will be cut off to a minimum depth of 3 m (10 ft) below ground level.
- All concrete structures will be broken up, and the debris disposed off as per the regulatory requirements.
- All other waste products, solid and liquid, will be disposed of in accordance with the requirements of the EIA and will be treated to render them harmless.
- All fencing and access gates will be removed and all pits whose contents will show regulatory compliance for on-site disposal, at the time of site closure, will be backfilled and closed out as per the legal requirements.
- Restoration of unusable portion of the access track, removal of pilings and landscaping.

Appraisal

When, exploratory drilling is successful, , more wells (termed as Apprisal wells), will drilled to determine the size and extent of the field. Wells drilled to quantify the hydrocarbon reserves found are called as “apprisal’’ wells. The appraisal wells will be carried out with an aim to evaluate the size and nature of the reservoir, to determine the number of confirming or appraisal wells required, and whether any further seismic survey is necessary. The technical procedures and activities in appraisal drilling will be the same as those employed for exploratory wells. A number of well may be drilled from a single well pad/drill site. Deviated or directional drilling at an angle from a site adjacent to the original discovery well may be used to appraise other parts of the reservoir, in order to reduce the land requirement.

Setting up of Early Production Units (EPUs)/ Quick Production Units (QPUs) and Early Production

Vedanta Ltd (Cairn Oil & Gas), as an interim plan, in case of commercially viable discovery (s) of hydrocarbons in the block and having established the size of the hydrocarbon field (s), proposes to immediately bring the field (s) into production using one or more of the appraisal wells for the production of crude oil by setting up of Early Production Units (EPUs) or QPUs (Quick Production Units). Early production of the Crude oil will enable the Country to reduce dependence on import of crude oil.

Here, it may be noted that after the commercially viable discovery (s) of the hydrocarbon field(s), following the typical life cycle of Oil & Gas Exploration & Production sector, full-fledged field development plan including development well drilling, establishing crude oil & natural gas processing facilities, laying of intra-field & cross country pipelines and other associated physical and social infrastructures will be taken up and prior development EC and other approval will be obtained as applicable. The lead time for entire process is about 3 – 4 years for the production of crude oil and natural gas.

Once the full-fledged field development comes up, the Early Production Unit(s)/ Quick Production Unit(s) will suitably be integrated with the full-fledged facilities and/ or phased out.

Early Production Units (EPUs)/ QPUs (Quick Production Units) will be installed for the processing of produced well fluid. A EPU/ QPU will be a packaged/ modular unit and will mainly consists of a three phase separator & production heater or heater-treater, oil storage tanks, oil tanker loading system, produced water separation and disposal system, power generation (GEG or DG), utility systems such as fuel gas, flare & Inst. Air packages, firefighting equipment, etc. Each EPU/ QPU capacity will be ~2,000 BFPD (Barrels of Fluid per Day).

The EPU/ QPU will be installed near the exploration and appraisal well location within the well pad in the commercially viable discovered oil field. The separated crude oil will be stabilized further, stored in storage tanks and subsequently send through road tankers to the nearing available facilities like terminals/ depots. The produced gas will be used for internal heating, power generation purpose as far as possible & surplus gas will be safely disposed off using flare system.

The produced water will be treated to achieve MoEF/ CPCB/ SPCB specification (discharge standards) and will be disposed off. The treated effluent (produced water) will be disposed off using either a nearby down hole disposal well (by reinjection in abandoned well) or other available & suitable onshore disposal medium or solar/ mechanical evaporators depending on feasibility.

The power requirement will be met through state electricity grid and/ or installation of Diesel/ Gas Engine Generator(s) using produced gas.

The water requirement for the oil and gas processing will be sourced locally through approved authorities or through extraction of ground water. In case of extraction of ground water, permission (NOC) will be obtained from CGWA/ CGWB (Central Ground Water Authority/ Board) of from State Govt. Installation of raw water treatment plant will be done depending on the need for process water and domestic water consumption.

The typical broad requirements envisaged for the well fluid processing and production of crude oil and associated natural gas through EPU/ QPU are the following:

- Wells with selected artificial lift; & flow lines;
- Combination of Heater (using produced gas) & 3 phase separator or single heater-treater
- Stabilized Crude oil storage, pumping & tanker loading facilities;
- PW separation and disposal system;
- Fuel gas system, Instrument air/ gas system;

- Flare system, Firefighting equipment, Raw water treatment plant;
- Diesel/ Gas Engine Generator (s);
- Domestic sewage treatment facility (STP or septic tank & soak pit system);

3.6 Raw materials required and source

No raw materials are required during the seismic acquisitions. The explosive sources (dynamites) and drilling fluid chemicals for shot hole drilling will be procured by the company before commencement of the operations.

Drilling related material like HSD, Steel (in the form of casings & tubulars) and chemicals like barite, oil well cement and bentonite will be required. Other production equipment like tubular (Casing and tubings), wellhead assembly, packer etc, and chemicals for mud and cementing required for the drilling operations and shall be procured by the company from within the country and from abroad before the commencement of operations.

Water based mud will be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations will be drilled using synthetic base mud (SBM). Synthetic base mud unlike oil based mud (OBM) is biodegradable but can be re-used. WBM typically consists of water, bentonite, polymers and barite. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation.

3.7 Resource optimization / recycling and reuse envisaged in the project

Maximum care will be taken for resource optimization, wherever possible with an aim of

- ✓ Resource Conservation
- ✓ Elimination of Waste Streams
- ✓ Minimizing Waste
- ✓ Reuse /Recycle of Wastes
- ✓ The drill cuttings from the drilling operations associated with WBM will be used for filling low lying areas as a sub grade construction material in construction of well pads and surface facilities.
- ✓ Synthetic base mud will be re-used in further drilling activities.

3.8 Water and power requirement

3.8.1. Water Requirement

3.8.1.1. Water Requirement during Seismic Operations

The water required during seismic operation will be mostly for domestic use, which is about 20-30 m3/day.

3.8.1.2. Water Requirement during Drilling Operations

The water requirement in drilling rig is mainly meant for preparation of drilling mud apart from washings and domestic use. While former constitutes majority of water requirement, latter or the water requirement for domestic and wash use is minor. Water for both process and domestic uses would be procured through surface water sources. The water requirement per well is shown in Table 6.

Table-6: Typical Water requirement per well

Description	Quantity (m3/d)
Total water requirement during drilling phase	750-1300 (m3 /well)
Water for Water based mud	600-1000 (m3/well)
Water for synthetic based mud	150-300 (m3/well)
Water for domestic use	20-30 (m3/day/Well)

The water requirement for all the project activities will be sourced locally through approved/ authorized sources of surface water and/ or ground water (e.g. PHD bore wells, privately owned bore wells, Irrigation Dept./ Water Resources Dept. of State Govt.). In case, required water could not be sourced from locally available approved sources, ground water will be extracted after obtaining permission from CGWA/ State Govt.

3.8.1.3. Water Requirement during Production Operations

The water requirement for the oil and gas processing will be sourced locally through approved authorities or through extraction of ground water. In case of extraction of ground water, permission (NOC) will be obtained from CGWA/ CGWB (Central Ground Water Authority/ Board) of from State Govt.

3.8.2. Power Requirement

3.8.2.1. Power Requirement during Seismic Operations

The power will be required in the campsite and the same will be supplied using diesel generators or from nearest state grid.

3.8.2.2. Power Requirement during Drilling Operations

The power requirement in the drilling site and the campsites will be provided through diesel generator (DG) sets. The rated capacity of the DG sets required for onshore drilling site is provided in following Table-7.

Table-7: Details of DG sets of Onshore Drilling Activity

Location	DG Capacity
Camp site	2 X 350 kVA (one working and one standby)
Drilling site	3 x 1000 kVA (two working and one standby)
Radio Room	2 x 100 kVA

3.8.2.3. Power Requirement during early Production Operations

The power requirement will be met through state electricity grid and/ or installation of Diesel/ Gas Engine Generator(s) using produced gas.

3.9 Quantity of wastes to be generated and its disposal

3.9.1. During Seismic Operation:

Insignificant amount of waste water will be generated from domestic use and the same shall be disposed through septic tanks/soak pits.

3.9.2. During Drilling Operations:

3.9.2.1. Waste water generation & mitigation

The drilling operation would generate wastewater in the form of wash water due to washing of equipment, string and cuttings etc. The only other source of wastewater generated from drilling operation is sewage from sanitation facilities, around 15-25 m3/day, which shall be disposed through septic tanks/soak pits. It is expected that wastewater in the form of Drill cutting washing + Rig washing+ cooling etc shall be generated at an average rate of around 30-40 m3/day during the drilling operations from a single well. Waste water will be discharged in HDPE lined evaporation pit for disposal, size of the pit is generally 50mx20mx1.5m.

3.9.2.4. Solid Waste Management

The drill cuttings and spent drilling mud will be generated at site per well during drilling operations. This shall be stored in well-designed HDPE line pit. It will be tested for its hazardous constituents (Oil and Grease), If found to be hazardous, It will be handed over to authorized TSDF. In case of Nonhazardous, it will be disposed in situ in HDPE lined pit.

Used /waste Oil generated shall be sent to authorized recyclers. Domestic waste of 25-30 kg/day per well will be generated at site, which will be segregated at source (Organic / Inorganic) and disposed accordingly. The expected waste generation from well drilling will be as per Table 8

Table-8: Quantity of generated waste from drilling

S.N	Nature of waste	Quantity
A	**Hazardous Waste**	
1	Drill cuttings associated with SBM	250-750 tons/well
2	Drill cuttings associated with WBM	500-1500 tons/well
2	Residual drilling mud, sludge and other drilling waste	250-500 tons/well
3	Used Lubricating oil	1-2 tons/well
B	**Non Hazardous Waste**	
4	Food waste	25-30 Kg per/day
5	Non-combustible waste containing metallic residues	1000-1200 Kg per well
6	Packaging wastes including drums, wooden pallets, plastic	1000-1200 kg per well
7	Left over chemicals and materials, scrap metal,	250-300 kg per well
8	Cement, grit, blasting and painting wastes.	500-600 kg per well

3.9.3. During Early Production:

The produced water will be treated to achieve MoEF/ CPCB/ SPCB specification (discharge standards) and will be disposed off. The treated effluent (produced water) will be disposed off using either a nearby down hole disposal well (by reinjection in abandoned well) or other available & suitable onshore disposal medium or solar/ mechanical evaporators depending on feasibility.

3.10 Schematic of feasibility drawing

The typical layout of a well pad/drill site for the exploratory/appraisal wells is shown in fig 7.

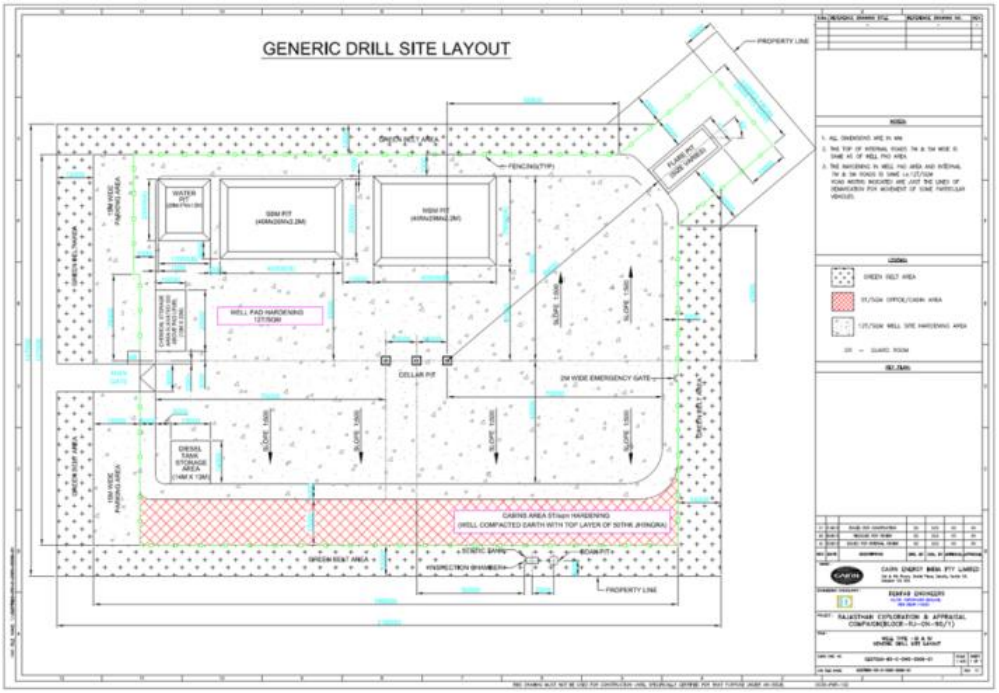


Figure 7: Schematic for a typical Well Pad

Each exploratory & appraisal well drill site will require the following:

- Potable office cabins / rest rooms (container type cubicles);
- Drilling rig foundation and cellar;
- Foundation / Pits for equipment;
- Space for drill rig equipment, working area and materials lay down area;
- Waste storage pits;
- Cutting disposal (impervious lined) pits;
- Solar evaporation pits (waste drilling fluid disposal);
- Water storage pit;
- Septic tank with soak pits;
- Paved and contained chemical storage area;
- Above ground Diesel storage tanks with paved and bunded area;
- Below ground level flare pit (well testing);
- Provisional space for definitive fracking program.
- Radio room;
- Storm water drainage system;
- Internal roads and fencing.

The drill site is restricted access area and is fenced all round with round the clock watch. Entry of vehicles into the drilling site area is prohibited except for material movement. Adequate parking are provided outside the drilling location.

4. Site Analysis

4.1 Connectivity

The block is a part of Dhemaji district and is accessible from the north side of Block. The area is accessible by road and train from the town of Tezpur by road and by ferries from Sibasagar. It is connected by road from Tezpur to Dhemaji by NH 52. The block area part of Lakhimpur district is accessible from the south side of Block. The block is accessible by road and train from the town of Tezpur. It is connected by road from Tezpur to Lakhimpur via NH 52. The nearest town Tezpur is well connected through road. NH-15, SH-22 and SH-42 passes through the block. Railway stations are available in Sibsagar (13 km), Dhemaji (within block) and Lakhimpur (20 km). The nearest airport to the project location is Lakhimpur (20 km).

4.2 Land form, land use and land ownership

Block area partly covered by Brahmputra River and few small Rivers.

4.3 Topography (along with map)

Topography sheet is given as Fig.-4B of Chapter-3 in this document.

4.4 Existing land use pattern and relative location of protected areas

Jiadhol Reserved Forest falls within the block and Sisi Reserved Forest is located 4 km from the block.

4.5 Existing infrastructure / industries

There are no large-scale industries present in the study area, some small scale industries are present there.

4.6 Soil classification

The soil of the district is broadly classified into four groups, namely new alluvial, old alluvial, red loams and Laterite. The new alluvial soil is found in the flood plain areas subjected to occasional flood and consequently receives annual silt deposit when the flood recedes. The old alluvial soils are developed at higher level and are not subjected to flooding. Red loamy soils are formed on hill slopes under high rainfall conditions.

4.7 Climate data from secondary sources

The district is located near the foothills of Arunachal Pradesh; it exhibits difference in temperature, rainfall, fog, wind etc. The climate of the district is per-humid characterized by high rainfall. Mild summer and winter and falls under cool to warm per humid thermic-agro ecological sub-zone.

4.7.1 Wind

The wind blows from north east to south west over the region.

4.7.2 Storms and cyclones

There are no past records of storms and cyclones over the region.

4.7.3 Rainfall

The annual rainfall of the district ranges from 2600 to 3200 mm with a monthly maximum rainfall of 11102.47 m and minimum rainfall of 1.00 mm. The maximum rainfall occurred during the month of July (91.9mm) and December is the dry month.

4.7.4 Temperature and humidity

The district is located near the foothills of Arunachal Pradesh; it exhibits difference in temperature, rainfall, fog, wind etc. The climate of the district is per-humid characterized by high rainfall. Mild summer and winter and fall under cool to warm per humid thermic- agro ecological sub-zone.

4.8.4 Water quality

According to the CGWB report there are some problem of arsenic contamination in ground water, in some region.

5. Planning Brief

5.1 Planning concept

The project is a green field oil and gas exploration & appraisal and early production spread over in AA-ONHP-2017/15 Block of area 1367 km2 in Lakhimpur, Dhemaji, Jorhat, Dibrugarh and Sibsagr district of Assam and West Siang district of Arunachal Pradesh.

Well sites and roads will be built or upgraded for transportation of rig and its equipment for seismic acquisition and drilling. The drilling will be carried out following the international safety standards. Upon successful exploration the well will be completed and suspended for further activities and the wells devoid of hydrocarbon will be plugged and abandoned. The land will be restored back to its original form.

5.2 Population projection

Direct and indirect employment will be created due to project. Temporary influx of people will be there as the managerial and supervisory staff will generally be outsider.

5.3 Land use planning (break up along with green belt, etc)

The land within the block will not be taken completely for drilling of well. An area of about 300m X 300m would be taken on temporary lease basis for the construction of well pad, drill site etc. For the preparation of suitable access roads connecting to well pads, OHL and other utilities in future, a width of 30m RoU (approx.) will be required.

5.4 Assessment of Infrastructure demand

No major infrastructure (physical and social) is anticipated. The Infrastructure demand will be very less as the number of employees at drilling wells is 80-100. Access road will be taken up by Vedanta for the drilling well site for the movement of heavy equipment.

5.5 Amenities and facilities

The amenities/ facilities will be in the scope of Contractor.

- Potable drinking water
- Firefighting/ alarm system and ambulance is available in case of emergency
- Drinking water, canteen and electricity facilities is provided
- Separate sanitation facilities will be provided for men and women.

6. Proposed Infrastructure

No measure physical and social infrastructure is envisaged. Only drill site / well pad and temporary camp site (Porta cabin) for the drilling of exploratory (including) appraisal wells are envisaged.

7. Rehabilitation and resettlement (R&R) Plan

For exploration and appraisal activities, the project does not envisage any R & R of the project, since the land requirement would be very less and on temporary and short term lease and away from the settlements. If the identified lands are of private landowners then land lease mode will be applied and in case of govt. land, land allotment from Govt. to be applied. Initially temporary and short-term lease will be taken for 3 - 5 years for exploration purpose and in case of commercially viable discovery of hydrocarbon resources; the land lease would be converted into long term lease up to life of the project.

For sites selected having settlements if any, Resettlement & rehabilitation (R&R) plan will be developed and implemented as per the applicable State/ Central Govt. policy. Compensation to affected landowners for any loss of land, Cairn will ensure the livelihood of local community, if any affected by the proposed land take, are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities.

8. Project schedule and cost estimate

Vedanta Ltd (Cairn Oil and gas) has planned to carryout seismic data acquisition, exploration and appraisal in the AA-ONHP-2017/15 Block in next 10-12 years. The cost of the project is estimated is given below:

1) Physical Surveys Cost estimated to be approximately INR 16 Crore.
2) Average Cost per well for exploratory & appraisal well is estimated to be INR 16 Crore.
3) Average cost of each EPU/ QPU is estimated to be INR 44 Crore.

9. Analysis of Proposals

The implementation of this project will not have any adverse effect on the environment as appropriate pollution control measures will be taken from the initial stage itself.

Proposed drilling activities will result in growth of the surrounding areas by increasing direct and indirect employment opportunities in the region.