Pre-Feasibility Report

For

Offshore & Onshore Oil and Gas Exploration and Appraisal in Block GK-ONHP-2017/1 in Gulf of Kutch & Kutch District of Gujarat

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 and Gas) is the operator of the GK-ONHP-2017/01 block. The block is an offshore & onshore with a total area of 2690 Sq.Km. Out of which, about 2409.5 Sq. Km. is located onshore in Kutchh district of Gujarat and 280.5 sq. km. in offshore Gulf of Kutchh in the Arabian Sea of Gujarat coast. Vedanta Ltd. has been allocated with an exploration and production license by Government of India under the Revenue Sharing Contract (RSC) on1st October 2018.

1.1 Project Details

1.1.1 Proposed facilities

Vedanta Limited (Cairn Oil & Gas) proposes to carry out seismic survey/data acquisition covering the block and exploratory (including appraisal) drilling of 67 wells for oil and gas exploration. All the proposed Exploration and Appraisal wells will be entirely in onshore.

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 study area experiences a hot and dry climate. Predominantly being a dry land, Kutch experiences extreme climatic conditions characterized by sweltering summer and scanty rainfall. The summer season in Kutch is extremely hot and starts from the month of February and lasts till June. The Kutch

region receives an average rainfall of around 14 inch every year. Compared to the other two seasons, the winter season in Kutch is pleasant. It starts from the month of October and lasts till January with average temperature ranging from 12°Celsius to 25°Celsius. Since the state has a long coastal belt, the winter is not very cold.

1.2.2 Tides, currents and waves

Not applicable to the study area.

1.3 Water and power requirements

1.3.1 Water Requirement

A. Water Requirement during Seismic Survey

The water requirement is 20 - 30 m3/day 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 water requirement for WBM preparation will be 600-1000 m3/well. The water requirement for SBM preparation will be 150-300 m3/well. The other requirement approx. 25-50 m3/well/day would be for drilling activities like engine cooling, floor / equipment / string washing, fire-fighting storage / make-up. For domestic consumption, approx. 20 - 30 m3/day water will be required during drilling period. The water requirement will be sourced locally through approved authorities.

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 during drilling activity will be met through D.G. sets of 3*1000 KVA at drill rig, 2*350 KVA for drilling camp site and 2* 100 KVA for the radio room respectively.

1.4 Pollution control measures

1.4.1 Pollution Control measures during Seismic Operations

A. Air Emissions and Control Measure

Emissions to air include transient airborne dust raised by construction activities (e.g. preparation of seismic cut lines and moving vehicles and equipment) and emissions from vehicles and machinery. These emissions are transient and insignificant nature.

B. Noise Emissions and Control Measure

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

C. Wastes treatment and disposal

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

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, power generator and temporary from flaring activity during testing/Extended testing of wells.

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. 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 minimize exposure to noise.

C. Waste treatment and disposal

250-750 tons/well for drill cuttings associated with WBM and 500-1500 tons/well for drill cuttings associated with SBM and 250-500 tons/well WBM spent/residual drilling mud will be generated at site during drilling operations. This will be stored in well-designed HDPE line pit.

Used /waste Oil – During the drilling approx. 1-2 tons of used oil, sludge containing oil and other drilling wastes will be 250-500 tons/well will be generated per well. This oil will 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.

All kinds 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 will be generated and the domestic waste water will be treated suitably.

1.5 Project schedule and cost estimate

Vedanta Ltd (Cairn Oil and gas) has planned to carryout seismic data acquisition and 67 exploration (including appraisal) well drilling in the GK-ONHP-2017/01 Block in next 10-12 years.

The estimated cost of the project is given below:

1) Physical Surveys Cost estimated to be approximately INR 5.12 Crore.
2) Average Cost for each exploratory & appraisal well drilling is estimated to be INR 18 Crore.

1.6 Employment Generation

The seismic survey is expected to take about 6 to 8 months and will require a crew of approximately 400 to 500 persons. Most of the workforce will be from local/nearby areas. During the site preparation for drilling, approximately 30-35 workmen will be employed per drill site. It is anticipated that, at any given time, there will be about 80-100 personnel working on site including technical staff, drilling crew, security staff etc.

1.7 Rehabilitation and Resettlement

For exploration, appraisal and production activities, the project does not envisage any Resettlement & rehabilitation of the project, since the land requirement would be very less and on temporary 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 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 allocated the GK-ONHP-2017/01 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) of oil and gas in the block.

The wells will be tested by flowing hydrocarbons to assess the quality and commercial viability, to ascertain reserves oil parameters as a part of exploration and appraisal. Vedanta Limited has planned to acquire seismic data covering the block area and subsequently drill 67 exploratory & appraisal wells.

2.2 Brief description of nature of the project

The proposed project is green field in nature. The project is an oil and gas exploration (including appraisal) drilling and well testing.

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 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.

2.4.1Production 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.

2.4.2Imports

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, in case of commercially viable discoveries of hydrocarbon, will be utilized for domestic purpose to supply the increasing demand in domestic market

2.7 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 400 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 about 80-100 personnel working on site including technical staff, drilling crew, security staff etc.

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 GK-ONHP-2017/1 is located in Kutchh district of Gujarat. It encloses an area of 2690 Sq. Km. and is bounded by the points having following coordinates (Table-1). A map of the contract area is shown in Figure 1.

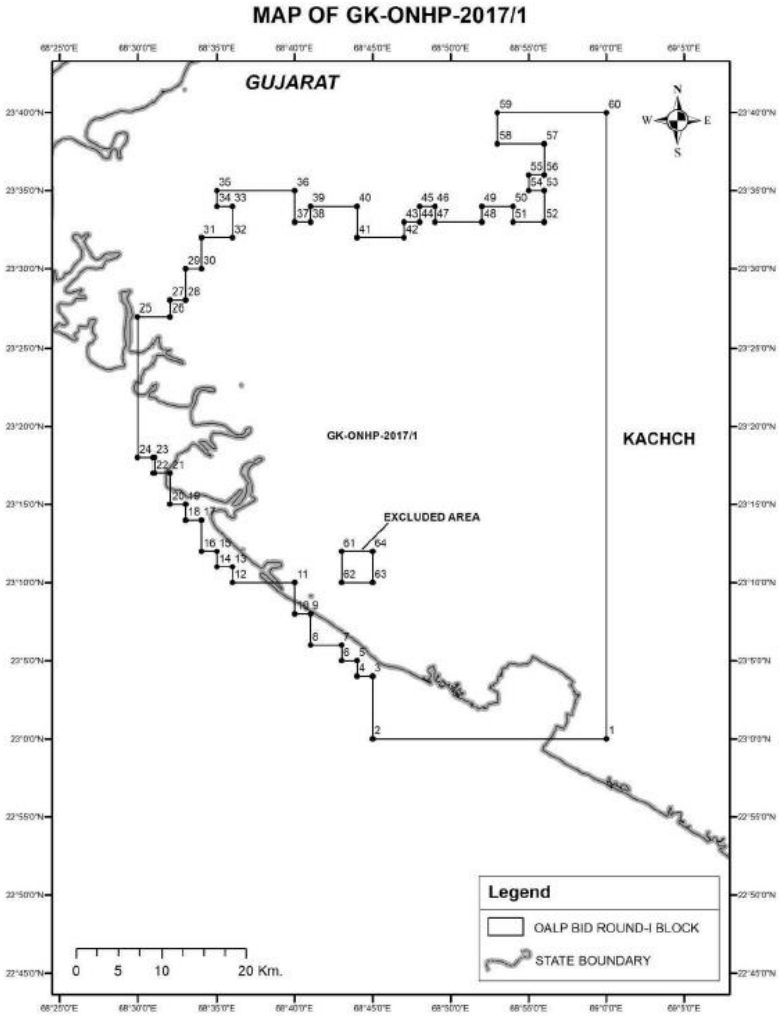

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Figure-1: Location map of block GK-ONHP-2017/1 with state and district boundary

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

Points	Longitude	Latitude	Points	Longitude	Latitude	EXCLUDED AREA		
1	69° 0'	23° 0'	31	68° 34'	23° 32'	Points	Longitude	Latitude
2	68° 45'	23° 0'	32	68° 36'	23° 32'	61	68° 43'	23° 12'
3	68° 45'	23° 4'	33	68° 36'	23° 34'	62	68° 43'	23° 10'
4	68° 44'	23° 4'	34	68° 35'	23° 34'	63	68° 45'	23° 10'
5	68° 44'	23° 5'	35	68° 35'	23° 35'	64	68° 45'	23° 12'
6	68° 43'	23° 5'	36	68° 40'	23° 35'			
7	68° 43'	23° 6'	37	68° 40'	23° 33'			
8	68° 41'	23° 6'	38	68° 41'	23° 33'			
9	68° 41'	23° 8'	39	68° 41'	23° 34'			
10	68° 40'	23° 8'	40	68° 44'	23° 34'			
11	68° 40'	23° 10'	41	68° 44'	23° 32'			
12	68° 36'	23° 10'	42	68° 47'	23° 32'			
13	68° 36'	23° 11'	43	68° 47'	23° 33'			
14	68° 35'	23° 11'	44	68° 48'	23° 33'			
15	68° 35'	23° 12'	45	68° 48'	23° 34'			
16	68° 34'	23° 12'	46	68° 49'	23° 34'			
17	68° 34'	23° 14'	47	68° 49'	23° 33'			
18	68° 33'	23° 14'	48	68° 52'	23° 33'			
19	68° 33'	23° 15'	49	68° 52'	23° 34'			
20	68° 32'	23° 15'	50	68° 54'	23° 34'			
21	68° 32'	23° 17'	51	68° 54'	23° 33'			
22	68° 31'	23° 17'	52	68° 56'	23° 33'			
23	68° 31'	23° 18'	53	68° 56'	23° 35'			
24	68° 30'	23° 18'	54	68° 55'	23° 35'			
25	68° 30'	23° 27'	55	68° 55'	23° 36'			
26	68° 32'	23° 27'	56	68° 56'	23° 36'			
27	68° 32'	23° 28'	57	68° 56'	23° 38'			
28	68° 33'	23° 28'	58	68° 53'	23° 38'			
29	68° 33'	23° 30'	59	68° 53'	23° 40'			
30	68° 34'	23° 30'	60	69° 0'	23° 40'			

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 block. The locations of wells are selected considering the drilling configuration (reach to reservoirs), protected source of hydrocarbon as general environment and social factor.

3.4 Size/ magnitude of operation

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

1. seismic data acquisition
2. Drilling of 67 exploratory (including appraisal) and Testing of wells
3. The exploratory and appraisal wells are expected to be drilled to explore the reservoirs depth is 2500-3500m.

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 gasdeposits identified. 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. In case of 2D seismic survey the receiver points to recorded the reflected vibration from the source point are to be 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 (1–2km) 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 groundwater, 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/3D 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.

3.5.2 Drilling of Exploration and Appraisal well:

Vedanta Ltd. (Cairn Oil & Gas) proposed to drill 67 exploration & appraisal wells within the present block boundary of GK-ONHP-2017/1.

The basic objective of the exploratory drilling will be as follows:-

- To determine the presence of potential hydrocarbon
- To appraise discovered oil & gas

The lifecycle of drilling activities involve well site selection, site and access road preparation and its maintenance, construction of drilling well, drilling activities, well testing and decommissioning and closure of wells, if not proved economically viable for production of oil and gas. The following are the commonly used terms in an oil and gas.

If a discovery is made it is likely to need to be appraised. This is an intermediate step between exploration and development which is necessary to confirm the reserve size and field deliverability to an acceptable degree of accuracy. This may be in order to determine whether the discovery is commercial, or to establish the parameters necessary to define the optimal development scheme for the field. Appraisal may consist of additional seismic, further drilling or extended testing of an existing well. Any or all of these types of operations may be deemed desirable or necessary.

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

- Portable Living quarters – To house Essential personnel on site on a 24 hr basis.These units are provided with Bath/Washroom.
- Crane age- Crane for loading/off- loading equipment and supplies.
- Emergency Systems- It includes fire detection and protection equipment.
- Environmental Protection – Blow Out prevention (BOP) system, Wastewater treatment unit, cutting 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 (DG sets), water, fuel (HSD) to the drilling process and will be set up as a part of the project. The following flow chart of **Fig 3.2** and **Fig 3.3** shows the various phases of the drilling activities and model of drilling process respectively:

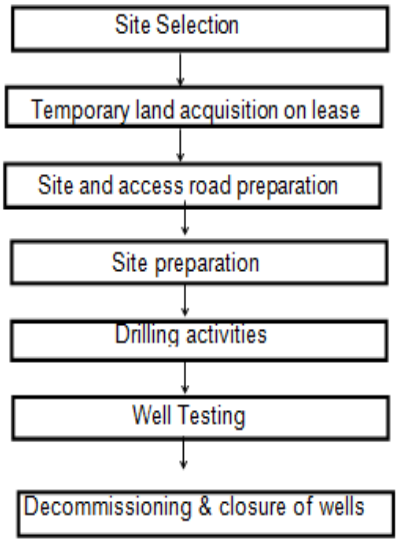

Figure-2: Flow Chart Showing Various Phases of Drilling Activities

Figure-3: Model of Drilling Process

3.5.2.1 Location &Description of Drilling of Exploration and Appraisal Wells

The exact locations for the drilling exploratory and appraisal 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 block is an offshore & onshore with a total area of 2690 Sq.Km. Out of which, about 2409.5 Sq. Km. is located onshore in Kutchh district of Gujarat and 280.5 sq. km. in offshore Gulf of Kutchh in the Arabian Sea of Gujarat coast. The tentative drilling locations are presented in satellite image **(Figure-5)** and Survey of India toposheet **(Figure-6).** Specific details of the proposed well are given in Table-2 and the tentative co-ordinate of the wells is given in the **Table 2.**

Figure-4. Google map with Tentative Location of proposed wells on satellite map

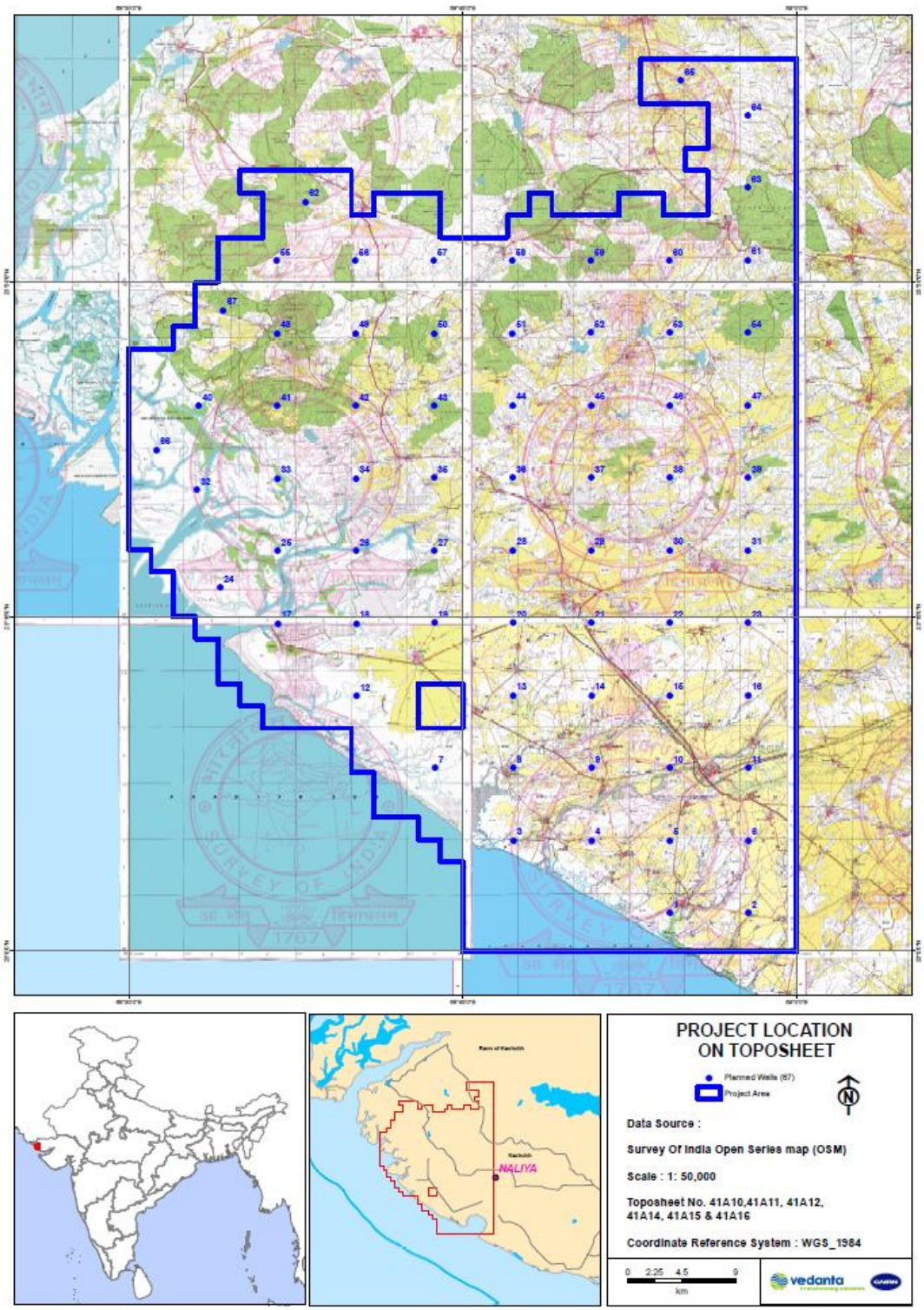

Figure-5. Toposheet map with Tentative Location of proposed wells on satellite map

Table-2: Proposed well co-ordinates to be drilled in block GK-ONHP-2017/1

Well_id	Longitude	Latitude	Well_id	Longitude	Latitude
1	68° 54' 17.981" E	23° 1' 43.007" N	35	68° 43' 42.989" E	23° 21' 12.874" N
2	68° 57' 48.793" E	23° 1' 43.125" N	36	68° 47' 14.308" E	23° 21' 13.232" N
3	68° 47' 16.021" E	23° 4' 57.655" N	37	68° 50' 45.629" E	23° 21' 13.511" N
4	68° 50' 46.915" E	23° 4' 57.930" N	38	68° 54' 16.950" E	23° 21' 13.711" N
5	68° 54' 17.811" E	23° 4' 58.128" N	39	68° 57' 48.272" E	23° 21' 13.831" N
6	68° 57' 48.707" E	23° 4' 58.246" N	40	68° 33' 8.350" E	23° 24' 26.430" N
7	68° 43' 44.702" E	23° 8' 12.419" N	41	68° 36' 39.751" E	23° 24' 27.028" N
8	68° 47' 15.680" E	23° 8' 12.773" N	42	68° 40' 11.153" E	23° 24' 27.546" N
9	68° 50' 46.660" E	23° 8' 13.049" N	43	68° 43' 42.557" E	23° 24' 27.984" N
10	68° 54' 17.640" E	23° 8' 13.247" N	44	68° 47' 13.963" E	23° 24' 28.344" N
11	68° 57' 48.620" E	23° 8' 13.366" N	45	68° 50' 45.369" E	23° 24' 28.623" N
12	68° 40' 13.214" E	23° 11' 27.100" N	46	68° 54' 16.776" E	23° 24' 28.824" N
13	68° 47' 15.339" E	23° 11' 27.890" N	47	68° 57' 48.184" E	23° 24' 28.944" N
14	68° 50' 46.403" E	23° 11' 28.167" N	48	68° 36' 39.145" E	23° 27' 42.134" N
15	68° 54' 17.468" E	23° 11' 28.365" N	49	68° 40' 10.634" E	23° 27' 42.654" N
16	68° 57' 48.533" E	23° 11' 28.485" N	50	68° 43' 42.124" E	23° 27' 43.094" N
17	68° 36' 41.555" E	23° 14' 41.700" N	51	68° 47' 13.616" E	23° 27' 43.454" N
18	68° 40' 12.701" E	23° 14' 42.214" N	52	68° 50' 45.109" E	23° 27' 43.734" N
19	68° 43' 43.848" E	23° 14' 42.649" N	53	68° 54' 16.602" E	23° 27' 43.935" N
20	68° 47' 14.996" E	23° 14' 43.005" N	54	68° 57' 48.096" E	23° 27' 44.056" N
21	68° 50' 46.146" E	23° 14' 43.283" N	55	68° 36' 38.538" E	23° 30' 57.240" N
22	68° 54' 17.296" E	23° 14' 43.482" N	56	68° 40' 10.113" E	23° 30' 57.760" N
23	68° 57' 48.447" E	23° 14' 43.602" N	57	68° 43' 41.690" E	23° 30' 58.201" N
24	68° 34' 5.777" E	23° 16' 18.127" N	58	68° 47' 13.268" E	23° 30' 58.562" N
25	68° 36' 40.956" E	23° 17' 56.810" N	59	68° 50' 44.847" E	23° 30' 58.843" N
26	68° 40' 12.187" E	23° 17' 57.326" N	60	68° 54' 16.427" E	23° 30' 59.045" N
27	68° 43' 43.419" E	23° 17' 57.762" N	61	68° 57' 48.008" E	23° 30' 59.166" N
28	68° 47' 14.653" E	23° 17' 58.119" N	62	68° 37' 56.401" E	23° 33' 35.910" N
29	68° 50' 45.888" E	23° 17' 58.398" N	63	68° 57' 47.919" E	23° 34' 14.275" N
30	68° 54' 17.123" E	23° 17' 58.597" N	64	68° 57' 47.830" E	23° 37' 29.383" N
31	68° 57' 48.359" E	23° 17' 58.717" N	65	68° 54' 47.134" E	23° 39' 3.439" N
32	68° 33' 3.434" E	23° 20' 40.496" N	66	68° 31' 14.650" E	23° 22' 28.535" N
33	68° 36' 40.354" E	23° 21' 11.920" N	67	68° 34' 14.013" E	23° 28' 44.076" N
34	68° 40' 11.671" E	23° 21' 12.436" N			

Note: Actual geographical surface coordinates of exploratory and appraisal well locations will be within 4000m radius of the proposed coordinates

Site Selection

The exploration history of the area exhibits the potential presence of the oil and gas in the region. The seismic data interpretation of the seismic survey would decide the exact locations of the drilling well. The proposed exploratory well site will be identified based on the study and interpretation of the stratigraphy and seismic data. Within the identified location the actual well drilling site will be selected based on the following factors:

- Located at least 200 m away from the nearest habitat / sensitive receptors
- Located at a safe distance (at least the boom / mast length away) from public road

- Safe distances from any radio transmitters so that the use of explosives and detonators may proceed without the danger of external activation
- Ensure natural drainage channels are avoided or drainage channels rerouted to ensure unhindered flow of rain / flood water. Where necessary adequate erosion control measures will be provided

Land Requirement

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 a width of 15 m RoU (approx.) will be required.

Site Preparation

Site preparation will involve all activities required to facilitate the operation of the drilling rig and associated equipment's 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. Leveling 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. A backhoe will be used for all excavation and cutting activities (for construction of pits) on site. Subsequently, the proposed well site & campsite will be duly fenced using chain link and barbed wires.

Mobilization of Rig

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 4500 meters (TVDSS) as planned for the project. The typical configuration of a Drilling Rig is shown in the **Figure 7**. 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.

Details of the drilling rig

Type of Rig	**Electrical Rig**
Drilling mud composition	Water based Drilling Fluid
Power generator type & nos.	AC – SCR Type. (03 Nos.)
Details of solids handling systems on rig	Shale Shakers - 1200 GPM Capacity Desander – 1200 GPM Capacity Desilter – 1200 GPM Capacity

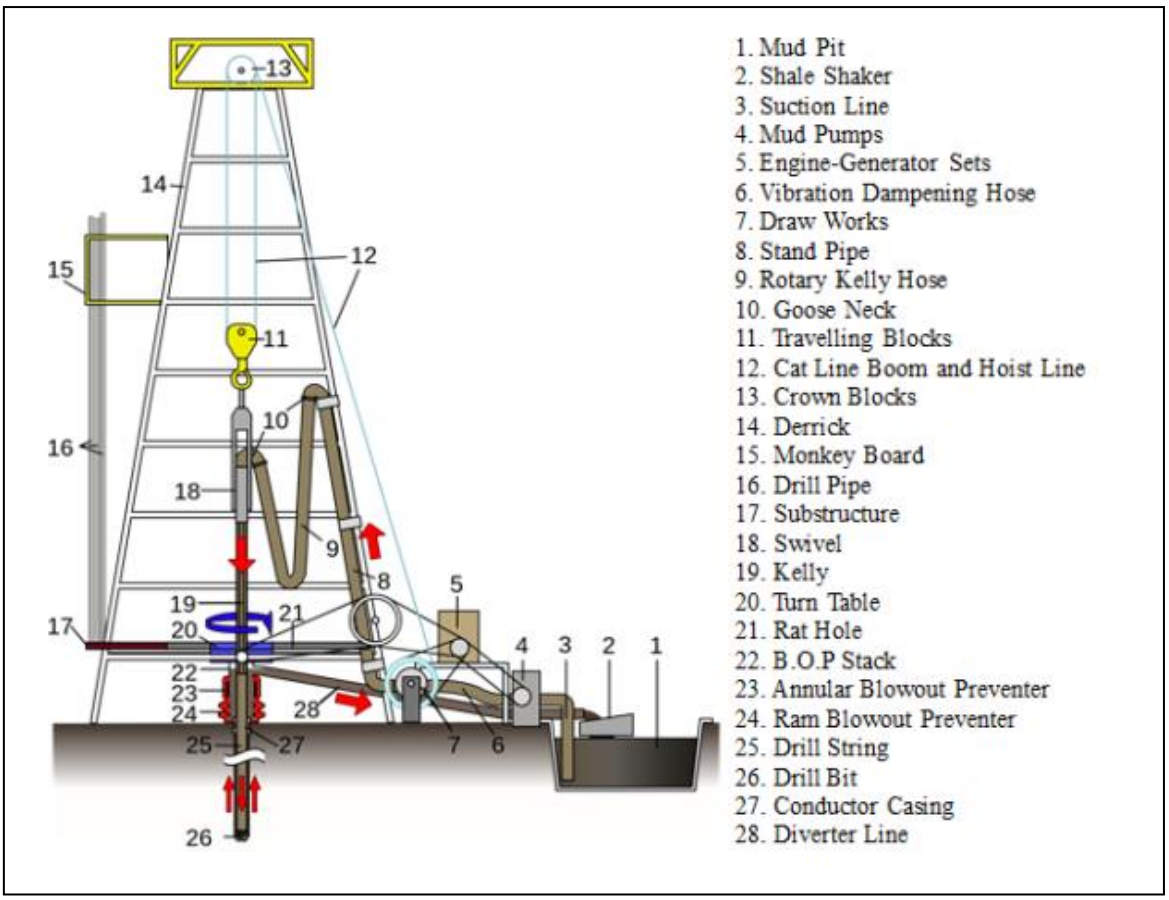

Figure-6: Typical configuration of a Drilling Rig

Drilling Activities

Initial Well Construction

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 whole unconsolidated material falling into hole and potential washout problems. Typical depths of such pipes are 6m. 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. The casing helps to maintain the stability of the hole and reduce fluid losses from the well bore into surrounding rock formations.

The Drilling Process

A rig will be installed at the potential site of drilling after thorough inspection for its working capability and quality standards. Well spudding shall be 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”. “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. Drilling process is associated with various hazards such as well active situation (kicks), blowouts, H2S situation etc,

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 8 shows the schematic layout of drilling mud & solids discharge involved as a part of the drilling system for exploratory wells.

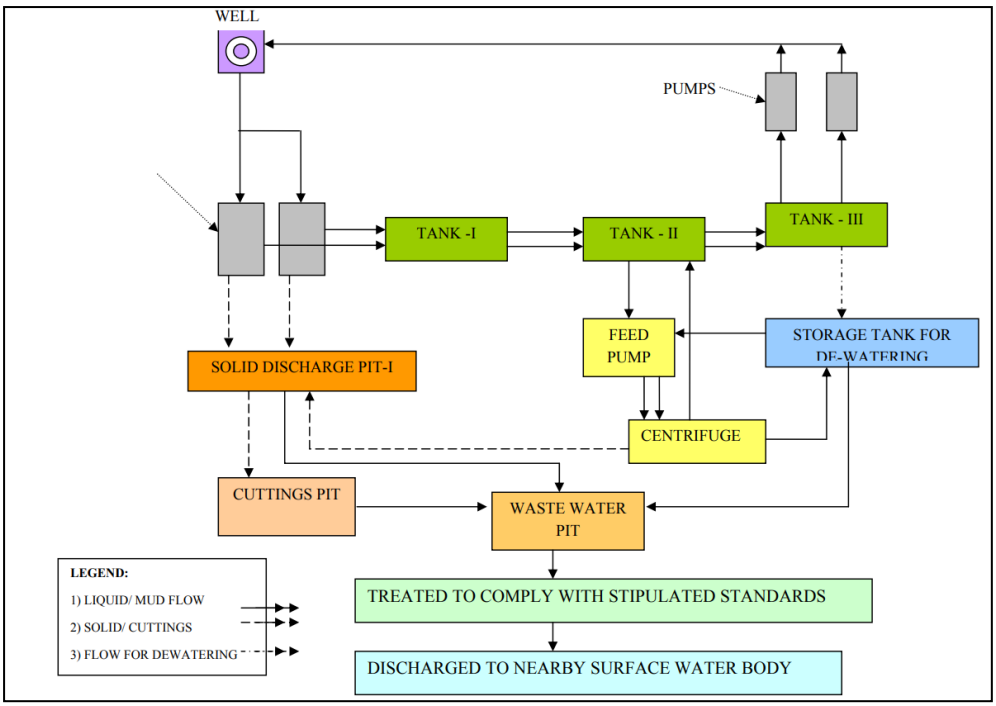

Figure-7: Flow Chart for Drilling Mud & Solid Discharge

Cementing

Cementing is a necessary aspect of exploratory 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 tests (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 nature of the reservoirs, the exploratory and appraisal wells will be tested for longer/extended durations to ascertain the reservoir parameters. During the well testing, crude oil, natural gas and produced water could be generated and will be treated/ disposed appropriately. Hydrocarbons will be flared. Efficient test flare burner will be used to minimize incomplete combustion. As an alternative option, if feasible, crude oil/ slop oil will be transferred to nearby refinery (terminals/depots) for processing or will be sent to a SPCB authorized 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. The Crude oil produces during the well testing at appraisal stage will be collected and sent to nearly and approved waste oil recyclers.

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.

Appraisal

When, exploratory drilling is successful, more wells (termed as Appraisal wells) will be drilled to determine the size and the extent of the field. Wells drilled to quantify the hydrocarbon reserves found are called as 'appraisal' wells. The appraisal activity 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 exploration wells. A number of wells 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.

3.6 Raw materials required and source

Broad requirements of raw materials:

Seismic Acquisition

The seismic survey will be conducted using dynamite charges. The explosive sources (dynamites) and drilling fluid chemicals for shot hole drilling will be procured by the company before commencement of the operations. During surveying the main tasks include initial installation of a small number of survey control points, then setting-out source points and receiver stations for use. This would be done by the conventional survey method of using RTK GPS backpack surveying units and biodegradable markers. Cutting activities though minimal for the receiver and source lines shall be done manually or mechanically where appropriate. In open areas where there is clear line of sight no cutting shall be done. Recording involves laying of geophones on the receiver stations and generating energy (vibrations) on the perpendicular source lines to generate seismic energy, which are reflected and recorded on magnetic tapes via the recording instrument.

Drilling

During drilling activities, materials like HSD, Steel (in the form of casings & tubulars) and chemicals like barite, oil well cement and bentonite will be required. Other production equipments 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.

- Requirement WBM (approx.) 800-1000 m^3/well
- Requirement SBM (approx.) 600-800 m^3/well

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 water based mud will be used for filling low lying areas as a sub grade construction material in construction of well pads etc.
- ✓ 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 3.

Table-3: Typical Water requirement per well

Description	Quantity (m^3/d)
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)

3.8.2. Power Requirement

3.8.2.1. Power Requirement during Seismic Operations

The power requirement during seismic is 350 KVA will be provided through diesel generator (DG) sets or 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-4: 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

3.9 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. The Air emissions and noise emissions will be also very insignificant and will be temporary in nature. Domestic effluent of about 15-25 m^3/day is anticipated. Also, non-hazardous solid wastes like food waste, paper, etc. are expected.

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. The wash water would contain variable quantities of mineral salts, solids, suspended and dissolved hydrocarbons, and other organic and inorganic components in very minor quantities.

3.9.2.2. Solid Waste Management

The drill cuttings and spent drilling mud will be generated at site per well during drilling operations. This will be stored in well-designed HDPE line pit.

Used /waste Oil generated will 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 5

Table 5:: Quantity of generated waste from drilling.

S.No	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, glass	1000-1200 Kg per well
6	Packaging wastes including drums, wooden pallets, plastic containers, plastic foils.	1000-1200 kg per well
7	Left over chemicals and materials, scrap metal, sludges, scales, batteries, spent acids, spent lubricants, filters etc.	250-300 kg per well
8	Cement, grit, blasting and painting wastes.	500-600 kg per well

3.10 Schematic of Feasibility Drawing

The typical layout of a well pad/drill site for exploratory and appraisal well is as below:

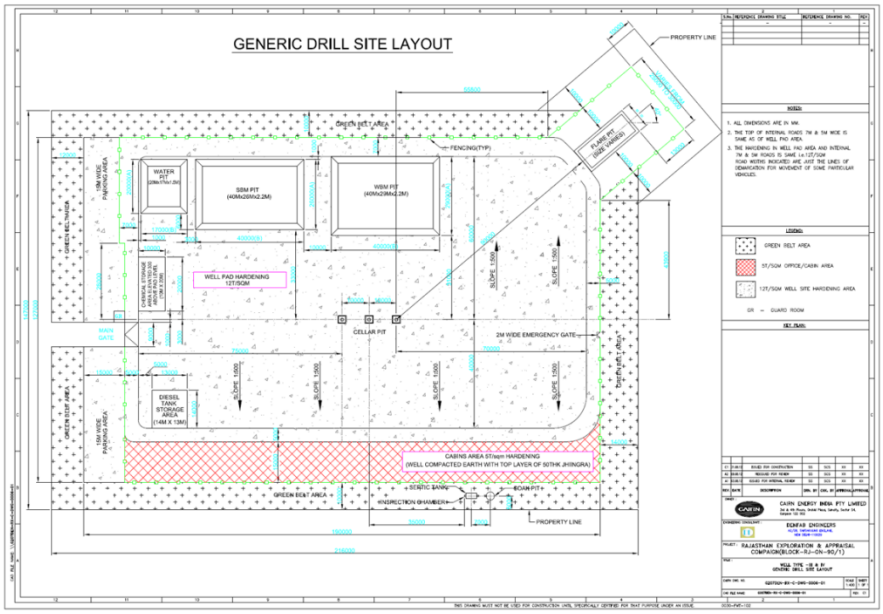

Figure8: Schematic for a typical Well Pad

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 project location is situated in Kutchh district of Gujarat. The nearest major town for this project is Mandvi. Nearest airport is in Bhuj. Mandviis the nearest port. The project location is well connected by road, rail and by air.

4.2 Land form, land use and land ownership

The block is covered with mines, water bodies, Mangrove forest & mudflats.

4.3 Topography (along with map)

The block area is undulating topography with elevation varying approximately 2m to 200m across area.

4.4 Existing land use pattern and relative location of protected areas

The entire block area is divided into following land use types,

- Mines
- Habitation
- Water bodies
- Mudflats
- Mangrove forest

4.6 Existing infrastructure/ industries

The block area is located in Kutch district and well equipped with existing infrastructure like roads, rail lines, water supply, power supply, sewerage facility, telecommunication facilities, hospitals, schools etc.

4.6 Soil classification

The soils found in Kutch district can broadly be grouped into four types, i.e., Shallow Black soils, Residual Sandy soils, Coastal Alluvial soils and Desert soils. The Coastal Alluvial soils are found all along the southern coast. These soils are sandy clay loam to clay in texture. The soil reaction varies with situation ranging from neutral to highly alkaline. These soils are normally medium in fertility. At places, these soils are saline in nature.

4.7 Climate data from secondary sources

Table 6: Climatological Summary at IMD Bhuj (1971 – 2000)

Month	Daily mean Temp. (0C)		Relative Humidity (%)		Rainfall (mm)		Cloud cover (in Oktas)		Mean Wind Speed (km/h)	Predominant Wind Direction	Calm (%)	
	Max	Min	8:30	17:30	Monthly Total	No. of Rainy days	8:30	17:30			8:30	17:30
January	27.4	8.4	74	30	2.0	0.3	1.3	1.3	6.1	SW	75	8
February	30.1	11.4	70	26	0.6	0.1	1.4	1.5	6.9	SW	71	9
March	35.4	17.0	67	26	1.2	0.2	1.6	1.7	8.0	E	54	8
April	39.2	21.9	66	26	0.2	0.1	1.5	1.7	11.0	E	16	4
May	39.7	25.2	70	36	2.6	0.4	1.5	0.9	15.6	E	3	1
June	37.9	27.2	73	50	34.7	1.4	4.2	3.7	17.2	NE	3	2
July	34.3	26.4	80	63	104.6	4.4	5.9	6.0	16.7	ENE	4	2
August	33.0	25.3	82	64	74.4	3.5	5.9	6.0	14.6	ENE	5	1
September	34.9	23.9	80	52	43.5	2.3	3.3	3.9	10.8	EN	17	4
October	36.8	20.7	71	33	8.1	0.7	1.3	2.0	6.5	ES	60	15
November	32.9	14.7	69	30	4.3	0.5	1.2	1.3	5.6	SW	82	15
December	28.8	9.6	71	31	0.2	0.0	1.4	1.5	5.8	SW	83	10
Annual or Mean	34.2	19.3	73	39	276.4	13.6	2.5	2.6	10.4	SW	40	7

4.7.1 Wind

Monthly average wind distribution ranged from 5.6 km/hour in November to 17.2km/hr in June. The Average Predominant wind directions were mostly from NE to SW

4.7.2 Storms and Cyclones

The rainfall pattern in Indian coast is governed by the cyclones and its intensity. The interpretation of the data points out that number of cyclones hitting Kachchh district has increased in period 1990 to 2010 and a total of 10 cyclones were reported during this span of 20 years. Prior to 1990s, the maximum number of cyclones recorded within a span of two decades was only 5. The years of heavy rainfall is closely associated with cyclones during that year.

4.7.3 Rainfall

The rainfall data from period of 1932 to 2010, the average rainfall has been increased. For the entire period of 78 years (1932 to 2010) 50% of the years had period of drought of different intensities and around 30% of the year were with excessive rainfall. The scenario is typical to that of arid climate of Kutch, but in the last decades (2000-2010) the rainfall has increased and the drought years have come down. The annual average rainfall in the area during the period of 1971 to 2000 is about 273.2 mm with considerable variations from year to year.

4.7.4 Temperature and humidity

The Kutch region receives an average rainfall of around 14 inch every year. Compared to the other two seasons, the winter season in Kutch is pleasant. It starts from the month of October and lasts till January with average temperature ranging from 12°Celsius to 25°Celsius. Since the state has a long coastal belt, the winter is not very cold.

4.7.5. Water quality

The suspended solids (SS) are highly variable, spatially and largely resulted from the dispersion of fine sediment from the bed and the intertidal mudflats due to tidal movements. Obviously, near shore shallow region, invariably sustain higher suspended solids as compared to the central zones.

The region between Okha and Sikka has high variable suspended solids (4-308 mg/L). The pH range of the Gulf water is remarkably constant (8.0-8.3) though wide variations (7.6-8.8) are not iced sometimes. The average DO is fairly high (35 mg/L) most of the times and the BOD is low (<0.1-6.3 mg/L) indicating good oxidizing conditions. The nutrients (PO43–-P, NO3-N, NO2-N, NH4+-N) are more or less uniformly distributed in the Okha-Sikka-Mundra segment and their concentrations indicate healthy natural waters.

5. Planning Brief

5.1 Planning concept

The project is a green field oil and gas exploration and appraisal, spread over in GK-ONHP-2017/1 Block of area 2690 km2 in Kutch district of Gujarat.

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 well within the block will not be taken completely for drilling of the wells. An area of about 300m X 300m would be taken on temporary short-term lease basis for the construction of well pad, drill site etc.

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 employee at drilling wells is about 100. Temporary road facility 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 major 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, which will be dismantled after drilling of the wells.

7. Rehabilitation and resettlement (R&R) Plan

For exploration and appraisal activities, the project does not envisage any Resettlement & rehabilitation of the project, since the land requirement would be very less and on 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 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 GK-ONHP-2017/1 Block in next 10-12 years.

The estimated cost of the project is given below:

3) Physical Surveys Cost estimated to be approximately INR 5.12 Crore.
4) Average Cost per well for exploratory & appraisal well drilling is estimated to be INR 18 Crore.

9. Analysis of Proposals (Final Recommendations)

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 including ancillary development and supporting infrastructure.