WE FUEL AMAZING

NATIONAL SEMINAR ON CO-PROCESSING

16th Oct 2014 at **ITC GRAND CHOLA, CHENNAI**

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Contents

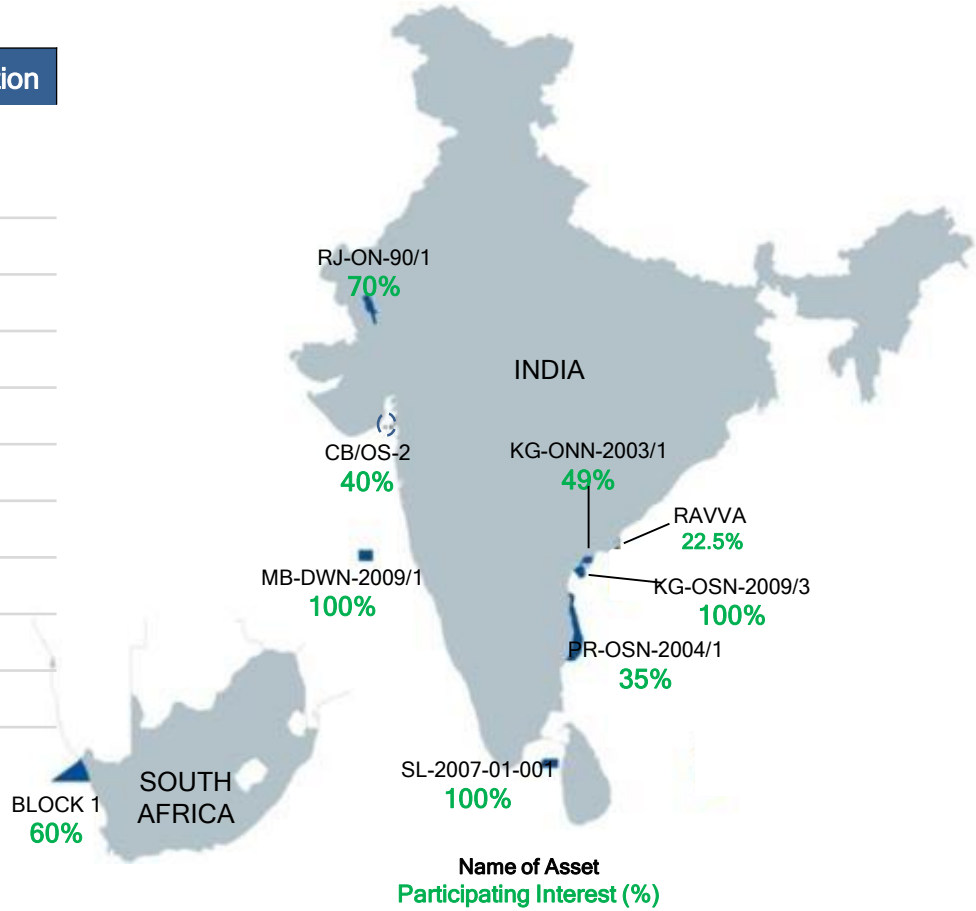
About Cairn India

- Asset portfolio, net acreage in > 42,000 km^2, ~ size of Switzerland
- Successful track record across Exploration, Development and Production cycle

Assets Across the Life-Cycle of a Field

Asset	Basin	Exploration	Development	Production
Domestic Assets				
RJ-ON-90/1	Barmer	✓	✓	✓
CB/OS-2	Cambay		✓	✓
KG-ONN-2003/1	KG Onshore	✓		
KG-OSN-2009/3	KG Offshore	✓		
Ravva	KG Offshore	✓	✓	✓
MB-DWN-2009/1	Mumbai Offshore	✓		
PR-OSN-2004/1	Palar - Pennar	✓		
International Assets				
SL-2007-01-001	Mannar	✓		
Block 1	Orange	✓		

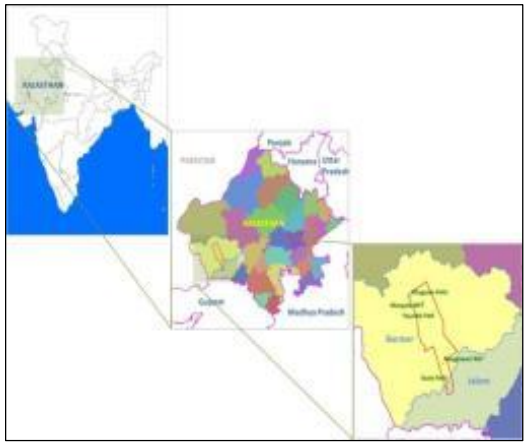
Asset Locations & Share of Production

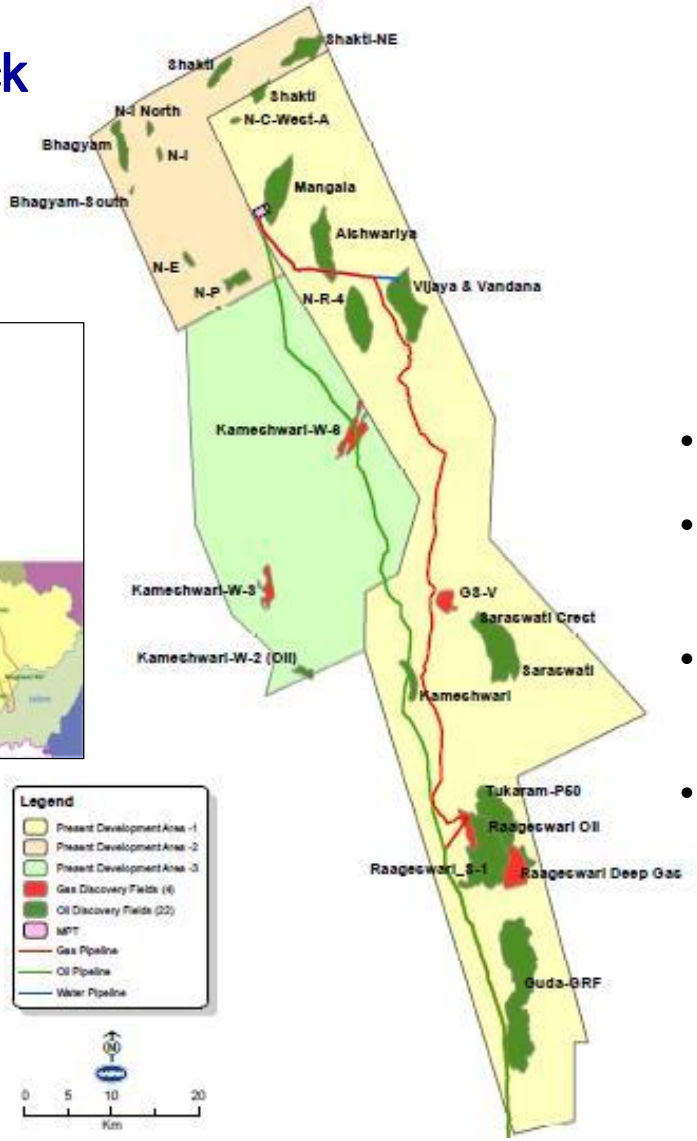


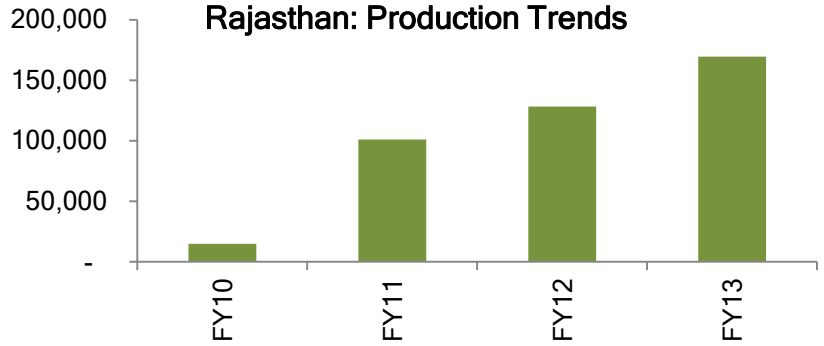
Note: Percentages represent Working Interest

About Cairn India

Rajasthan Block







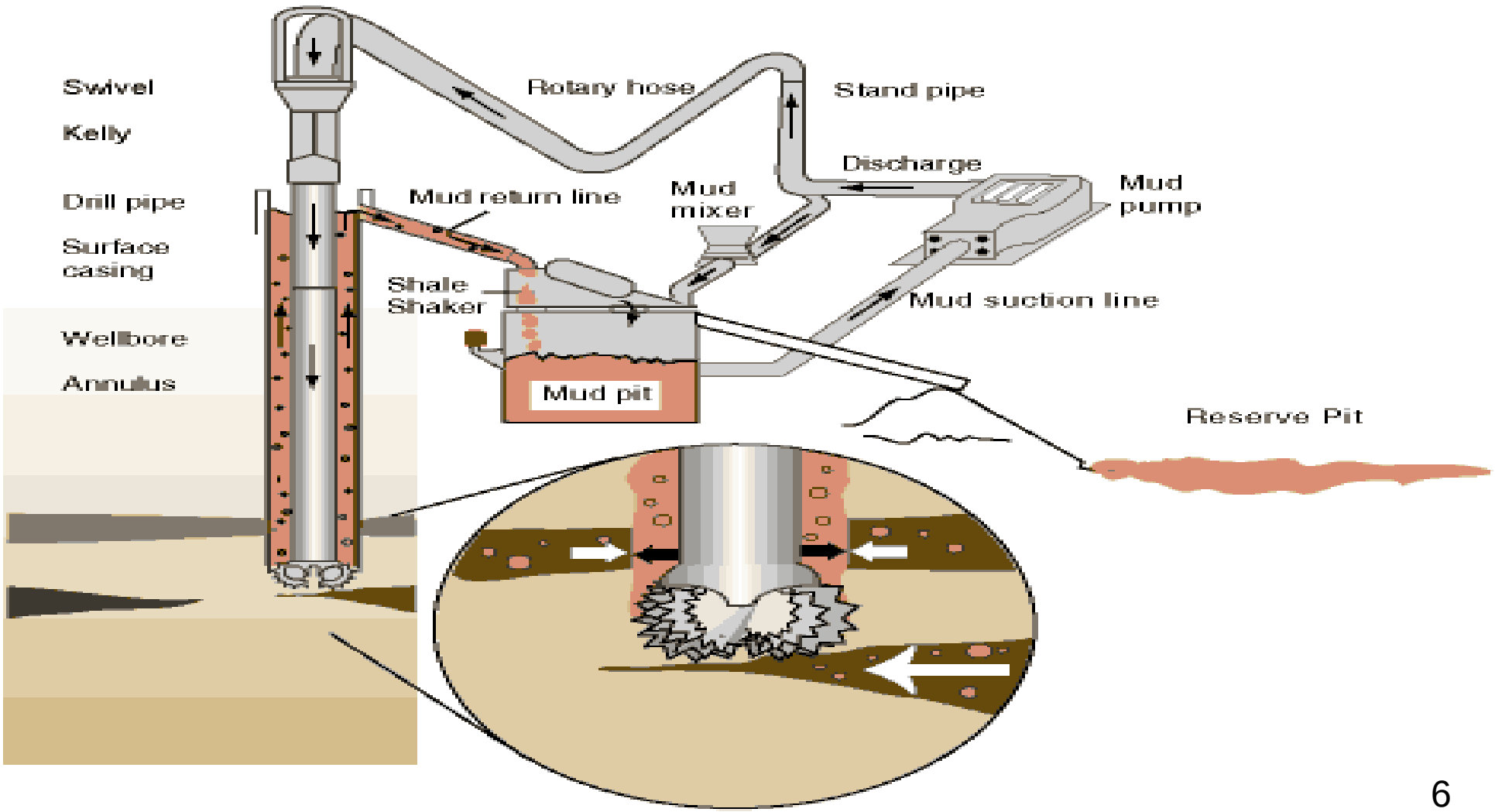
- Total area of the block is 3111 Km^2
- Spread across Barmer (94%) district and Jalore district (6%) area
- Marginal / low marginal hydro carbon fields spread across the block
- Till date around 300+ exploration & production wells have been drilled and same number of wells proposed to be drilled in next 3 to 5 years period.

About Drilling Process

Drilling Fluids

- Drilling fluids are used to control sub surface pressure, cool & lubricate the drilling bit, prevent the collapse of well bore, transport the drill cuttings to the surface and much more.
- Drill cuttings are mainly classified as water based and oil based.
- Water based drilling fluids are used in the initial geological formation and latter shifted to the synthetic oily based to overcome hard strata geological formation drilling.
- The main constituents in the synthetic oil based drilling fluids (also called as mud) are Barite, sodium formate, lime, calcium, mineral oils, polymers etc.
- The synthetic oil based drilling fluid received back along with the drill cuttings are washed in the shale shaker and recycled (never disposed). Where as only the drill cuttings (after washed) are disposed in the HDPE lined pit for further management.

About Drilling Process



Drill cuttings disposal practices

- At Rajasthan Block, around 80,000 MT is presently stored at the exclusive captive hazardous waste secured landfill
- For every 1000m drilling of hydro carbon well, around 200 MT of synthetic based mud drill cuttings is generated.
- This current year around 100 wells will be drilled, thus in addition to the existing quantity further 20,000 MT shall be generated.

Type of drilling waste	Present disposal method
Water based mud drill cuttings	• Initially segregated and stored in the HDPE liner pit at the generation site. • Latter used for the well pad sub grade construction as supplementary material based on the recent CPCB permission (otherwise usually disposed to the captive secured hazardous waste landfill site)
Synthetic oil based mud drill cuttings	• Initially segregated and stored in the HDPE liner pit at the generation site • Later after drying disposed to the captive hazardous waste secured landfill.

Drill cuttings disposal practices

SBMDC disposed from Shale shaker directly to Concrete pit

Dried SBMDC stored in the Concrete pit

Captive Hazardous waste (double composite liner) landfill

Landfill image taken after capping

Properties of Synthetic oil based mud drill cuttings (SBMDC)

Composition of SBMDC (during trial burn study)

S. No	Parameters	Concentration
Proximate Analysis		
1	Moisture Content	5.92 %
2	Ash Content	83.77%
3	Volatile Matter	10.28 %
4	Fixed Carbon	0.03 %
Ultimate Analysis		
1	Carbon	3.59 %
2	Hydrogen	1.1 %
3	Nitrogen	0.31 %
4	Sulphur	0.83 %
5	Mineral Matter	89.04 %
6	Oxygen	5.13 %
7	Gross Calorific Value	~ 1000 kcal/kg
VOCs in waste		
1	VOCs	BDL (µg/kg)
SVOCs, TPH & TOC in waste		
1	SVOCs	BDL
2	Total Petroleum Hydrocarbon	BDL
3	Total Organic Carbon	22.0%

S. No	Parameters	Concentration (mg/kg)
Heavy Metal Content in waste		
1	Cadmium as Cd	<0.1
2	Chromium as Cr	46.1
3	Copper as Cu	26.6
4	Cobalt as Co	2.7
5	Manganese as Mn	36.7
6	Nickel as Ni	304.1
7	Lead as Pb	4.7
8	Zinc as Zn	93.1
9	Arsenic as As	<0.1
10	Mercury as Hg	<0.1
11	Antimony as Sb	<0.1
12	Vanadium as V	2.4
13	Thalium as Tl	<0.1
14	Tin as Sn	<0.1
15	Iron as Fe (%)	4.04%
16	Selenium as Se	<0.1

Silica is ~ 60% by mass

Note: BDL – Below Detectable Limit

Proposed drill cutting disposal practice

- ACC unit at Lakheri, Rajasthan carried out Cairn SBM drill cutting material towards the co-processing trial burn study between 17th to 21st September 2013.
- The result of the trial study was encouraging and did not envisage any adverse impact to the environment and/or quality of the cement.
- Based on the trial result, permission for the regular co-processing was obtained from CPCB in February 2014 .
- The study conducted by NCCBM also suggested the suitability of the drill cutting material towards cement manufacturing.

Challenges towards co-processing

- As evident, the drill cutting consists of high silica content and also minerals essential for the cement manufacturing with calorific value around 1000 Kcal/KG .
- Thus drill cutting will be more suitable as an alternate raw material for the cement manufacturing).
- It is extremely useful for Cement Companies surrounding states such as Gujarat, Chhattisgarh etc. who utilizes high grade Limestone.
- Now the distance plays a major role between generator (Cairn India) and the consumer (rich lime stone located cement industry). This long roadway distance of the drill cutting transportation will make the initiative unsustainable .
- If transportation permitted through railway (wagons), then the sustainable usage of material is viable.
- The initiative taken by CIL is also very important in not only converting a Hazardous Waste (HW) to Resource but also minimizing the HW load on Land and liability of managing these HW sites.

Challenges towards co-processing

Advantages due to transportation of the drill cuttings through railways

Drill cuttings are similar to any fine sand with having around <10% moisture content and does not have any leaching property.

- Through railway wagons (at one stretch of cargo) around 3000 MT of drill cuttings can be transported to the cement industry.
- Low carbon foot print due to the transportation
- Low transportation cost compare to the roadways
- Safe mode of transportation such as free from road accidents and any spillage
- Established tracking movements of the waste and handling (similar to any coal or other mineral ores).
- Importantly railways have agreed and also classified drill cutting materials in consultation with Traffic Transportation Directorate

Concluding Remarks

- Sustainable option of the drill cutting disposal shall be possible only by the means of the railway transportation (considering the drill cutting quantity of generation) permission for the bulk generators and also considering long distance.
- A website shall be exclusively maintained
  - to have information related to the co-processing (regular and trail) permission issued to various waste materials / cement industries.
  - Authorized transporters
  - Any other useful information such as waste material property, monitoring mechanisms etc.






Thanks for Kind Attention

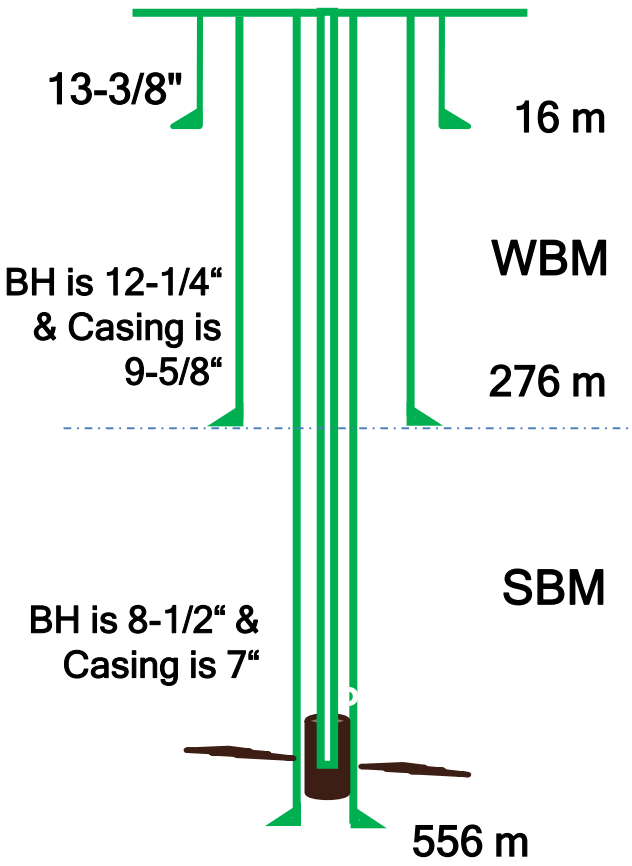


Backup Slides

About Drilling Process

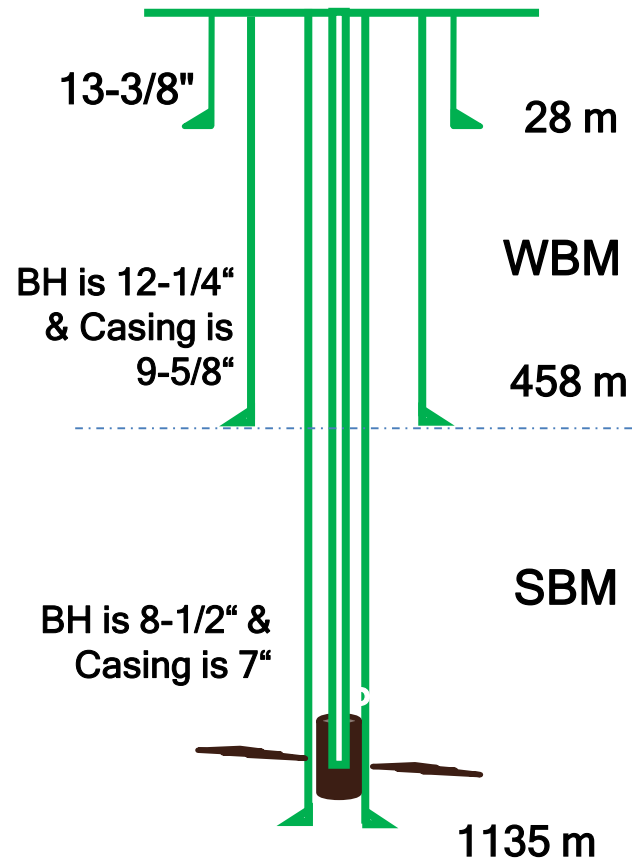
Typical Well Diagram

Shallow Depth



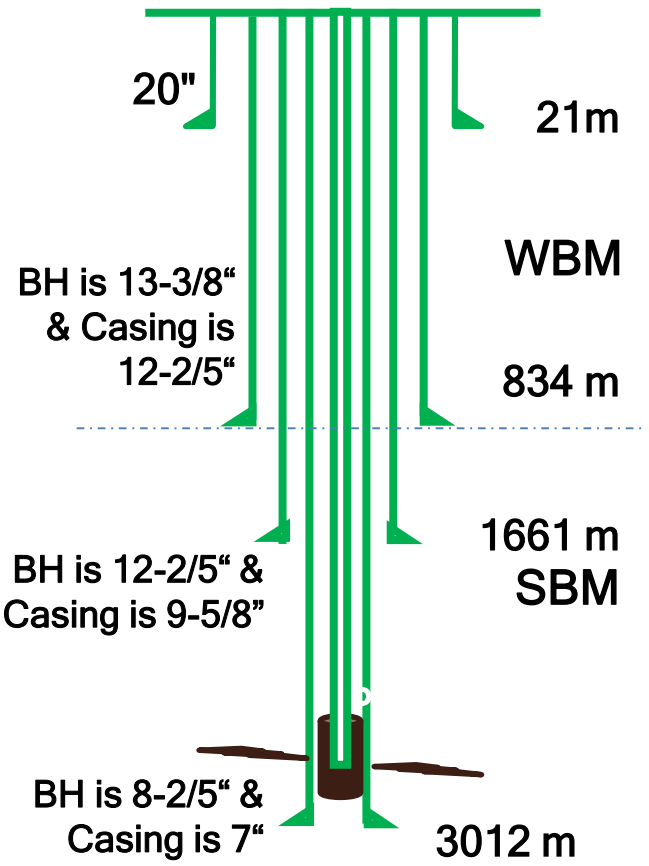
WBMDC = 100 MT & SBMDC = 80MT

Medium Depth



WBMDC = 225 MT & SBMDC = 100MT

Deeper Depth



WBMDC = 600 MT & SBMDC = 300 MT

Note: WBM - Water Based Mud; SBM - Synthetic Oil Based Mud and DC is Drill Cuttings

About Drilling Process

Typical Stratigraphy Details

STRATIGRAPHY (LITHOLOGY & DEPTH)	DRILLING PROBLEMS	PORE PRESSURE, MAX TEMP, FRACTURE GRADIENT, MUD WEIGHT PPG	DIRECTIONAL PLAN	HOLE SECTIONS	PROPOSED COMPLETION DIAGRAM	CASING/ CEMENT OUTLINE	DRILLING FLUIDS	WIRELINE LOGGING / LWD
Recent sediments/ Thumbli	Drill out conductor with low gpm to 80m to avoid wash out. Conduct Wiper trip midway, and back ream as hole condition dictates Fault expected at ~ 575m MDBRT (+/- 31m)	Drill out with 9.4ppg, further increases in mud wt may be required to maintain hole stability. Consult with office before increasing mud weight Maximum expected pore pressure 9.4 ppg Max. expected temperature 49.02°C Expected Frac pressure 15-16 ppg	Drill 12 ¼" section vertical till 155m MDBRT KOP at 155m MDBRT Build @ 3.0°/30m till 279.23 m MDBRT @ Inc. 12.42° & Azi 331.92° Hold Inc. 12.42° & Azi. 331.92° till section TD	13-3/8" Conductor grouted to ~34m MDBRT 12 ¼" Hole to 584m MDBRT (576m TVDBRT) 9 5/8" Casing shoe @ 584m MDBRT		9⅝", N-80, 40 ppf, BTC ~24 m shoe track ~Cement to surface Final cementation and centralization as per CemCADE program LEAD: 12.5 ppg TAIL: 15.8 ppg Pressure test casing to 2,200 psi on bump. Displace cement with SBM to be used next section.	KcliSO4 Polymer WBM MW 9.4 – 9.8 ppg PV – 35+ (avoid). PV - ASLAP YP – 18 - 25 6 RPM - 12 - 16 Gels - 5-10 / 10-20, PH – 8.5 - 9.0 API FL < 3 mls Initial, 5 mls by section TD MBT < 8 KclSO4 – 10 % / 35 ppb PHPA –0.75–1.0 ppb EP Lube - 5 ppb Monitor shaker for cavings. Minimize surface vol. Reduce Rheology / YP before running casing.	Firm: No Logging Contingent: No Logging
Dharvi Dungar / Barmer Hill / Fatehgarh FA1 FA2 FA3 FA4 FA5 FA6 Basement	Fault expected at ~ 1061m MDBRT (+/- 31m) Possibility of encountering sub-seismic faults, losses in Fatehgarh sand.	Maximum expected pore pressure 8.90 ppg Planned Mud Wt. this section 9.8 ppg unless hole condition dictates otherwise. Max. expected temperature 79.57°C Expected Frac pressure 15-16 ppg	Hold Inc. 12.42° & Azi. 331.92° till well TD	8 ½" Hole to 1441m MDBRT (1413m TVDBRT) 7" Casing shoe @ 1441m MDBRT		7", 29 ppf, L-80 1Cr / 13 Cr, Vam Top HC (Top string will have 1Cr casing & bottom will have 13Cr casing). Packer to be set in 13 Cr casing 13Cr from TD to 70m above FA1 sand top. - 24 m shoe track: - Cement to surface Centralization and final Cementation as per CemCADE program Pip-tag at +/- 50m above FA1 sand & Pup joint at one single below pip tag. Lead Slurry: 11.5ppg Tail Slurry: 13.5 ppg (Gas tight) Displace cement with Inhibited Drill Water (Additives as per Mud programme) Pressure test casing to 4,000 psi on bump. If plug doesn't bump, pressure test casing to 2000psi	SBM Coring Fluid - Saraline 185v MW 9.8 ppg OWR 70/30 PV - ASLAP YP 15 - 20 LSRYP 7 - 9 HPHp FL - <3 mls before coring point (@250F / 500 psi) ES Volts > 400 Aw 0.82 – 0.84 XS Lime ~3 ppb LGS % < 5% (adjust for CaCO3) Add 80 ppb graded CaCO3 as per mud programme Initial mud, maintain conc. throughout interval. Fit –6next API mesh screens possible on shakers Reduce YP prior to running csg.	Firm LWD: ARC-ADN Firm Wireline: CMR Plus, Dual OBMI, Spectral GR+DSI, MDT Firm Coring: 38m coring in Upper Fatehgarh from 1112 m to 1148 m. 64 m coring in Lower Fatehgarh from 1270 m to 1334 m. (Exact coring Depth/Length will be decided real time) Contingent Wireline: Basic Suite (Contingent on quality of LWD data)

Properties of Synthetic oil based mud drill cuttings (SBMDC)

Sl NoTests Carried Out		Test Method	Test Results	Low As
1. Loss on ignition		IS:1760:1991	17.85 %bymass	
2. Silica		IS:1760:1991	57.28 %bymass	
3. Iron Oxide		IS:1760:1991	5.54 %bymass	
4. Alumina		IS:1760:1991	11.61 %bymass	
5. Calcium Oxide		IS:1760:1991	2.46 %bymass	
6. Magnesium Oxide		IS:1760:1991	1.46 %bymass	
7. Sulphur trioxide	SO3	IS:1760:1991	0.55 %bymass	
8. Alkalies	Sodium Oxide	NCB STANDARD	0.46 %bymass	
9.	Potassium Oxide		0.56 %bymass	
10.	EquivalentAlkaliNa2O		0.83 %bymass	
11. PhosphorusPentaoxide		IS:12423:1988	0.27 %bymass	
12. Chloride		IS:1760:1991	0.041 %bymass	
13. Proximate Analysis(ADB)	Moisture	IS:1350(PT-1):1984	0.43 %bymass	
14.	Ash Content		86.82 %bymass	
15.	Volatile Matter		14.63 %bymass	
16. Calorific value(ADB)	GrossCalorificValue	IS:1350(PT-2):1984	986 Kcal/kg	
17. Reactive SiO2		IS:3812:2003	16.44 %bymass	
18. Minor/ Heavy Metals	Chromium	ICP	0.006 %bymass	
19.	Manganese		0.077 %bymass	
20.	Zinc		0.003 %bymass	

Note: As analyzed at NCCBM