Approach for CBM Field Development

North Karanpura CBM Block

International Workshop on

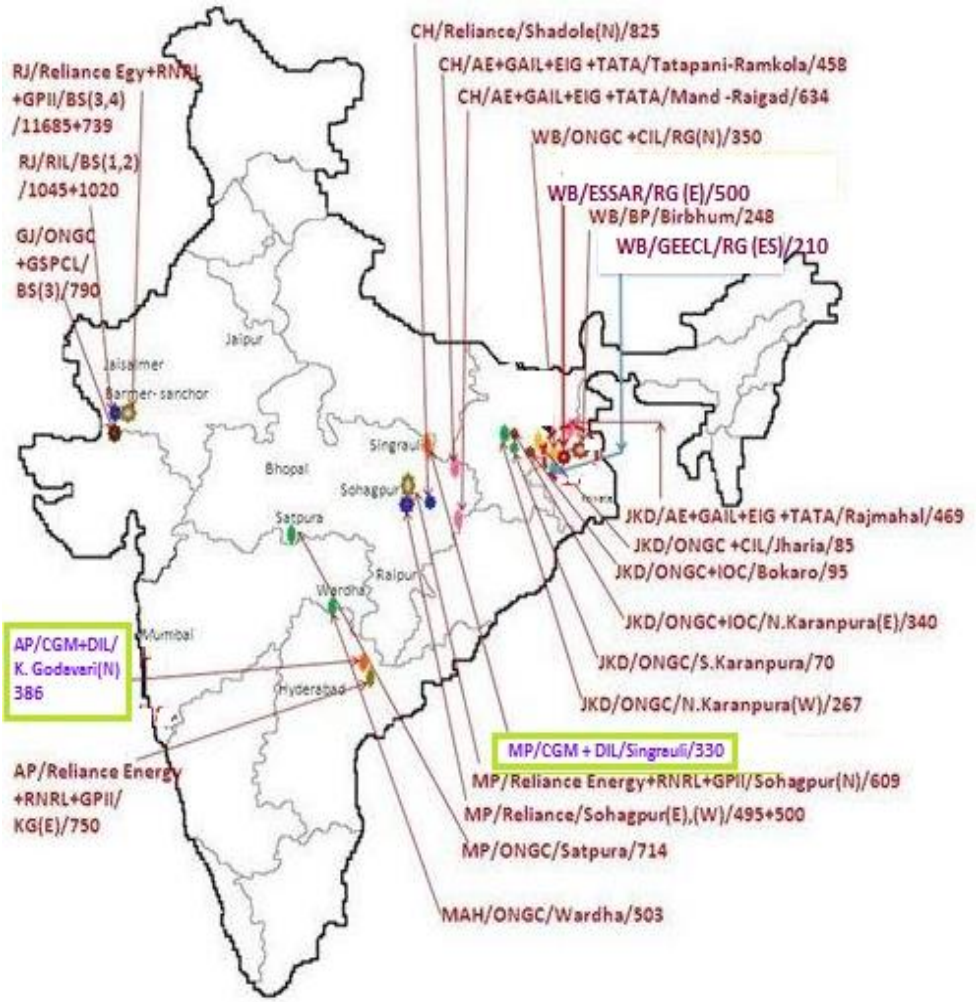
Optimum Utilization of CMM/CBM in India

24th April 2018

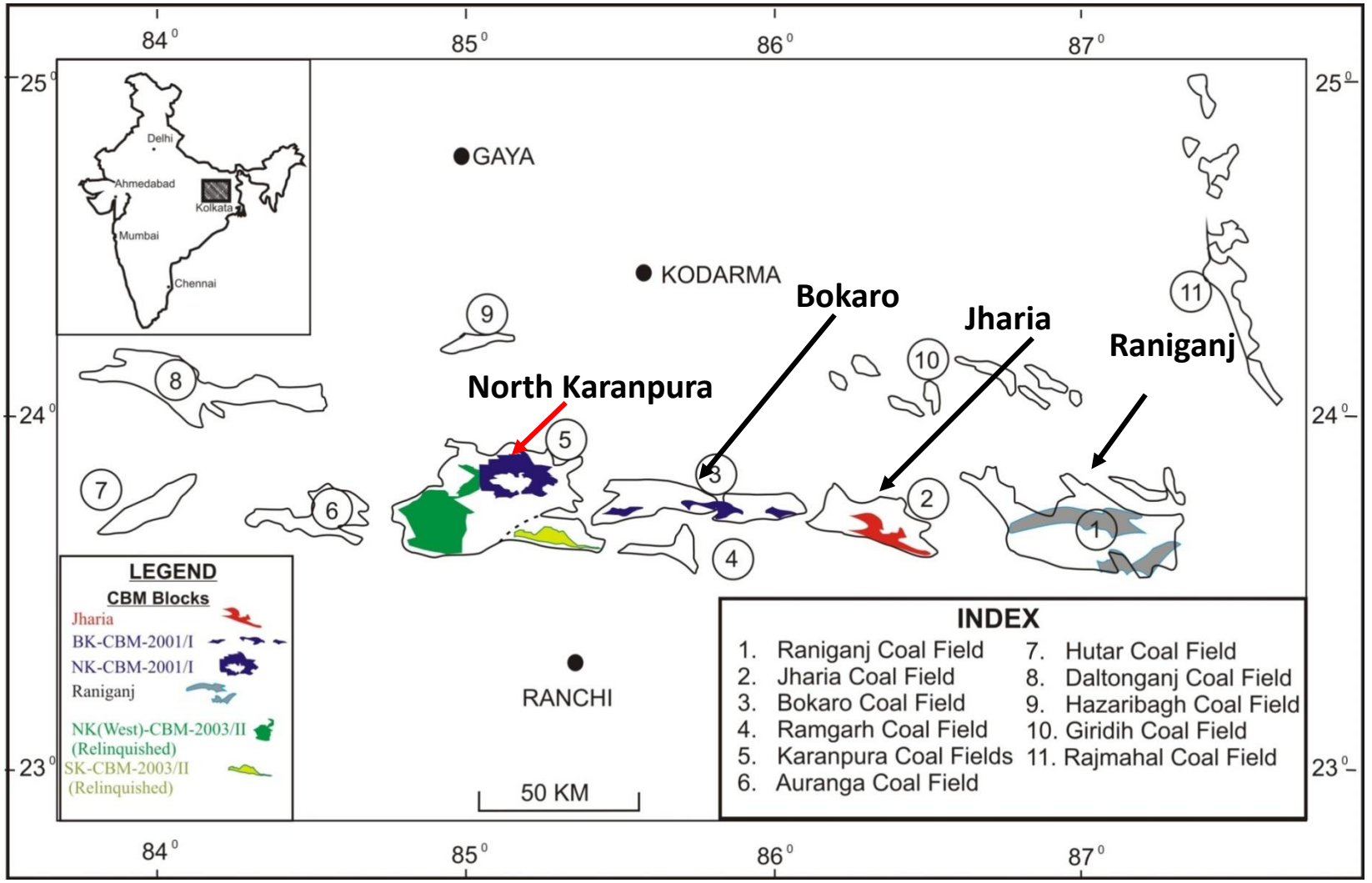
India CBM- Effort So far

- 2001 Onwards , 4 CBM Rounds 33 Blocks (17246 Sq. Km) CBM & 62 TCF Resource potential
- Established 9.9 TCF as GIIP
- Recoverable 3.978 TCF
- Main operators are Reliance Industries, Essar, ONGC, GECL & PEPL

Basin	Resource	Recoverable
Raniganj (E)	2.15	0.993
Bokaro	1.06	0.130
N Karanpura	0.34	0.052
Sohagpur (E)	1.69	0.620
Sohagpur (W)	1.96	0.670
Raniganj (N)	0.26	0.066
Jharia	0.52	0.107
Raniganj (S)	1.92	1.340
	9.9 TCF	3.978 TCF



CBM Producing Blocks : Damodar Valley



CBM Field Development Approach

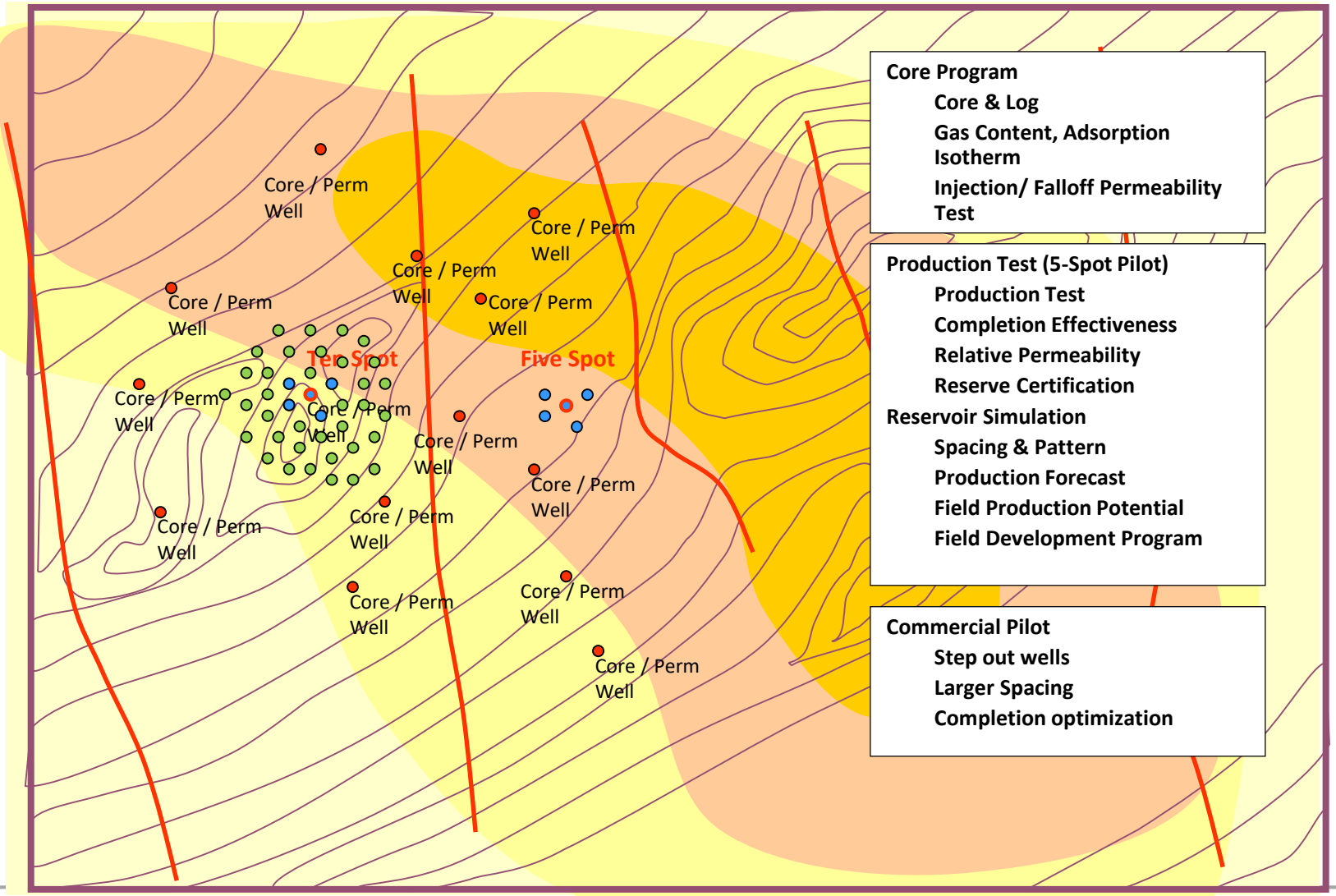
Exploration

- Establish Coal Thickness & Continuity
- Accurately measure Gas content & Saturation
- Get fix on Permeability Variations
- Establish CBM Well Producibility
- Get CBM Reserves Certification for Bankability

Field Development

- CBM Well Drilling
- CBM Well Completion
- CBM Well Spacing
- Surface facilities & Production Operations
- Gas Evacuation & Marketing
- Social, Environmental, Logistical & Regulatory

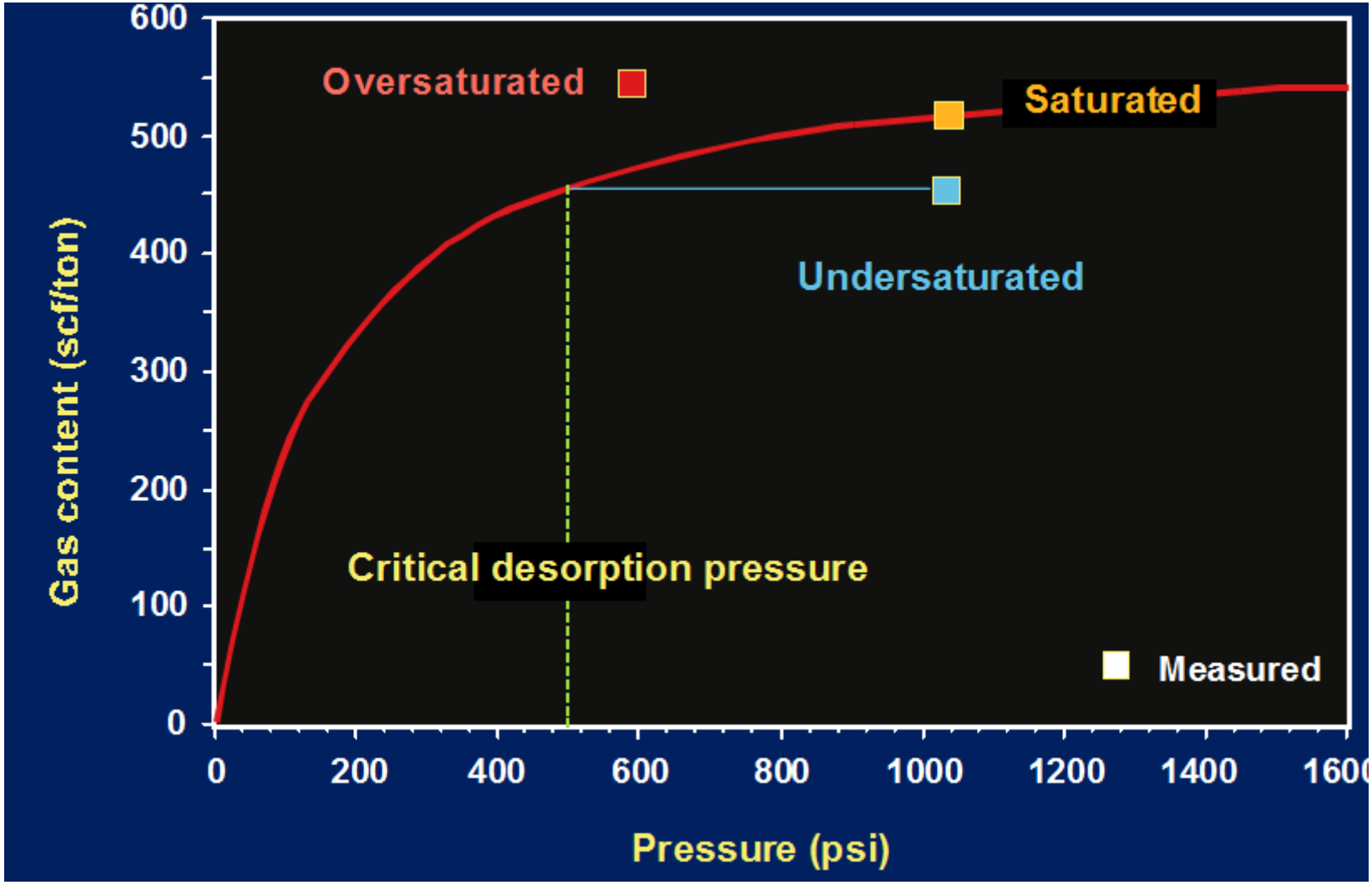
CBM Prospect Evaluation / Field Development Approach



Gas Content Measurements

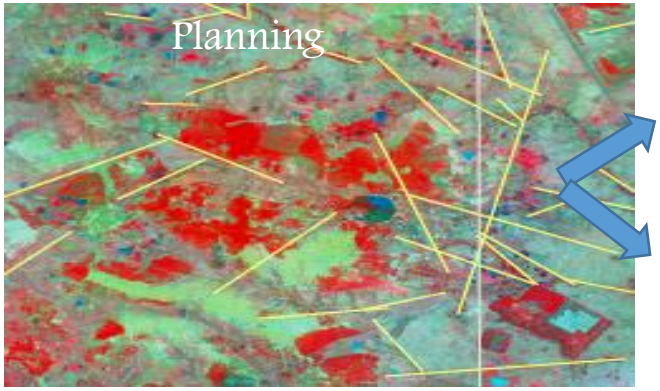
- Major to be precautions taken are:
  - ✓ To minimize the lost gas time.
  - ✓ To record accurate desorbed gas volume and weight of coal samples.
  - ✓ Correction of head-space volume
  - ✓ To ensure zero leakage of gas during the entire period of desorption.
  - ✓ Maintain Reservoir temperature
  - ✓ To determine the residual gas through an industry standard procedure.

Saturation Conditions in Coal Beds

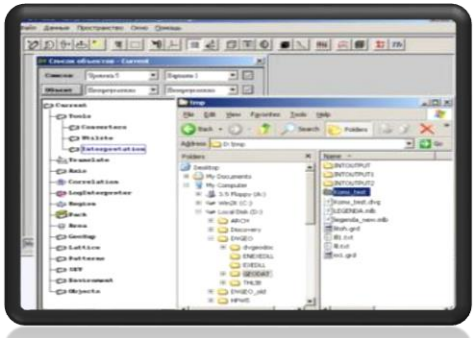


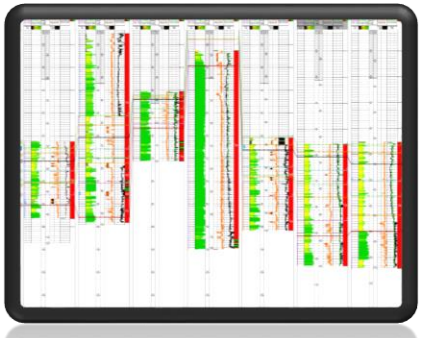
Phased Exploration programme

Data Collection

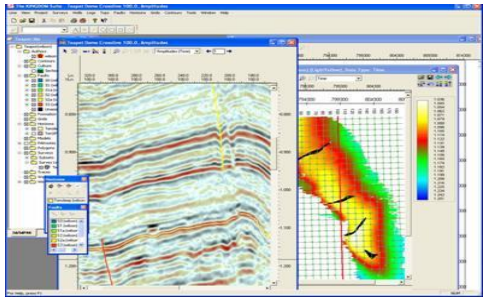


Data Management

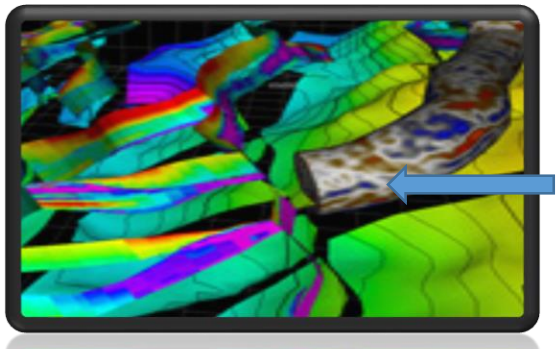




Data Analysis



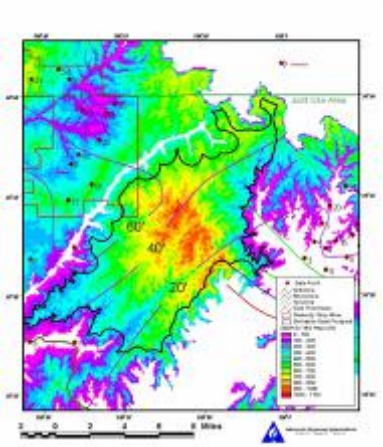
Interpretation



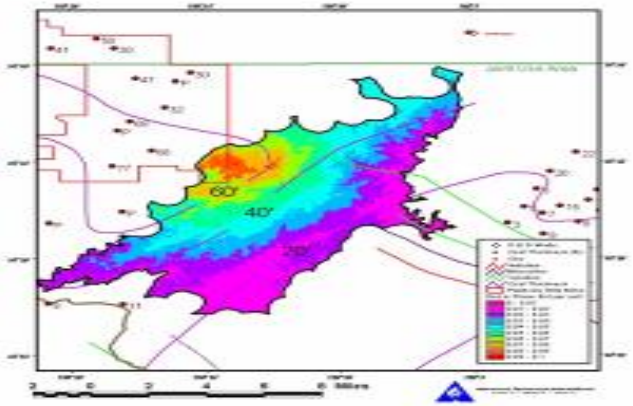
Modeling

CBM Gas-In-Place Analysis

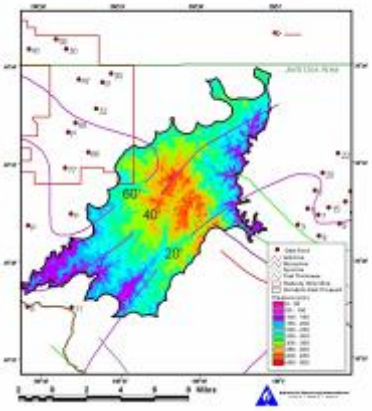
1) DEPTH (< 1000 m)



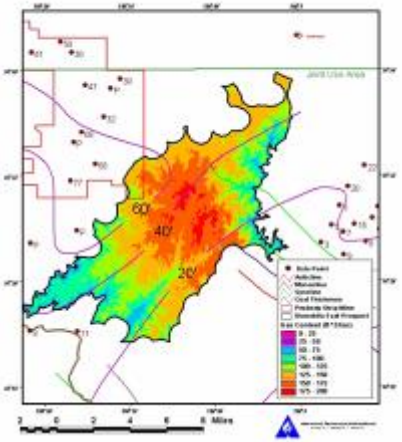
2) Thick Coal (Five Seam)



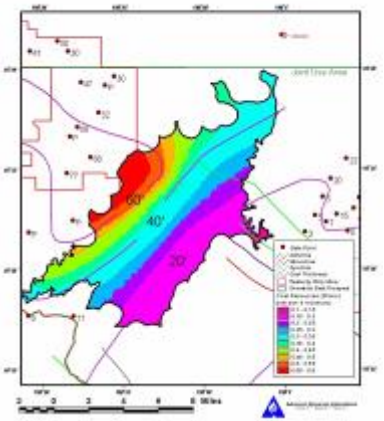
3) RESERVOIR PRESSURE



4) GAS CONTENT (Av 6 m3\t)



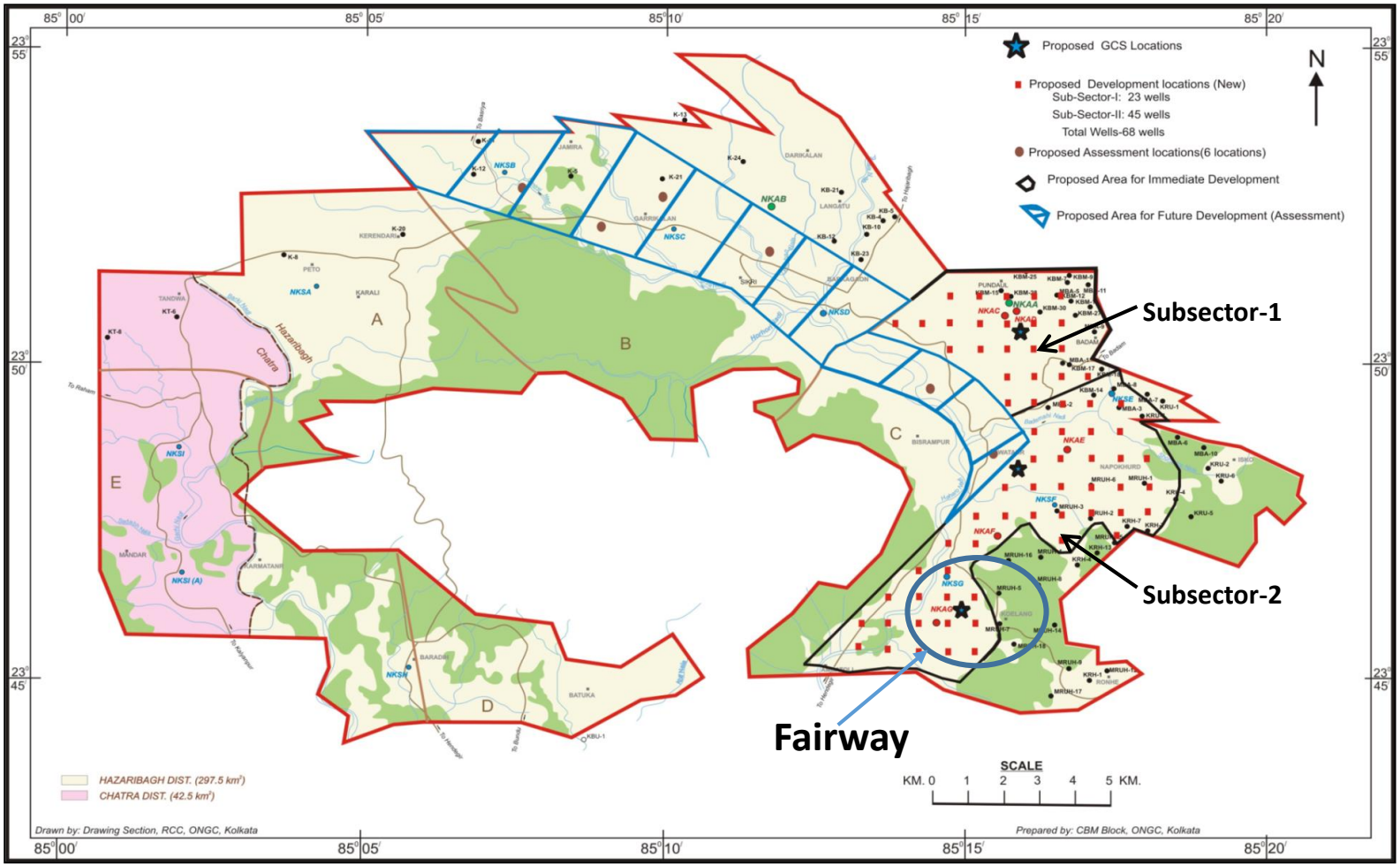
5) GAS IN PLACE



North Karanpura CBM Block Details

Block Name	:	North Karanpura (NK-CBM-2001/I)
Area	:	Original - 340 sq.km.
		Area relinquished – 68.5 sq.km.
		Present – 271.5 sq.km.
Coalfield	:	North Karanpura
State	:	Jharkhand
Award route	:	CBM Round I
Effective Date :		21.02.2003
JV	:	ONGC- PEPL - IOC (55:25:20) (w.e.f. 28.12.2015)
Operator	:	ONGC & PEPL

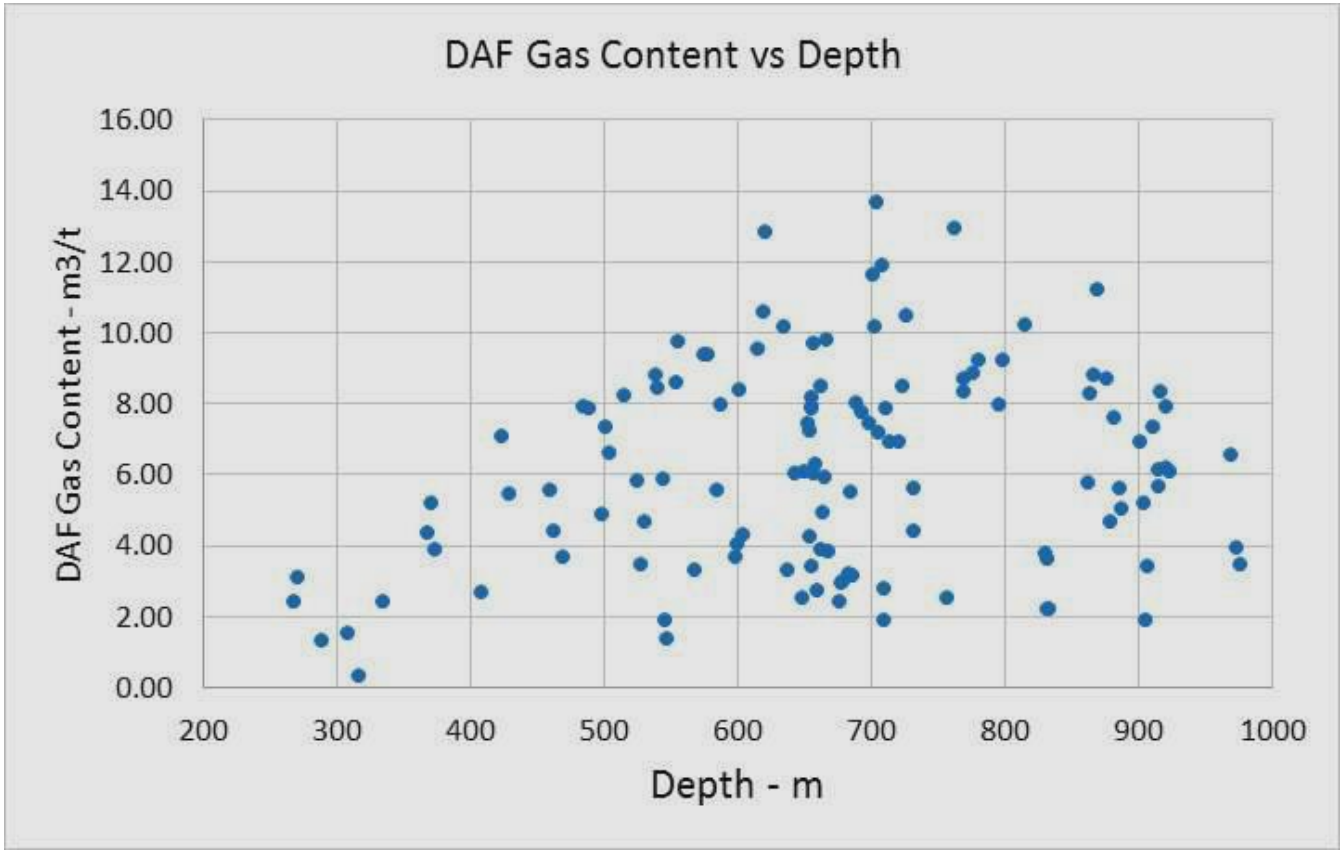
North Karanpura Block Fairway Area



Relatively Simple Geology

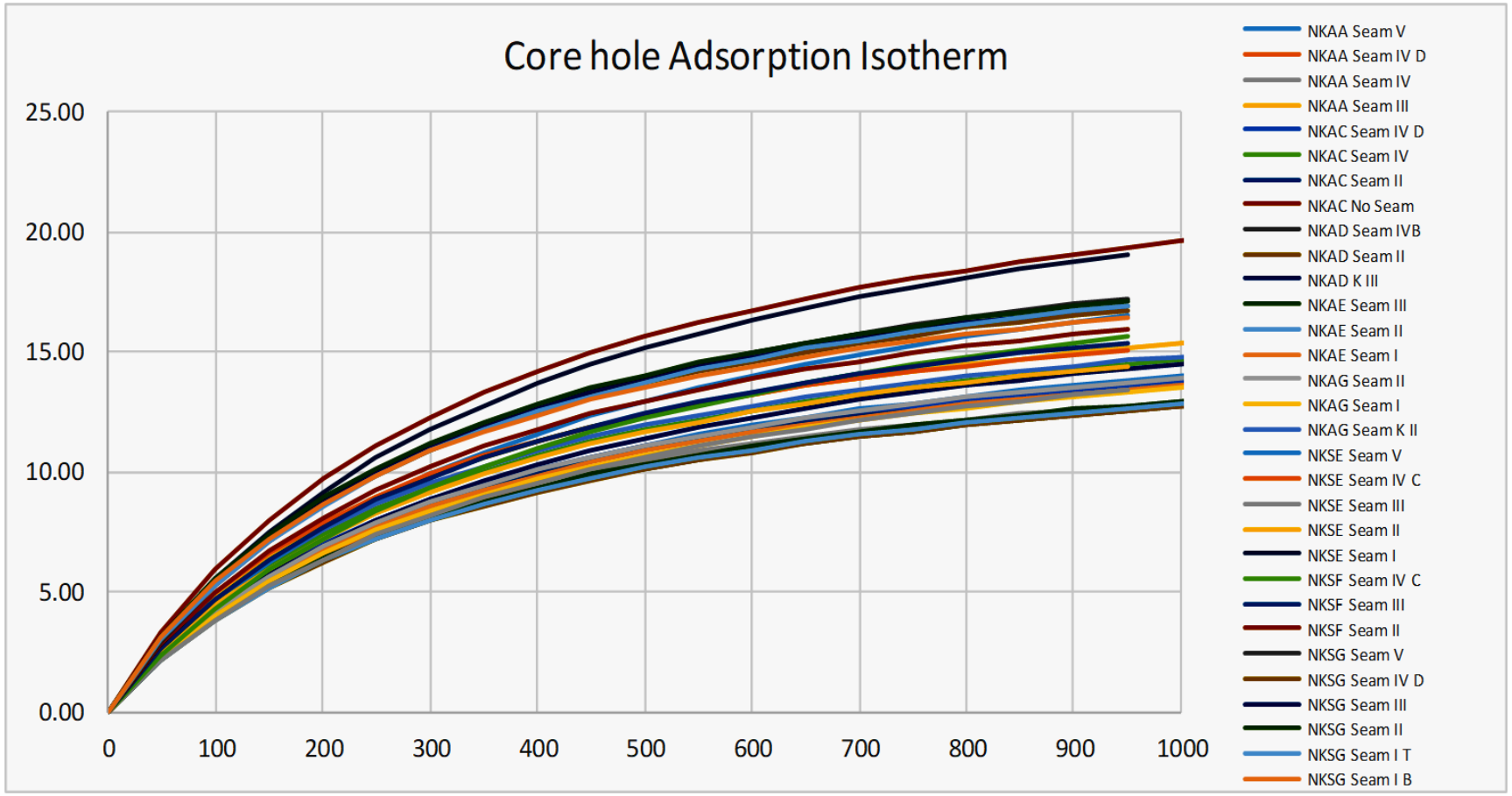
Sparse Distribution – Gas Content

- **Gas Content : Depth Correlation not evident**
- **Coal under saturation**



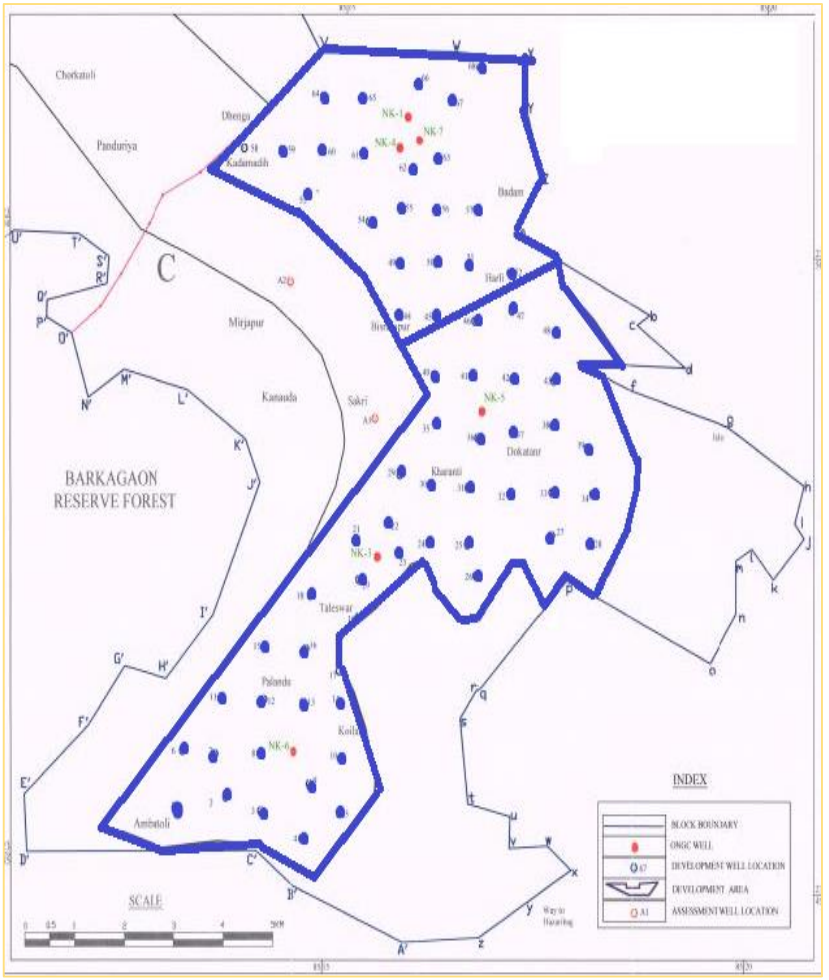
Adsorption Isotherm

A very large variation in the adsorption capacities of coal within the block area



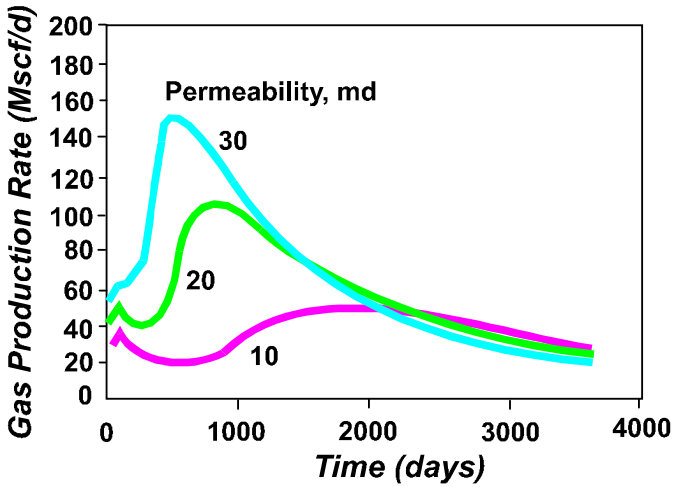
Findings of CBM Exploration Work

- Block Area : ~350 Sq. km.
- Fairway area of about 93 sq. km identified
- Estimated GIP: 0.62 tcf
- Encouraging coal reservoir parameters
  - Coal thickness : 40-100 m
  - Gas content : 8 m3/t (avg.)
  - Expected Permeability : 5-10 md
  - Saturation: Good (<85%)
- Estimated plateau field gas production: 1.0 mmscmd

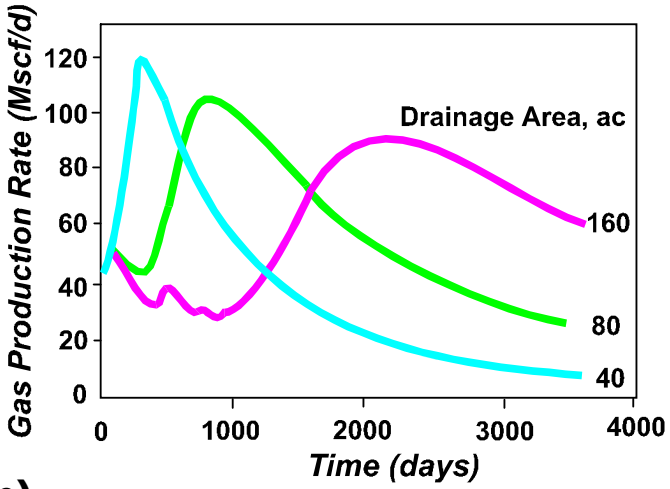


Gas Recovery Factors

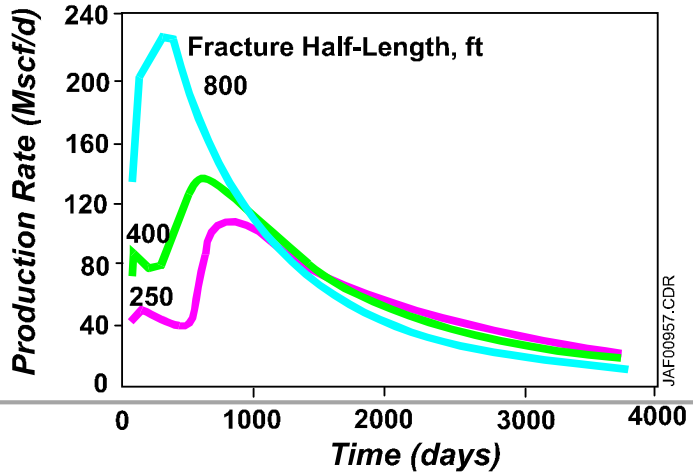
Permeability (10-30 md)



Well Spacing (40 - 160 acre)

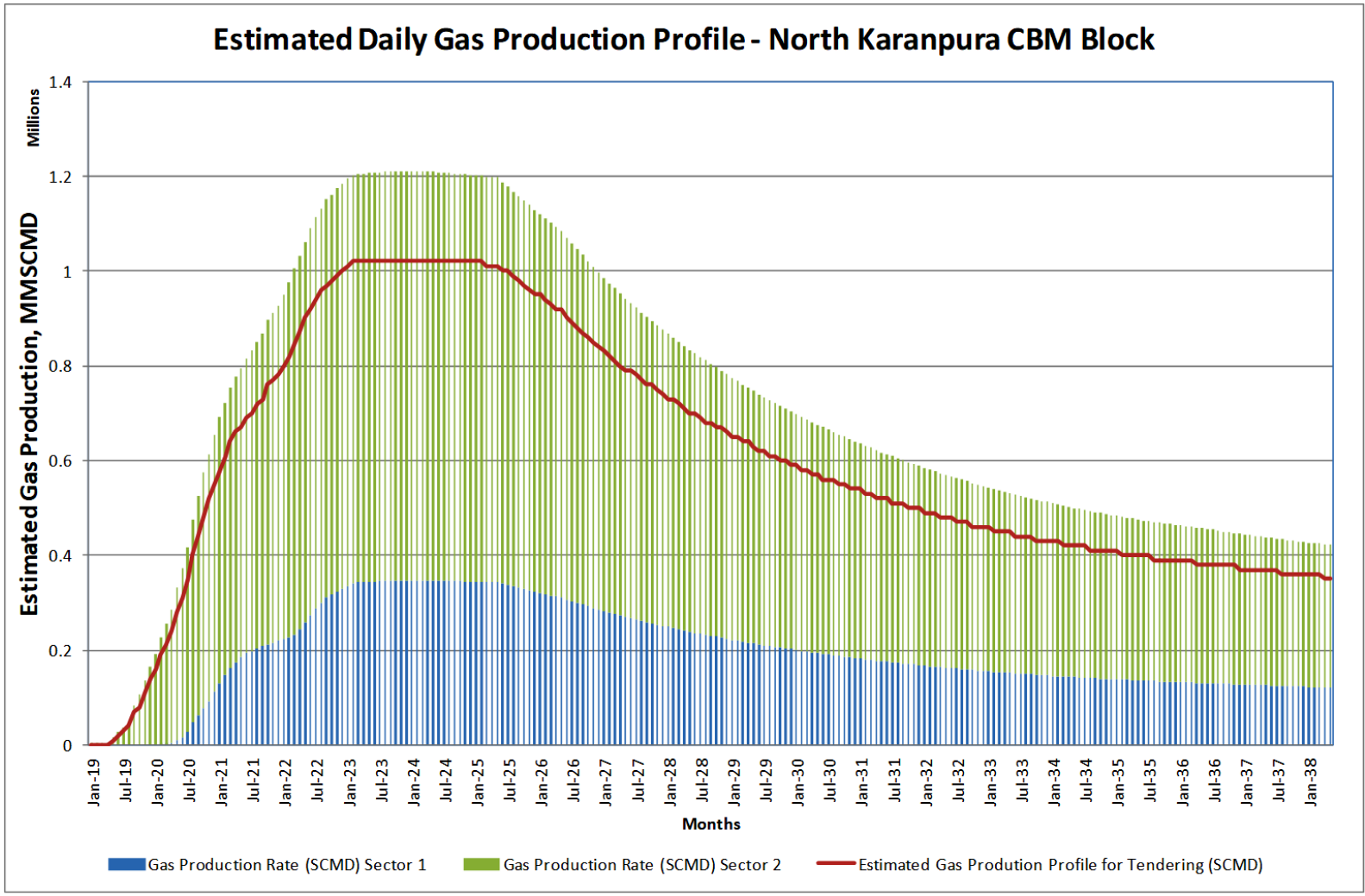


Stimulation (Multiple Seam)



Estimated Gas Production Profile

Estimated Gas production based on reservoir simulation software (Comet)



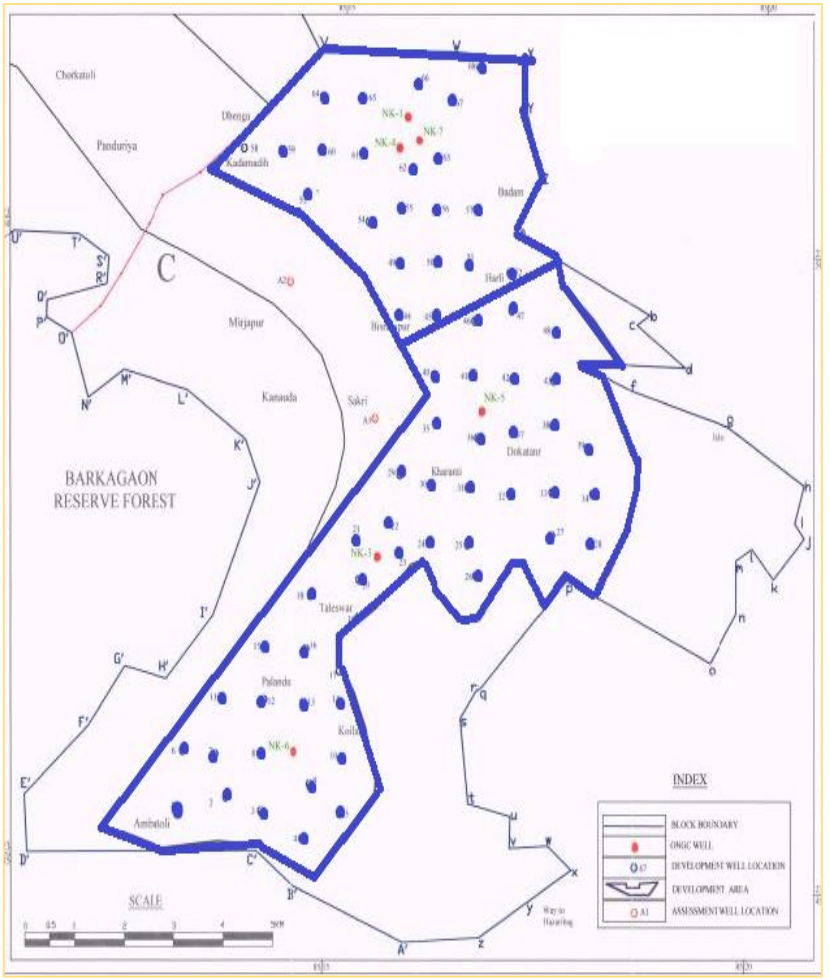
Development Plan – NK CBM Block

Fairway Area

50 sq. km of Sector C (Shallow Coal deposits & inaccessible area excluded)

Work plan

- **68 Development + 6 Assessment wells to be drilled (as per approved FDP)**
- **6 Wells already drilled (In Sector-C during Phase I & II)**
- **41 Wells possible from additional upside potential area**
- **LAQ & ROU for well sites, access roads, surface facilities,**
- **FDP approved wells to be drilled in 2 years by June 2020**
- **2 sets of Surface & Air Drilling Rigs**
- **Well Completion : Cementing, Hydro-fracturing & Dewatering**
- **Production : Dewatering using PC pumps, Build Surface facilities : Gathering, Processing, Compression & Transport**

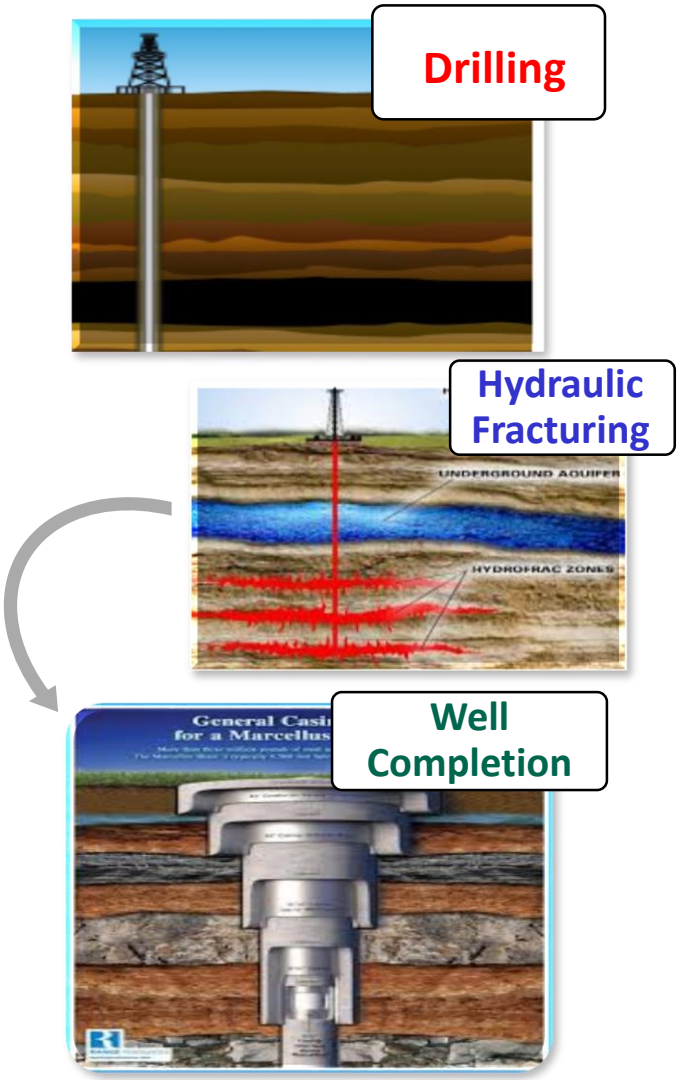


Approach for Development of North Karanpura Block

Drilling & Completions

- An integrated drilling service contract broadly including CBM well drilling, logging, cementing, perforations, hydraulic fracturing & well completion

- Contractor also provides some materials for these operations including casings accessories, drilling fluid, fuel, water, additives and chemicals



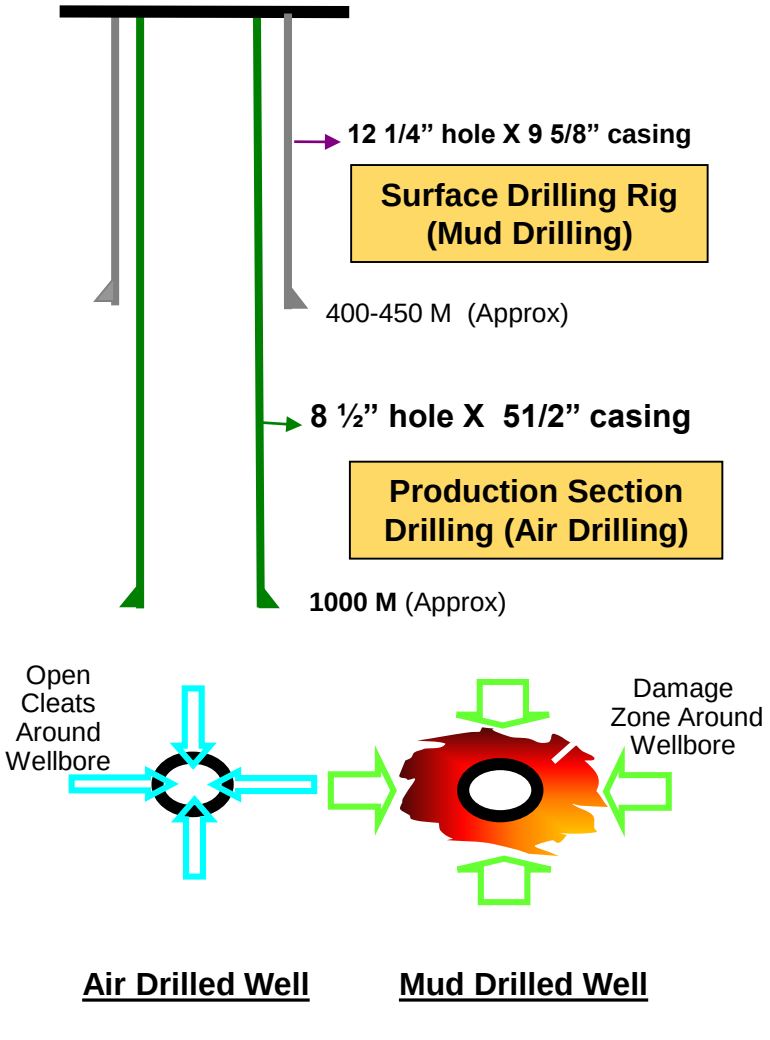
Approach for Development Drilling

Surface Drilling Rig

Air Drilling Rig

- Drilling large number of wells at low cost is a big challenge in CBM.
- Drilling up to surface casing using water well rigs
- Coal section to the target depth to be drilled using Air
- This innovative combination drilling results in:
  - Minimum formation damage
  - Faster penetration rates, Longer bit life and fewer trips

Air Drilling and Water Well Rig combination reduces drilling Costs by over 30%



Block Progress : Drilling & Completion

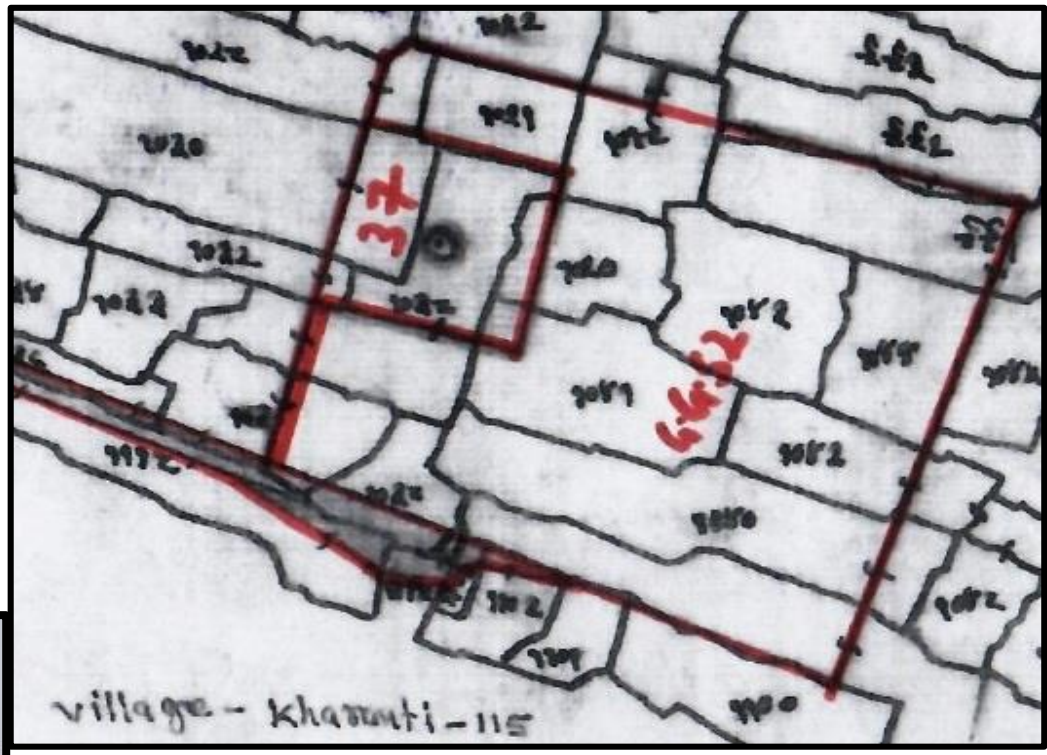
- Development drilling in the block started by spudding first surface well on **7th June 2018.** Drilling of **27 wells** completed till date
- First Production well spudded on **16.11.2018.** Till date **16 wells** drilled and completed
- Hydrofracturing and Coil Tubing Unit along with all accessories mobilized on **7th March 2019**
- Completed Hydrofracturing of three **wells** (NK#8, NK#9 & NK#10) till date.
- Carried out 23 HF jobs in NK#8, NK#9 & NK#10 wells with proppant placement of **~250 MT (Completed coal:51.4 m), 280 MT (Completed coal :51.2m) and 225 MT (Completed coal: 43 m)** respectively.

Coil Tubing Unit

HF Fleet

Land Acquisition – A Challenge

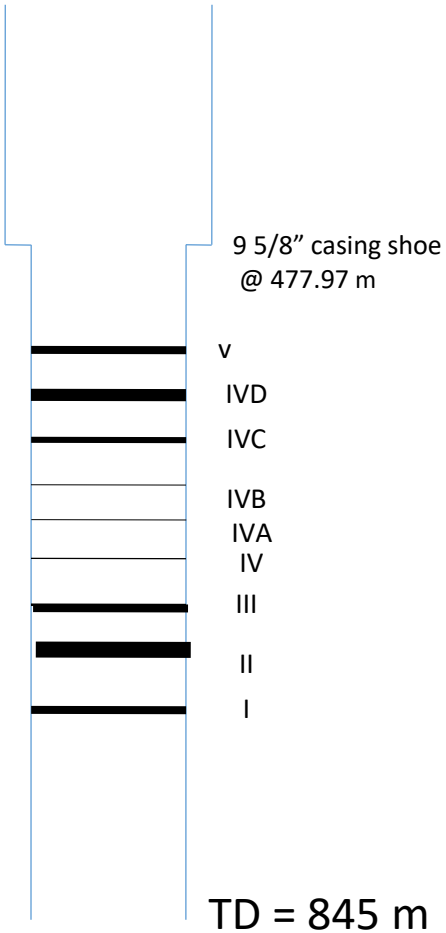
- Middleman
- Fragmented Ownership
- Sentimental Attachment
- High Cost
- Lengthy Process



Fragmented Ownership

Currently acquired 50 wellsites & 2 GGSs on long term lease

Major Coal

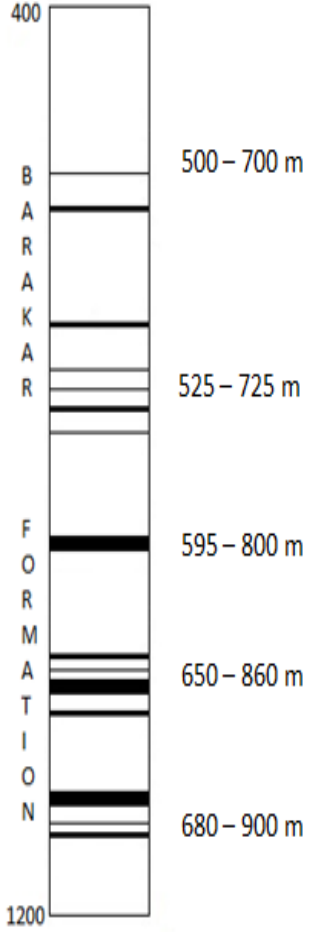


Nine Coal Horizon			
SEAM	Depth		Thickness
	From	To	
v	558.7	552.8	6.8
	561.2	560.3	
IVD	592	587.3	6.7
IVC	602	600	2.8
	604.6	603.8	
IVB	612.5	611.6	0.9
IVA	615.2	613.8	1.4
IV	621.7	617.3	4.4
III	631	630	12.9
	644.2	632.3	
II	711.3	691.8	**19.5**
I	745.8	725.3	**20.5**

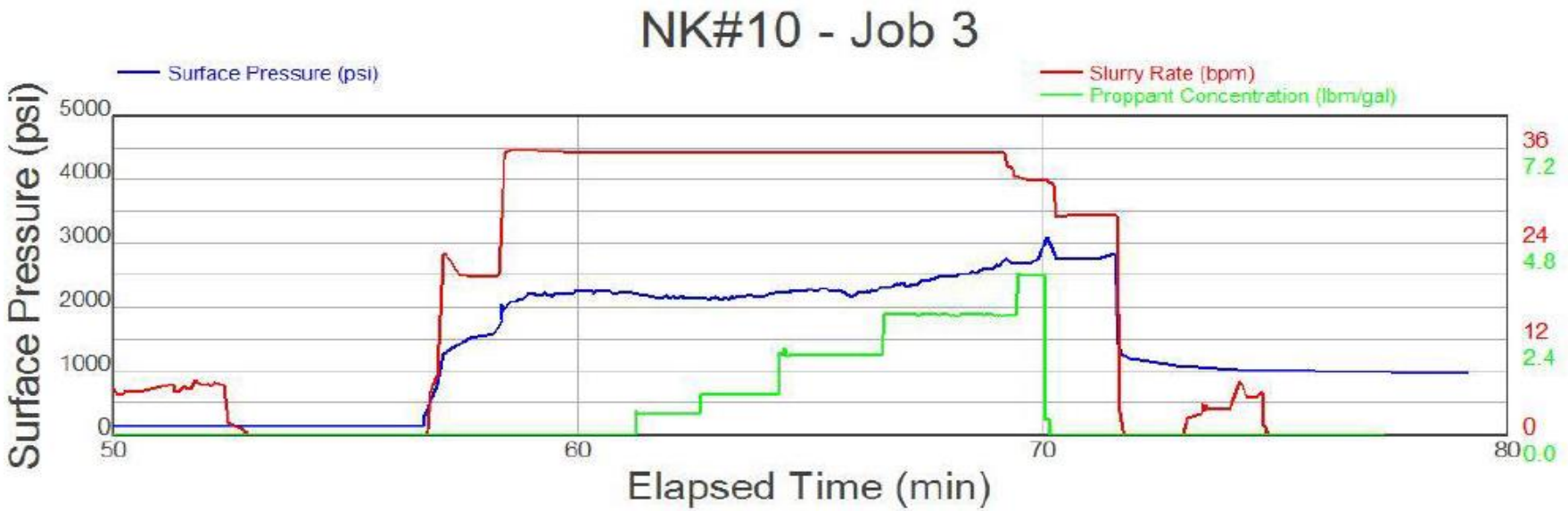
Net Coal 76 M

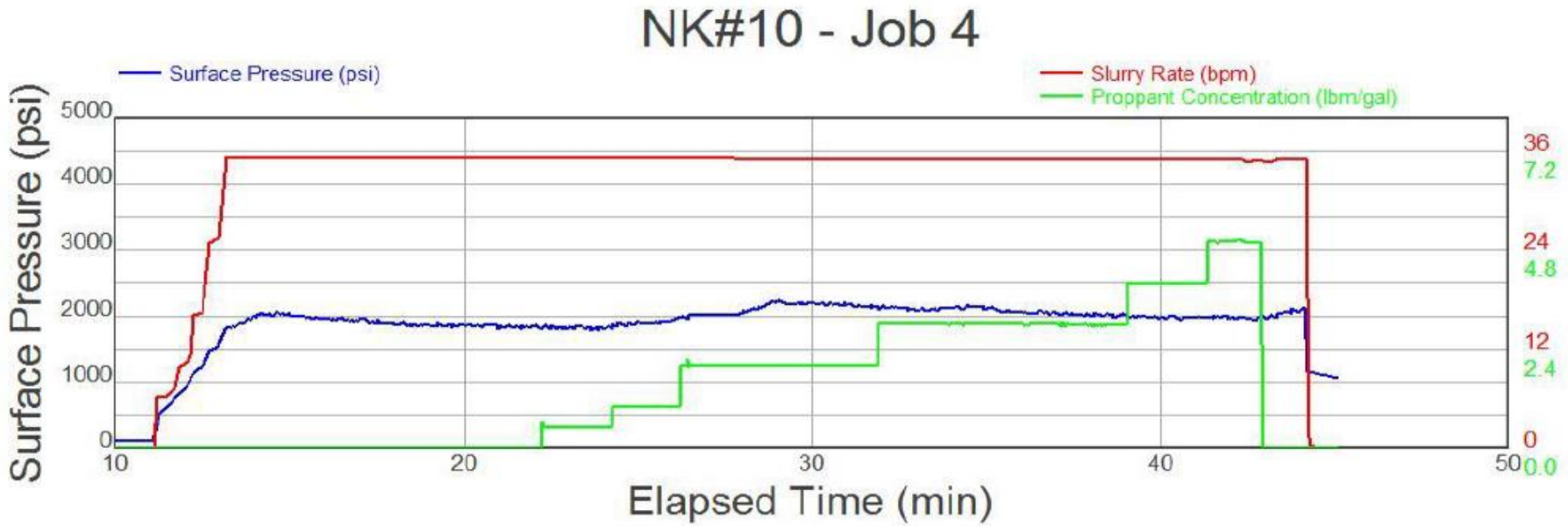
Hydrofracturing

- Over 4,000 lbs. proppant per foot of coal placed resulting in 40 to 80 tons per job.
- Pump rates of 36 bpm & average surface treating pressure of about 1500 psi
- 5 to 7 jobs per well will be performed
- Using CTU equipment reduces the operational constraints, cost and time.
- Coiled Tubing unit is used to carry out perforations using sand jetting technique and eliminate the use of Wire line perforation.



Hydrofracturing Job Details





Dewatering and Producing the CBM Wells

- CBM Well Production Challenges
  - Produced water treatment and disposal
  - Sand flow back
  - Coal fines generation
- Produced Water Quality
  - Elsewhere CBM Projects are not so lucky as water quality is not so good & requires treatment and in-situ disposal.
- PC Pumps operated at right speeds to achieve optimum dewatering
- Dedicated Work Over Rig (s) required at all times for Pump repairs during initial periods.

Social, Environmental & Logistical Challanges

- **Social: Local population dynamics**
  - Effective CSR Programs
- **Environmental: As such CBM operations are easy on environment**
  - CBM reservoirs are normal to sub-hydrostatic & call for low pressure operations
  - Need to re-look at the existing regulations
- **Logistical: Generally all CBM operations occur in the frontier areas**
  - CBM requires drilling of very large number of wells and setting up required surface facilities
  - Extensive logistics needed due to zero or very low infrastructure

Summary - North Karanpura CBM Block

- Good Progress for Field Development per Approved Plan
- Initial Estimate : 22.9 BCM CIIP
- Upside Potential : 25-30% increment possible
- Assessment cum Development wells have recorded good CBM flow
- Appears a good CBM Fairway is under development

Conclusions

- Coalbed methane is a technology play that requires reservoir understanding and appropriate technology for all phases of prospect evaluation and field development.
- Drilling, completing and producing of large no of wells at low cost using innovative techniques always remains a challenge.
- CBM Reservoirs are generally water saturated & require dewatering and gas production takes time to commence.

CBM, therefore is a game of patience and perseverance

Thanks…