



## QGC - Co-existence with coal mining development through application of GRE casing



## Agenda

- Co-development agreement
- QGC's tenement - NDA
- What is GRE ?
- Initial well design – GRE
- Challenges faced & Lessons Learnt
- Drivers for revised well design
- Revised well design
- Industry experience

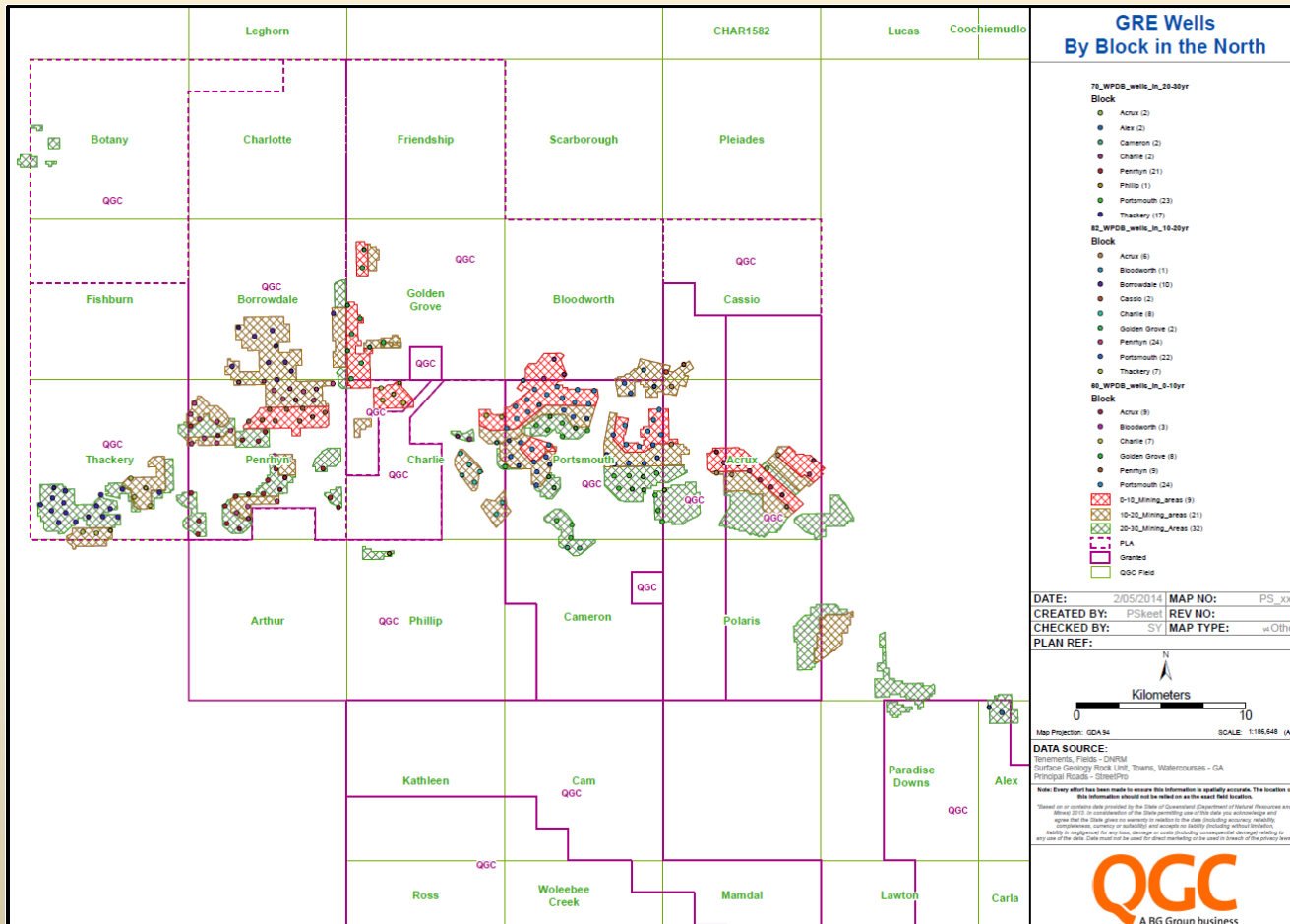


## Co-development agreement

- QGC – Coal mining companies overlapping tenements.
- A clear path to production and governments royalties.
- Current legislative framework for managing overlap
- **Co-Development arrangements (CDAs)** as an opportunity.
- Failure to negotiate CDAs leads to Ministerial Preference Decisions
- As a condition of the CDA, that QGC will install Glass Reinforced Epoxy (GRE) casings inside mining envelopes with no steel below 100m GL.
- Coals above 100m are classified as mineable and presence of steel will jeopardise the mining techniques.



## QGC's tenement – Surat NDA



A total of 212 wells lie within mining areas

- 60 wells within 0-10yr
- 82 wells within 10-20yr
- 70 wells within 20-30yr

NDA- Northern Development area

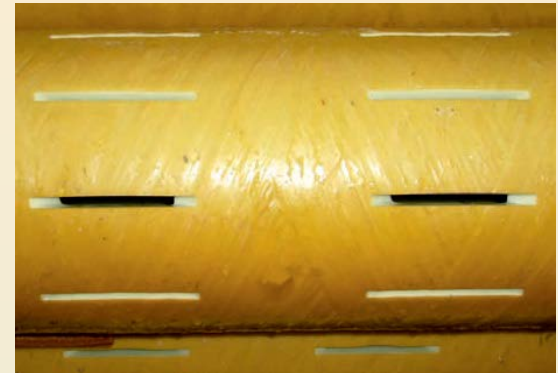
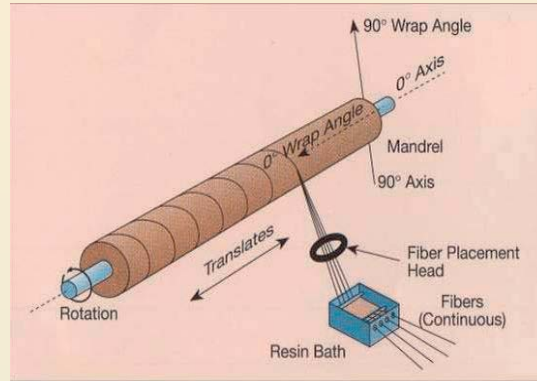
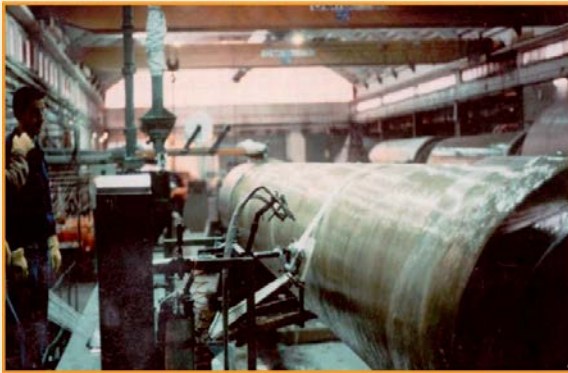


## What is GRE ?

Casing type	Composition	Application & Suitability
FRE – Fibreglass reinforced epoxy casing	Composite material made of polymer(epoxy, vinylester) matrix reinforced with fibres(glass, carbon, basalt)	<ul style="list-style-type: none"> <li>• Aerospace,</li> <li>• automotive,</li> <li>• marine,</li> <li>• construction industries and ballistic armour</li> </ul>
FRP – Fibreglass reinforced plastic	Polyester resin, isophthelic resin	<ul style="list-style-type: none"> <li>• Aerospace,</li> <li>• automotive,</li> <li>• marine,</li> <li>• construction industries and ballistic armour</li> </ul>
GRE – Glass reinforced epoxy casing	Epoxy resin plus one of the three different hardener systems aromatic amines, aliphatic amines or anhydrides	<ul style="list-style-type: none"> <li>• <b>Hydrocarbon &amp; water service</b></li> </ul>



## GRE tubular



Moulded coupling

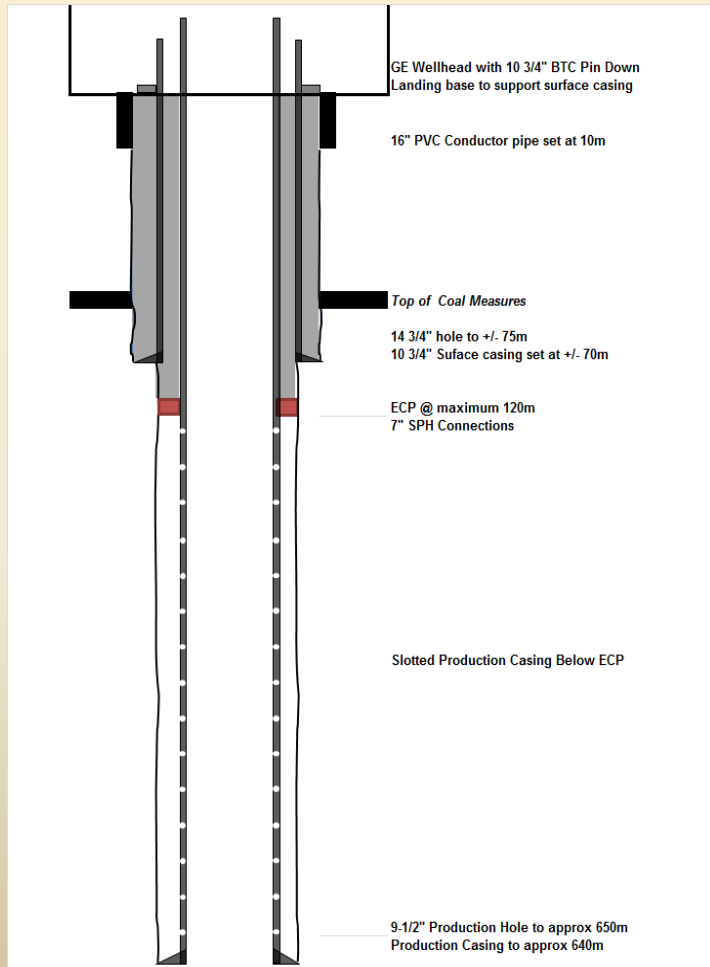


Threads cut





## Initial well design – GRE wells



Hole size	Casing size (in)	Weight (ppf)	OD	ID	Connection
16" PVC conductor Pre-set @ 10m					
14 3/4"	10 3/4"	12.5	12.9"	9.72"	SPH
9 1/2"	7"	8.65	8.55"	6.4"	SPH
Hole size	Casing size (in)	Burst (psi)	Collapse (psi)	Tensile body (1000 lbs)	
16" PVC conductor Pre-set @ 10m					
14 3/4"	10 3/4"	1150	210	55	
9 1/2"	7"	1750	750	44	



## Challenges faced & Lessons Learnt

Operations	Challenges
O-ring in the connections	<ul style="list-style-type: none"> <li>• Time consuming to make up</li> </ul>
Use of Mechanical port collar in place of hydraulic stage tool	<ul style="list-style-type: none"> <li>• Multiple production cementation issues as required separate inner string with collet arrangement</li> <li>• Hard to shift at shallow depths due to low wt</li> </ul>
Drilling 9 1/2" production hole	<ul style="list-style-type: none"> <li>• Reduced ROP due to bigger hole section</li> </ul>
Use of slip and seal hanger system	<ul style="list-style-type: none"> <li>• Increased HSE risk when cutting the landing joint</li> <li>• Inability to N/dn until WOC</li> </ul>
Running the casing	<ul style="list-style-type: none"> <li>• Inability to run the GRE casing with rig pipe arms due to high clamping pressures and fear of casing collapse</li> <li>• Lack of local experience in running casing.</li> </ul>



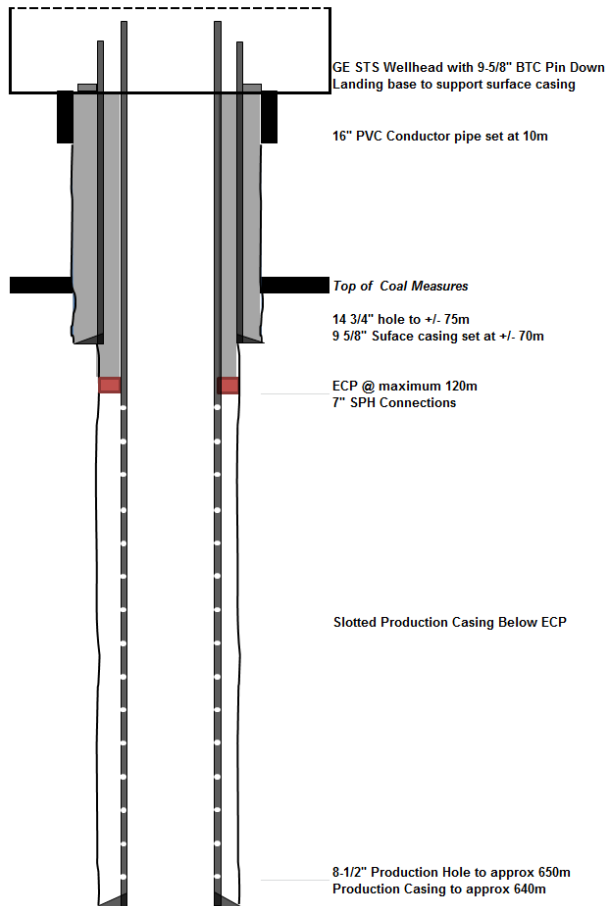


## Drivers for revised well design

Modifications	Benefits/Challenges
Standard oilfield connections (BTC & 8-Round options)	<ul style="list-style-type: none"> <li>• Easy compatibility with ACP, stage tool etc.</li> </ul>
Elimination of MPC and inner string cement jobs by replacing with hydraulic stage tool	<ul style="list-style-type: none"> <li>• Reduces time and cost but also requires a higher burst and tension rated production casing</li> <li>• Potentially increases the casing OD</li> </ul>
Standardisation with the current steel CSG development well design	<ul style="list-style-type: none"> <li>• Use of standard GE STS wellhead system – streamlined inventory, benefits for gathering.</li> <li>• Ideally standard production hole sizes (8-1/2")</li> </ul>
Rig pipe arm modification – reduce clamp pressures	<ul style="list-style-type: none"> <li>• HSSE, scheduling flexibility, cost savings</li> <li>• Ability to drill with any QGC rig</li> </ul>



## Revised GRE well design



Hole size	Casing size (in)	OD	ID	Connection
16" PVC conductor Pre-set @ 10m				
12-1/4" or 14-3/4"	9 5/8"	<13	8.78	API 8rd
8 1/2"	7"	8	5.5	API 8rd

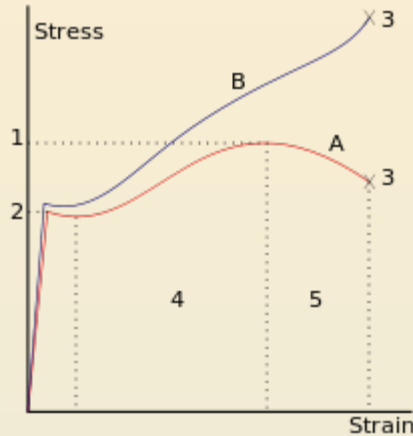
Hole size	Casing size (in)	Burst (psi)	Collapse (psi)	Tensile body (1000 lbs)
16" PVC conductor Pre-set @ 10m				
12 1/4"	9 5/8"	1000	900	45-60
8 1/2"	7"	1500	900	50-65

Recommended tubular properties



## Tubular properties GRE Vs Steel

### Steel casing selection



1. Ultimate strength
- 2. Yield strength**
3. Fracture
4. Strain hardening region
5. Necking region

"Engineering" (red) and "true" (blue) stress vs. strain curve typical of structural steel

- Unlike steel, GRE does not have a identifiable yield point
- Failure of GRE is by 'weeping' without any burst component
- Failure involves the pressures having broken the bond between the glass and resin increment by increment
- The internal pressure for GRE refers to the operating pressure rating for a 20 year life span

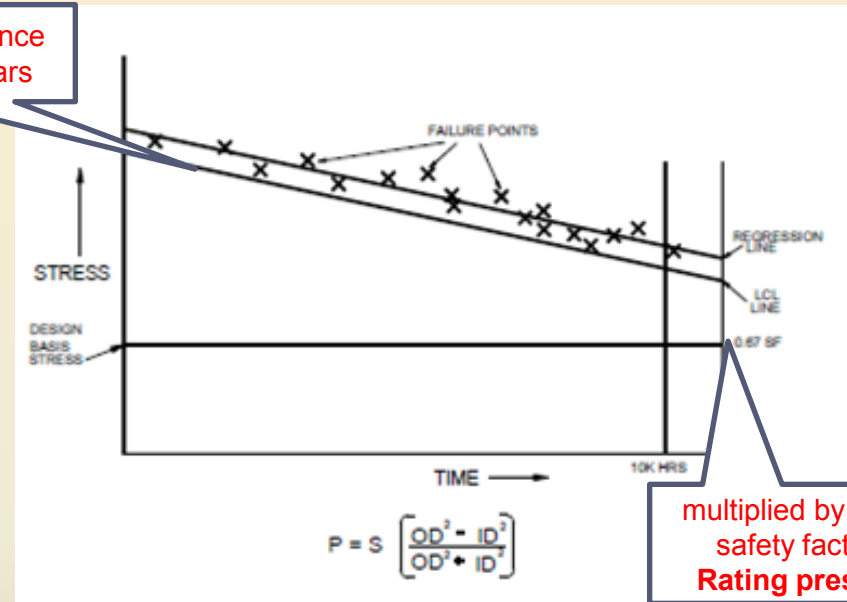


## Tubular properties GRE Vs. Steel

API 15HR- High pressure  
Fibreglass line:

- Test calls for 18 samples to be put under excessive internal pressure (hoop and axial stress)
- The samples are identical and each one is put under a different pressure
- The test lasts beyond 10k hours
- These failure points are graphed on a log stress y,/ log time x graph
- A regression line is drawn through the points and extrapolated out to 175,000 hours (20 years).
- A 95% LCL is calculated
- Then multiplied by 0.67 SF to calculate the hydrostatic design basis (internal operating pressure)

95% Lower Confidence  
Level line for 20years



multiplied by a 0.67  
safety factor =  
Rating pressure

**Conclusion:** Assume that the maximum pressure we will see is 1450psi, we can select 1500psi casing rather than 1750psi rated pipe.



## Tangible providers - Tubular

Supplier	Certification	Manufacture	Agent
Adtech	API 15HR API-Q1 API 15LR ISO 9001 ISO/TS 29001	CENTRON, NOV San Antonio, Texas, US	Adtech FRP Ltd.
NOV	API 15HR API-Q1 API 15LR ISO 9001 ISO/TS 29001	STAR FIBERGLASS HARBIN, HEI LONGJIANG, CHINA	NOV in Australia
Future Pipe Industries (FPI)	API 15HR API-Q1 ISO 9001 ISO/TS 29001	FUTURE PIPE INDUSTRY, HOUSTON, Texas	Global Pipe in Australia
Wagners	API 15HR API 15LR ISO 9001 ISO 14001	Jinguang Shangdong, China	Wagners in Australia
Drill Maco/XINDA	API 15HR API 15LR ISO 9001 ISO 14001	Shengli, Dongying, Shandong province, CHINA	Drill Maco in China
Teakle	N/A	Teakle	
Perma	API 15HR API-Q1 API 15LR ISO 9001 ISO/TS 29001	Daqing Harvest, China	Perma



## Industry experience?

- Any operators/service providers want to share their experience on GRE wells ??



Any questions ?