GLENCORE

Outburst Compliance Challenges
Oaky #1 Mine
MG33A_21-24c/t

Gas and Coal Outburst Seminar, Wollongong, November 2015

Oaky Creek Coal

Outline

Characteristics of the German Creek seam

The Issue – slow to drain

Management plan of attack

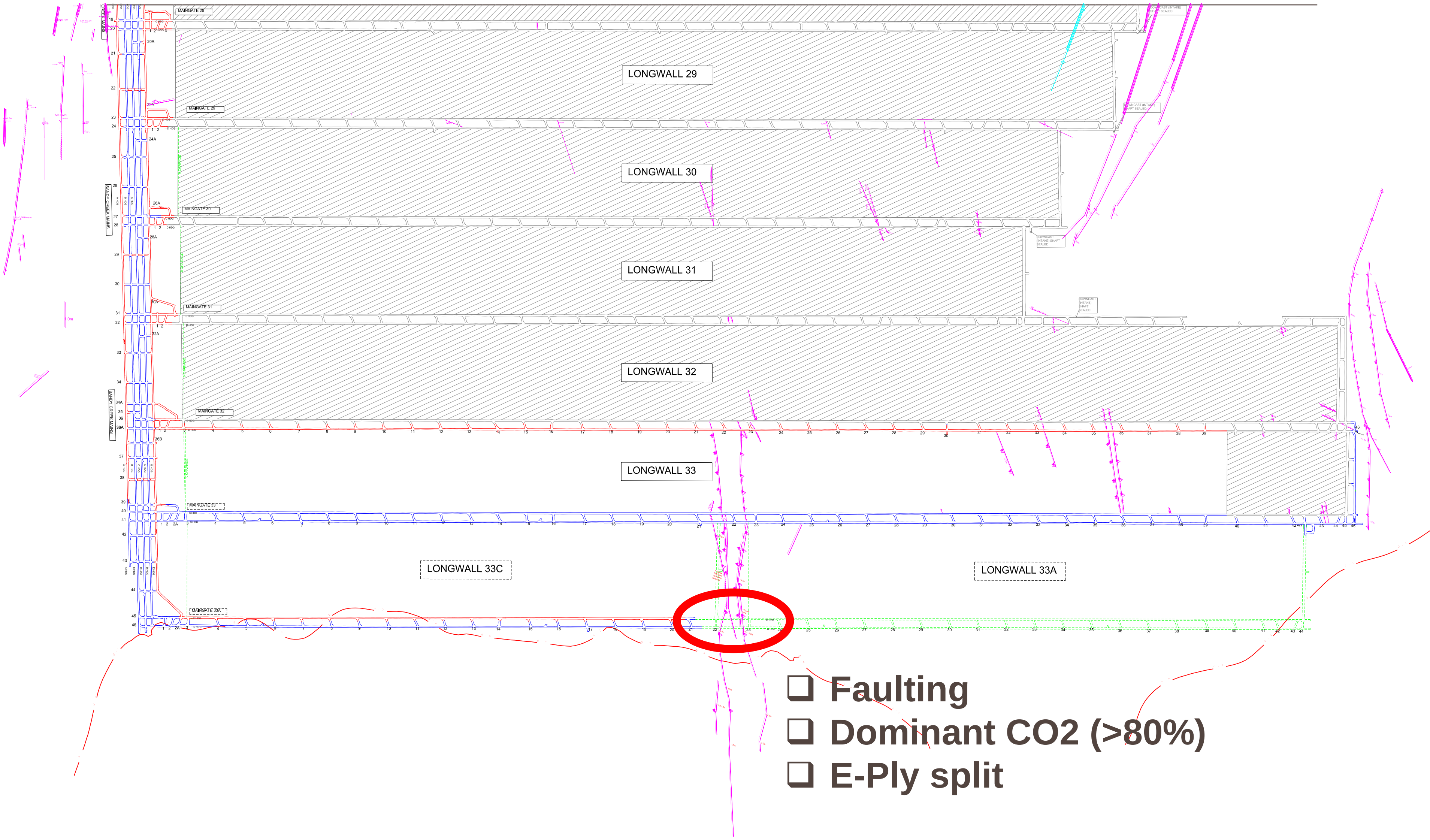
- Trial fraccing with sand proppant
- Implement some tightly spaced inseam drainage
- Consider contingencies of remote mining or grunching
- Maintain safe and efficient mining

The Action: what was actually undertaken

Gas Drainage Outcome

Conclusions

The problem zone, mid-panel Maingate 33A



- ❑ **Faulting**
- ❑ **Dominant CO_2 (>80%)**
- ❑ **E-Ply split**

The German Creek Main and the E Ply

German Creek Main section:

- Comprised of the F & G Plies
- Permeability 7 - 8mD at nearby test hole

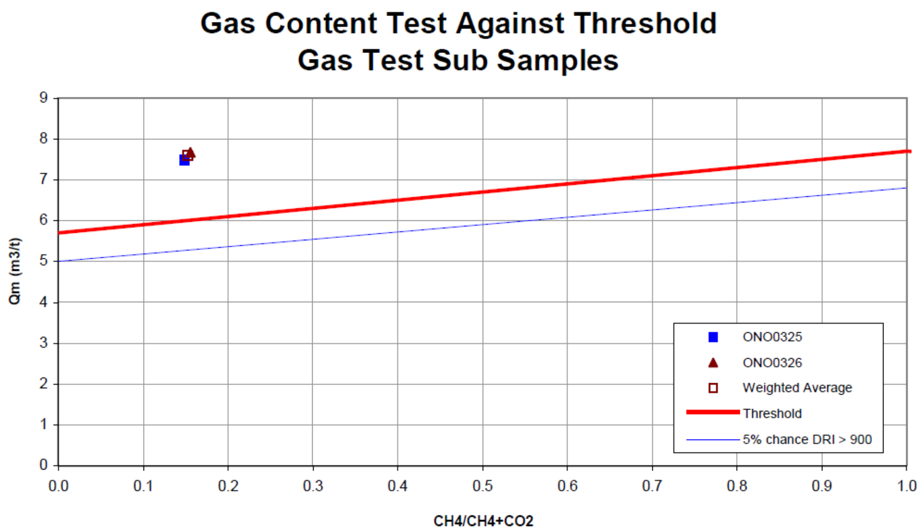
Carbonaceous Mudstone band (Split):

- Thickness range of 0 to 11cm over the problem zone

German Creek E ply:

- Lower permeability: 2 - 3mD at nearby test hole
- Higher ash content
- Higher outburst threshold than the Main section

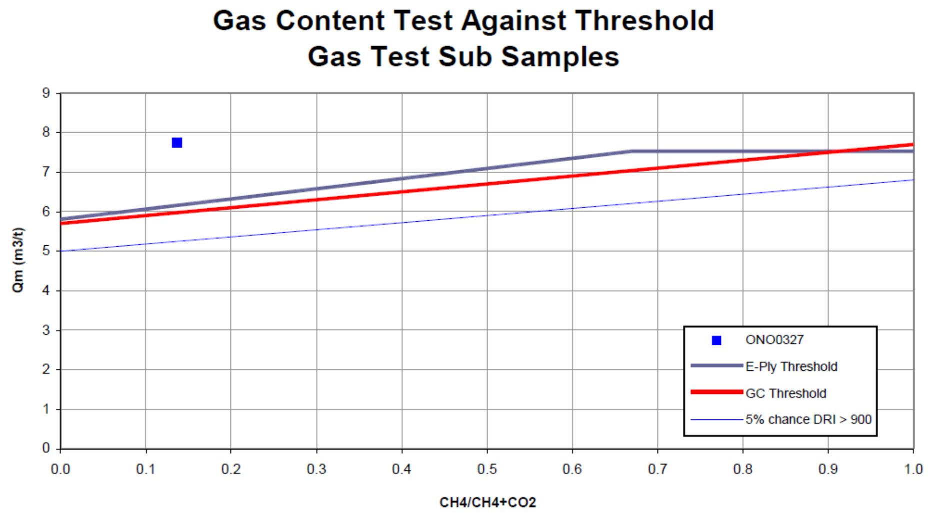
The German Creek Main and the E Ply – specific thresholds



German Creek Main:

900 DRI determined threshold line runs between:

- 5.7m3/t @ 100% CO2, and
- 7.7m3/t @ 100% CH4



German Creek E ply:

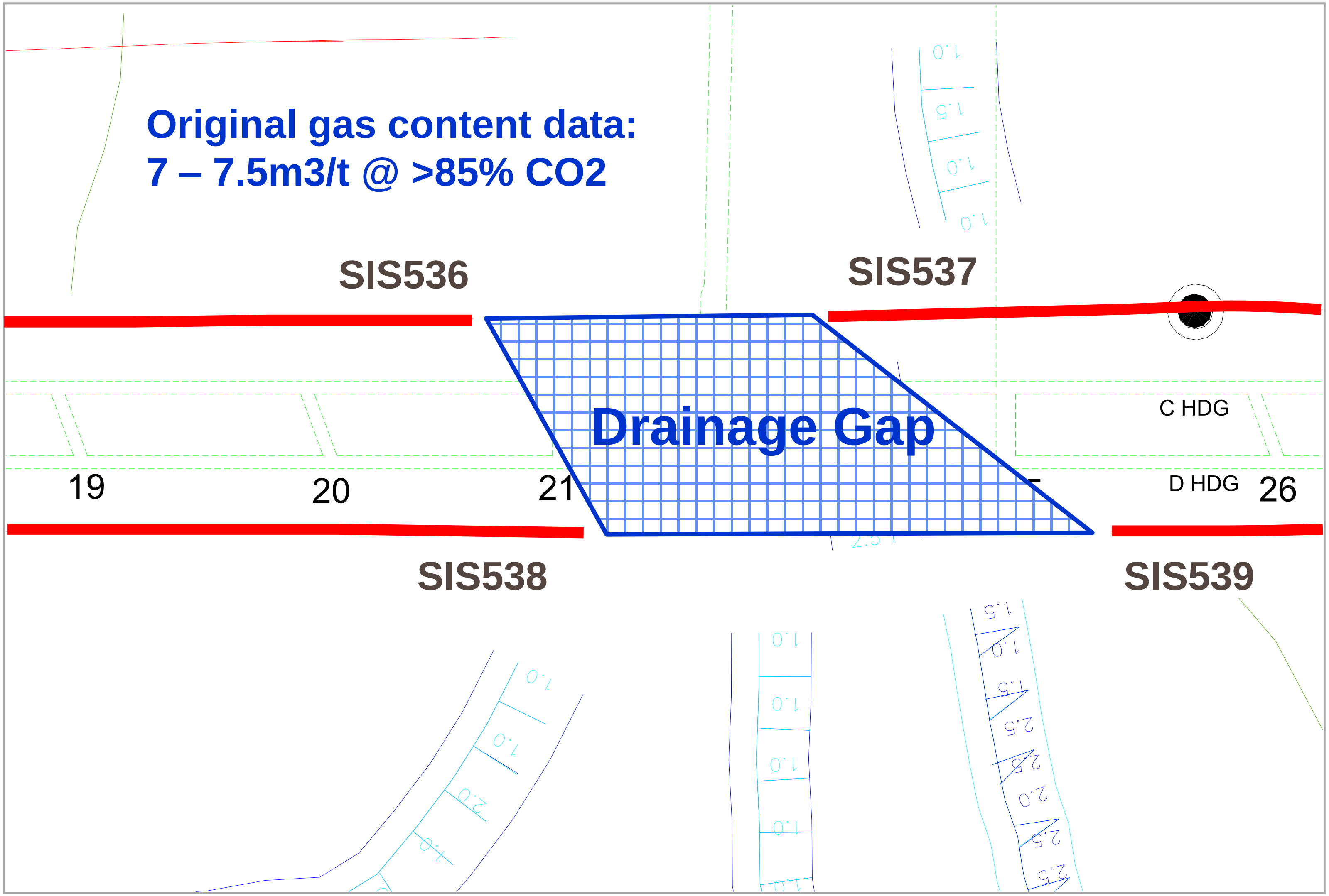
900 DRI determined threshold line runs between:

- 5.81m3/t @ 100% CO2, and
- 7.53m3/t @ 67% CH4, flat thereafter to 100% CH4 until sufficient high methane coal samples become available.

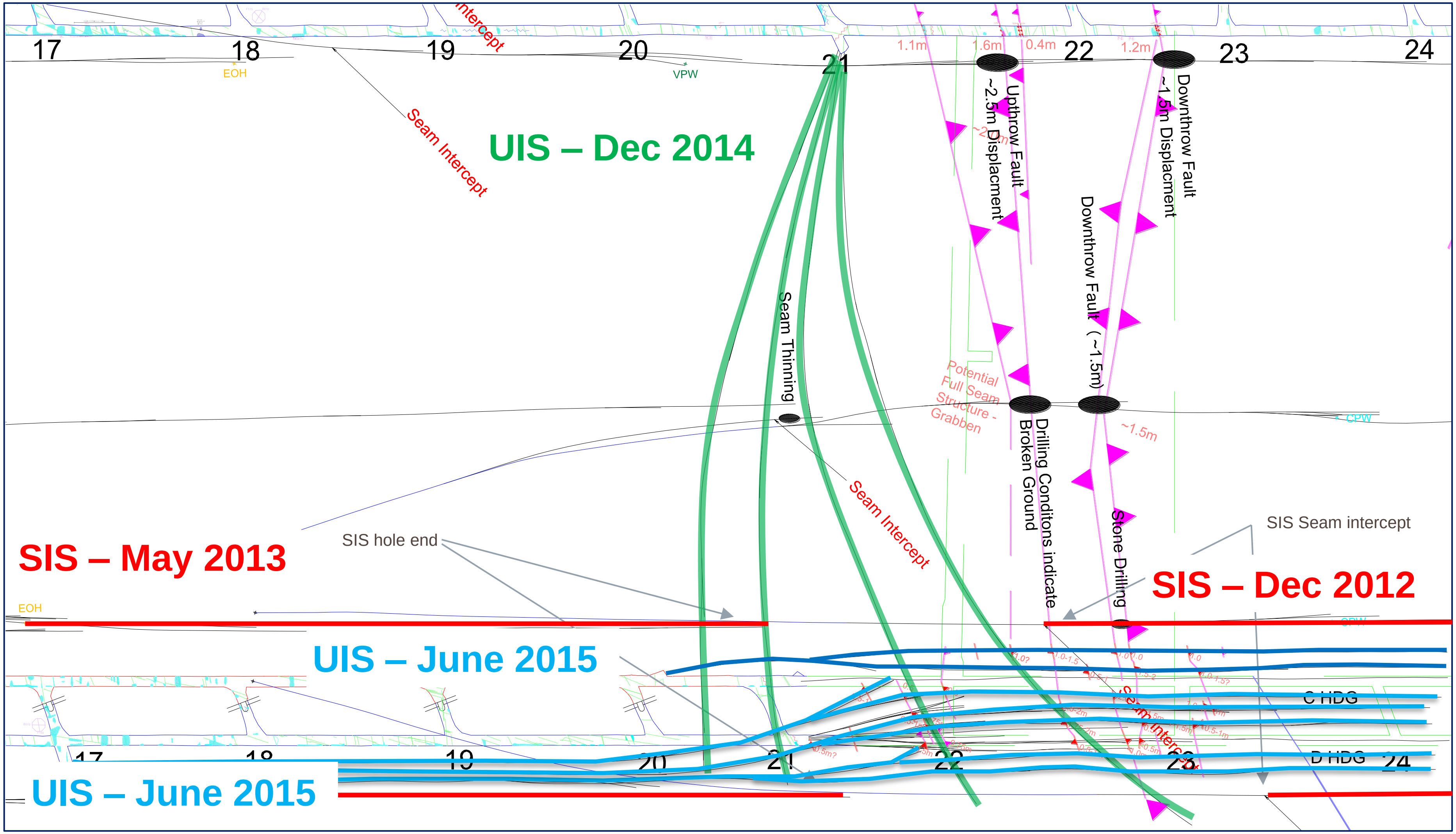
The Pre-Drainage story

- **Long term SIS drainage in place in late 2012 to mid 2013.**
- **Design flaws identified in August 2013.**
- **Infill UIS cross-block pattern drilled from MG33 December 2014.**
- **Infill UIS failed to drain adequately.**
  - Down-dip to target zone through existing drained (de-pressurised) areas.
  - Low desorption pressure CO_2 struggled to self de-water.
  - Some blockage issues around fault intersections.
- **Became obvious that more drainage was required**
  - More cross-block holes were rejected.
  - Elected to drill a tight spaced parallel pattern ahead of development.
- **Slow drainage still!**
- **Intersections compromised some boreholes soon after drilling**

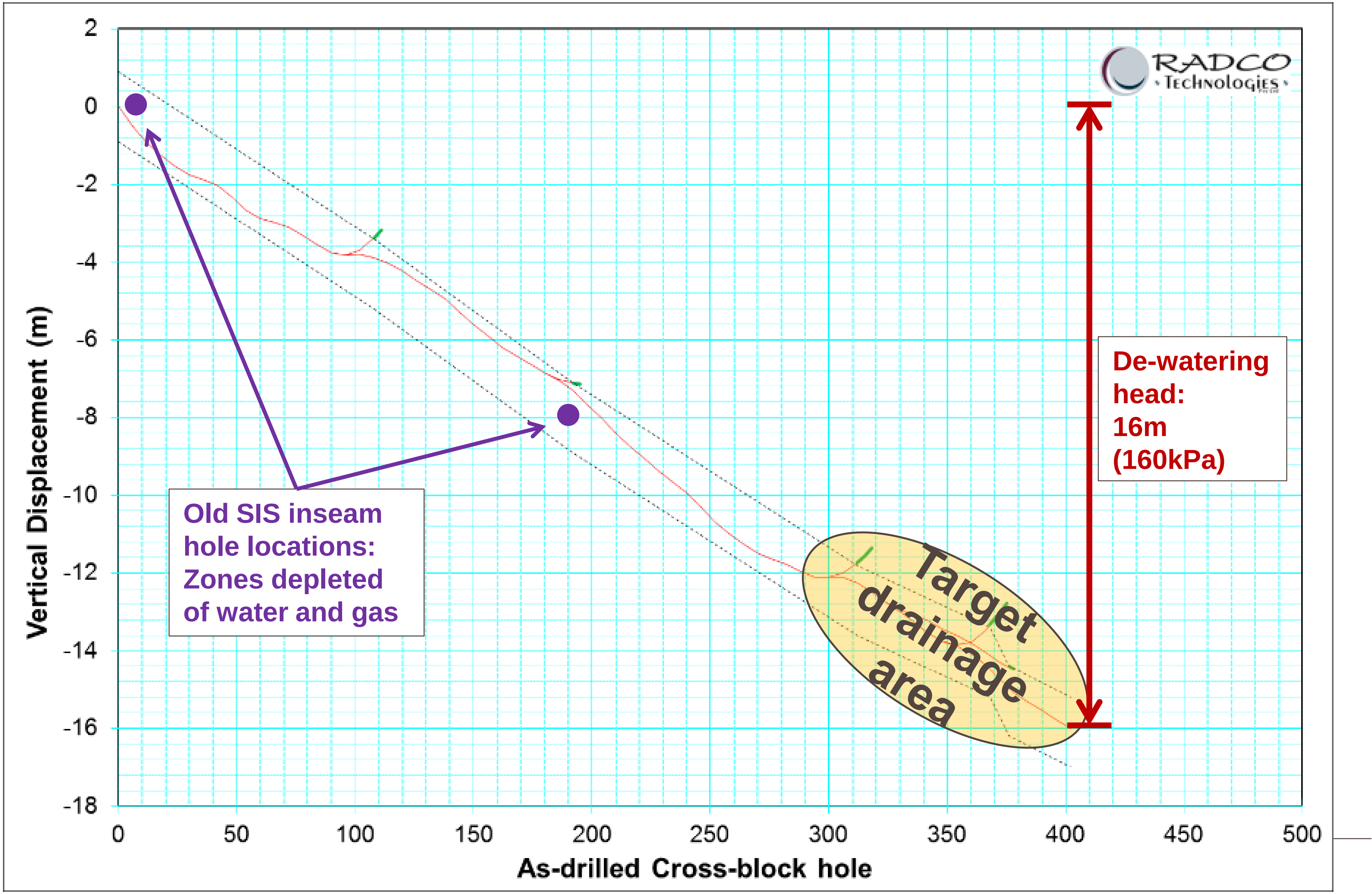
History: Situation in late 2012 showing 3D seismic predicted structures, and inseam portions of SIS drilling



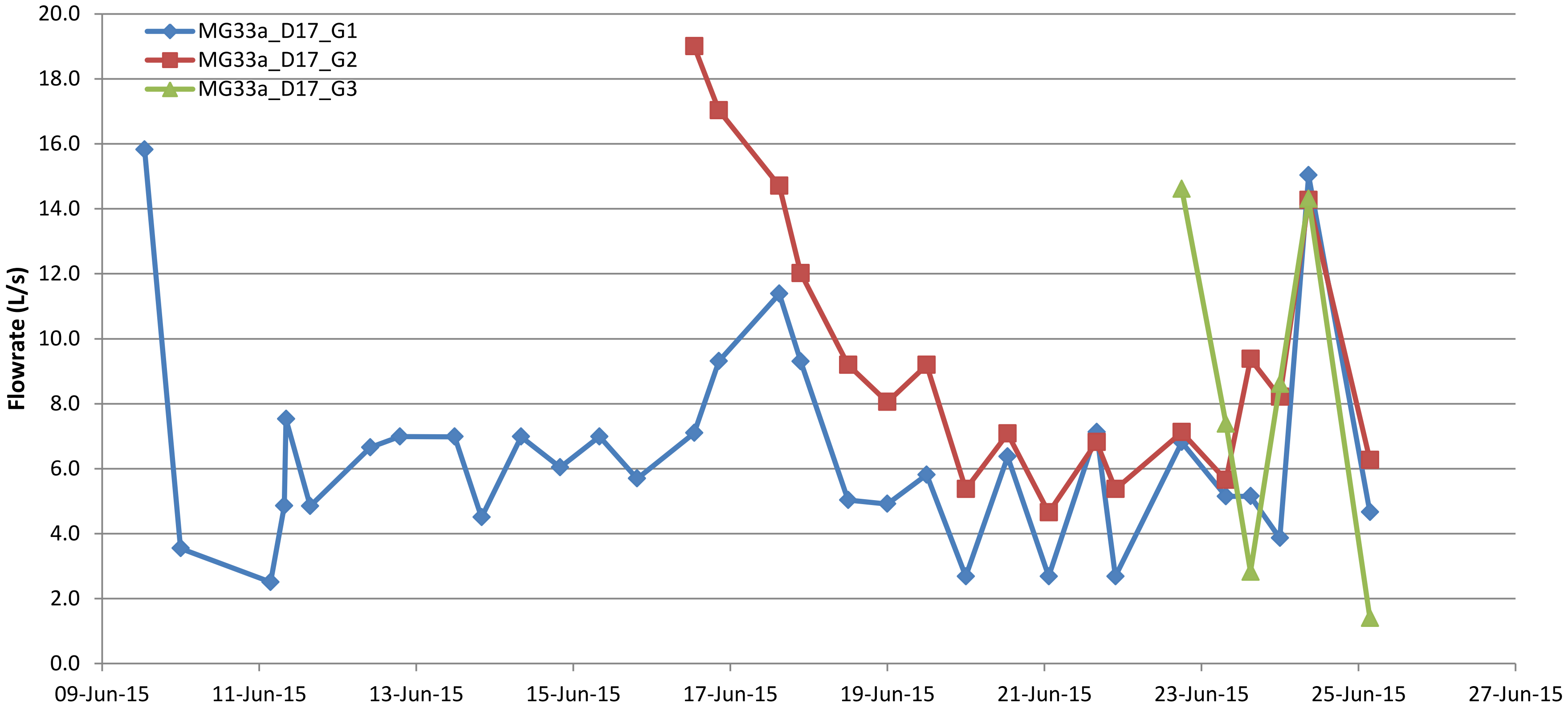
Pre-drainage phases: SIS followed by 2 sets of UIS



Sample section view of the down-dip cross-block UIS holes

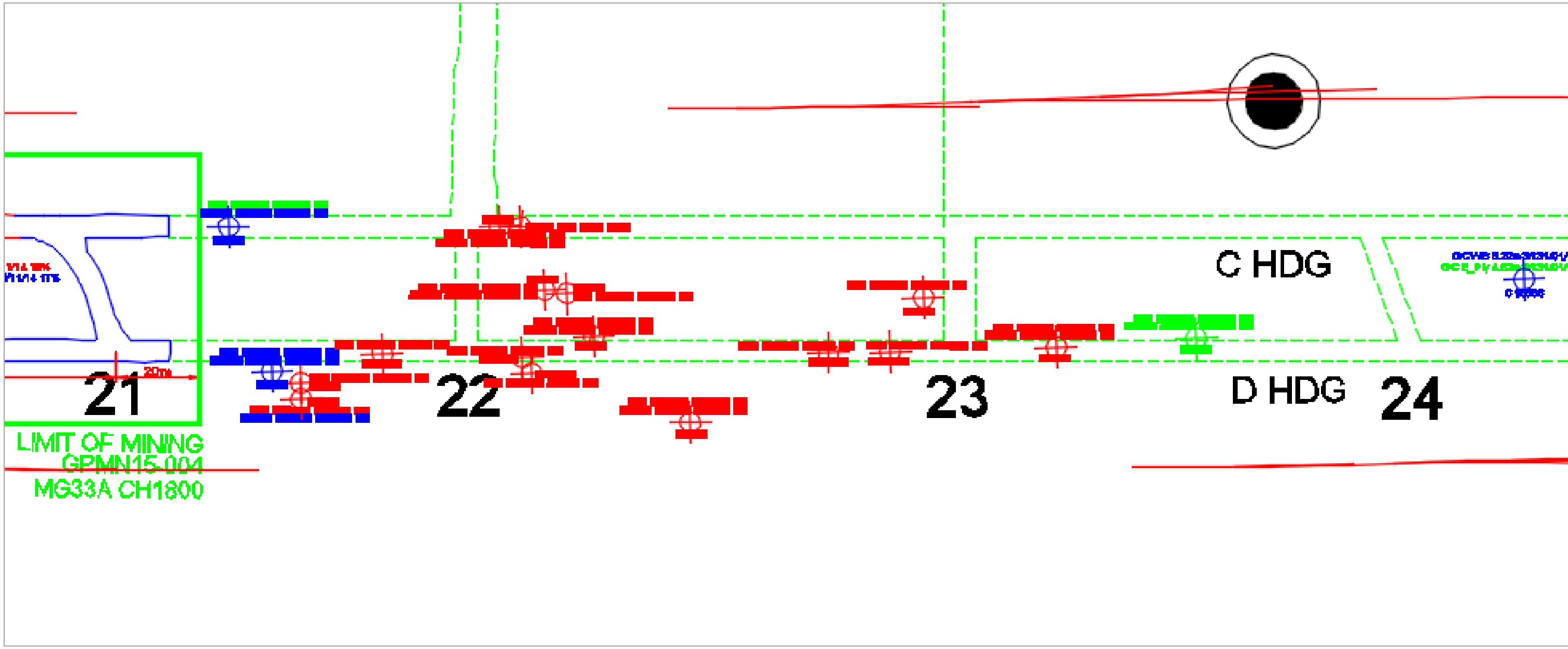


Additional Borehole Performance



- **Cores were 80 to 85% CO_2**
- **Borehole drainage was very slow**
- **Area appeared to have a very low permeability**
- **Development forecast was not achievable with existing draining system results**

Mining ceased at the 21ct line



- A sea of red ‘failed’ compliance cores ahead in amongst the SIS drainage gap.
- The additional UIS phases (not shown) had not rectified the situation.
- Inbye of 24ct through to 43ct, all core results were <u>below</u> threshold.

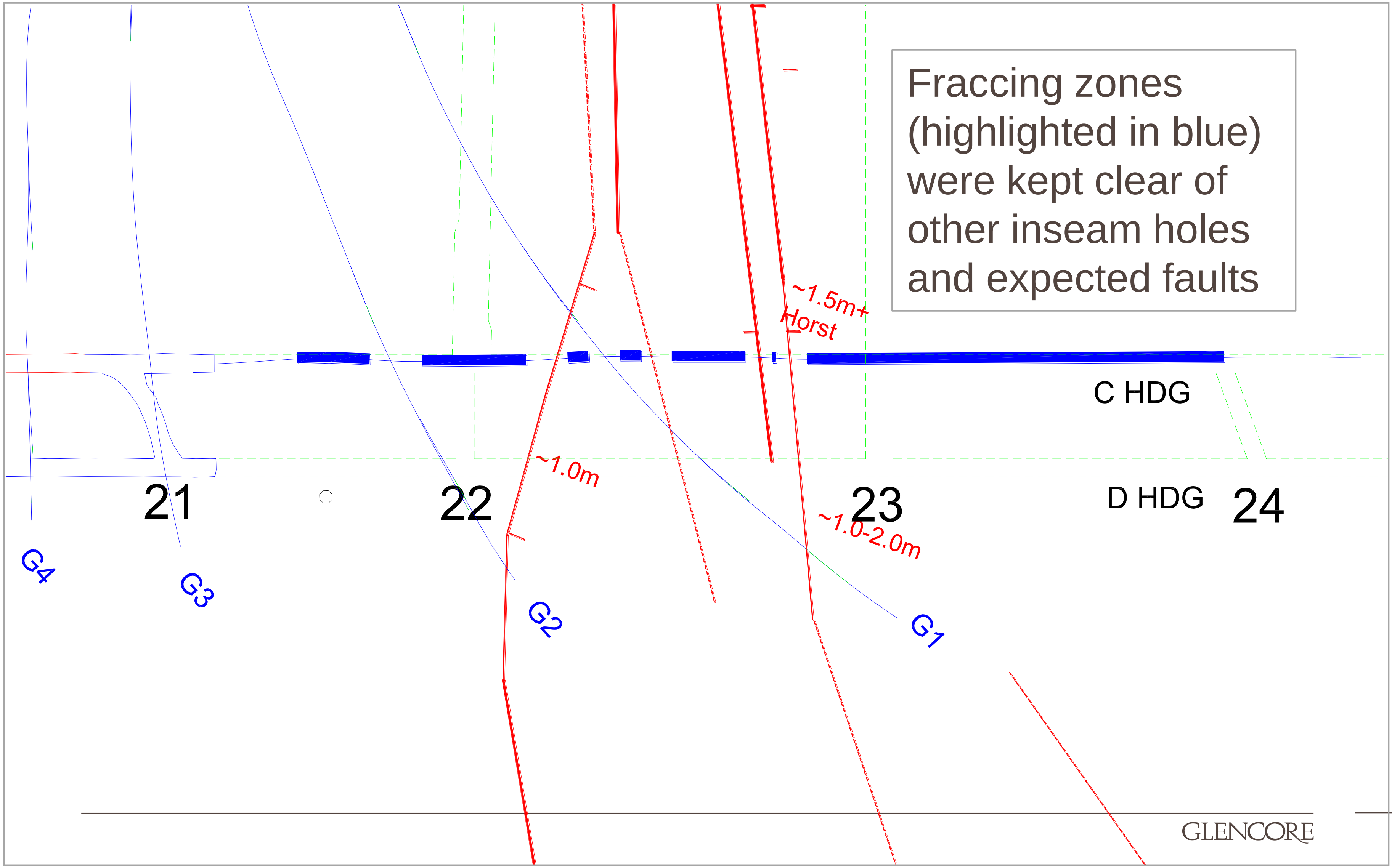
Where to?

- **Would additional UIS be successful, given the lack of results to date?**
- **Fraccing? With or without sand proppant? Water only fraccing used previously, elected to trial sand.**
- **Fraccing lead time!**
  - Sourcing of gear, and hire agreements
  - Transport to site, and site introductions, RAs and procedures.
  - Transport u/g, commissioning, and training.
- **Meanwhile one heading was intensely drilled while the other prepared with a single branch-free fracc hole.**
- **While drilling and fraccing, grunching was scoped out, and remote mining was risk-assessed and relevant procedures developed.**

Critical Fraccing Issues

- **Sourcing a suitable water pump**
  - *Longwall Salvage Pump utilised*
- **Adapting existing fracc procedures to include the changes introduced by the use of the sand-adder**
- **Sourcing of appropriate sand**
- **Supply of hardware from CSIRO and ACIM**
- **Lead time for equipment mobilisation to site**
- **Introduction to site process**
- **Suitable downhole fracc locations**
  - Clear of branches or close proximity to adjacent holes
  - Avoid zones of weakened or fractured coal

Planned Fraccing portions – C Hdg borehole



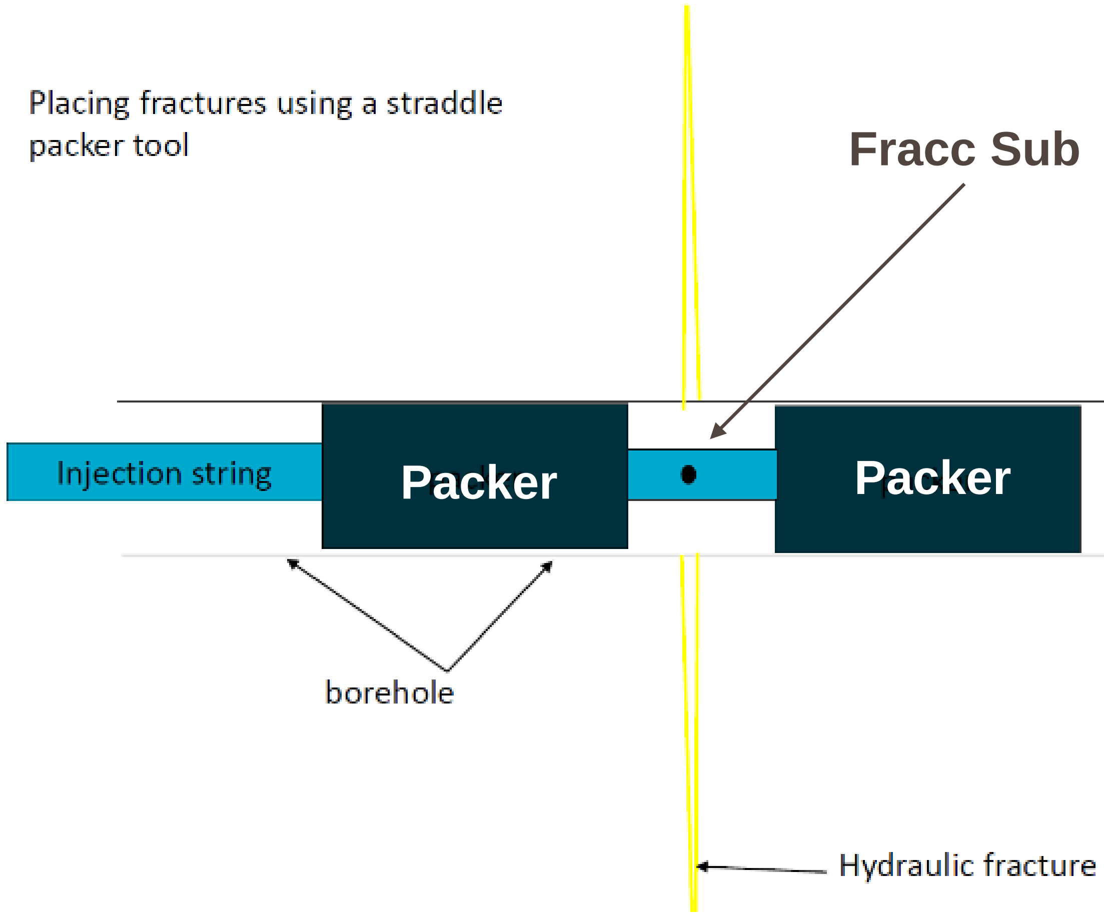
Sand Fraccing Equipment

Sand Adder – used to feed sand into the high pressure water lines

Down Hole packer assembly and fraccing sub

Sand Fraccing Equipment ctd

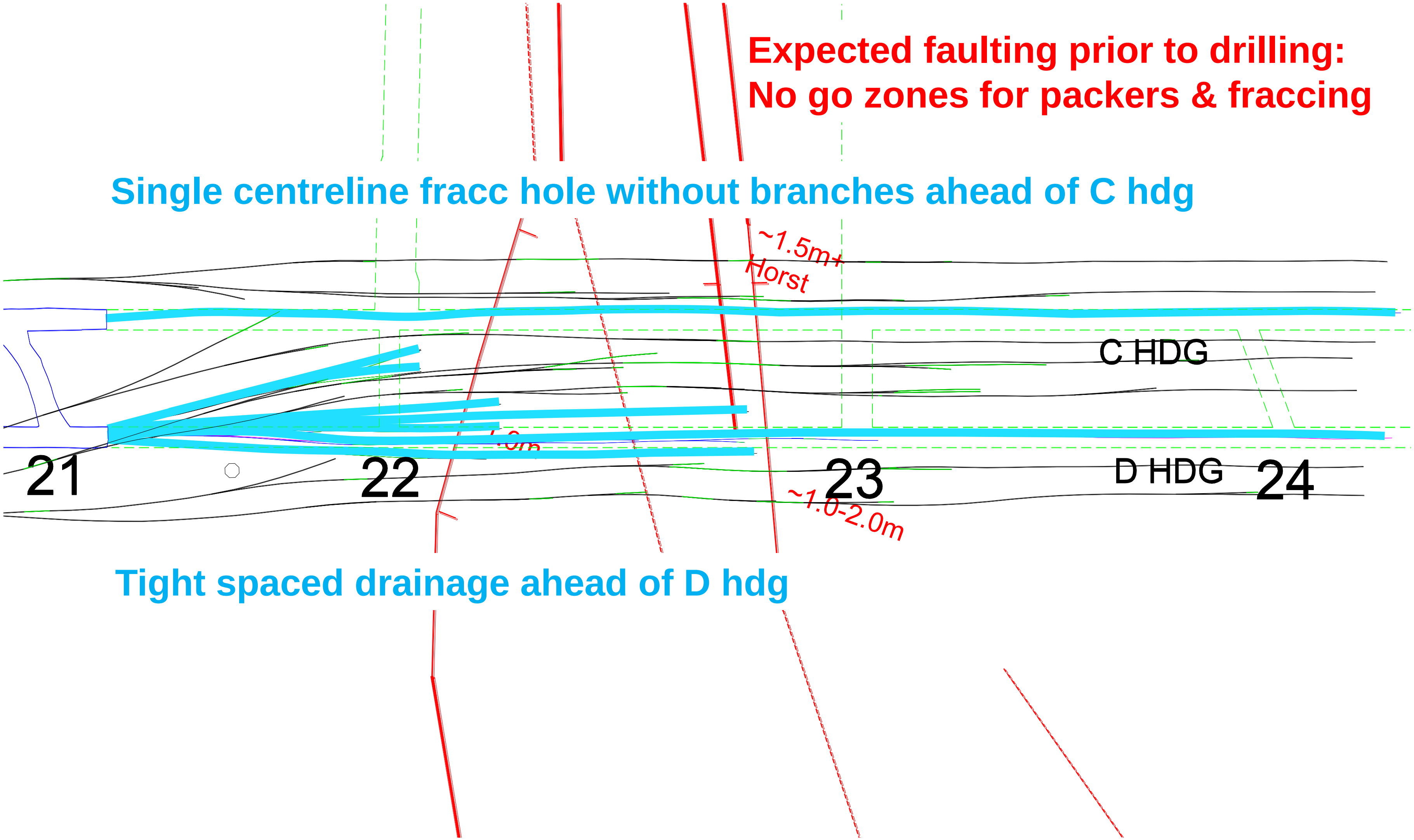
Water fracc



Placing fractures using a straddle packer tool
Fracc Sub
Injection string
Packer
Packer
borehole
Hydraulic fracture

Hydraulic Fracture Propped with Sand

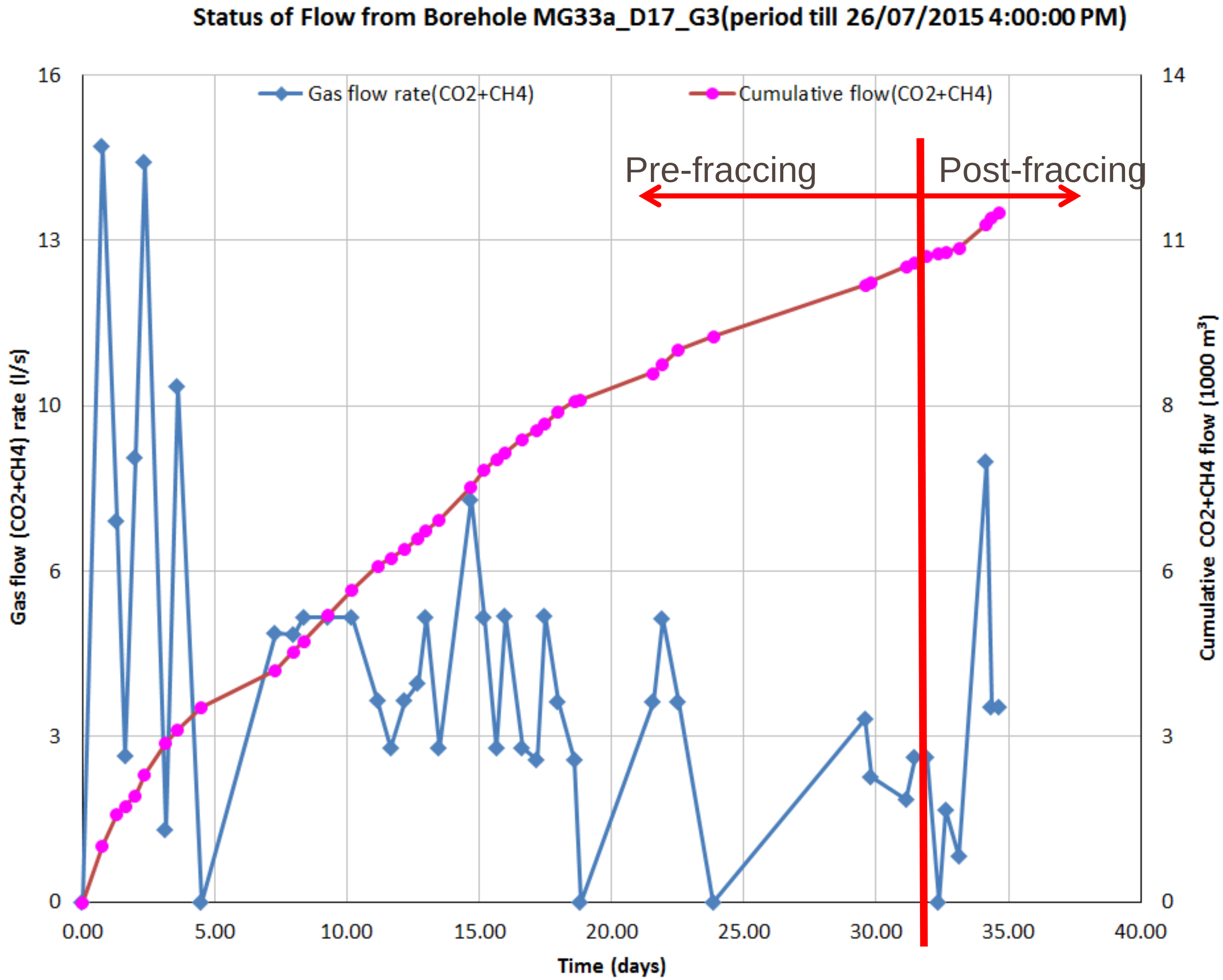
Drill-drain and Drill-fracc-drain phases: UIS from 21ct stubs



Fraccing operational notes

- **Safety**
  - pressure rated hardware
  - emergency isolation points
  - packer inflation and deflation
- **Separate air split for the sand adder**
  - sand spec, no more than 4% > 600µm, no more than 10% < 250µm
- **Discharge pipework set up to cope with potentially high flows**
- **Manage interaction with existing drainage holes**
- **Monitor outcomes**
  - gas flows
  - water make
  - sand make
- **Hole cleaning and lining at end of fraccing phase**

Updated Borehole Performance



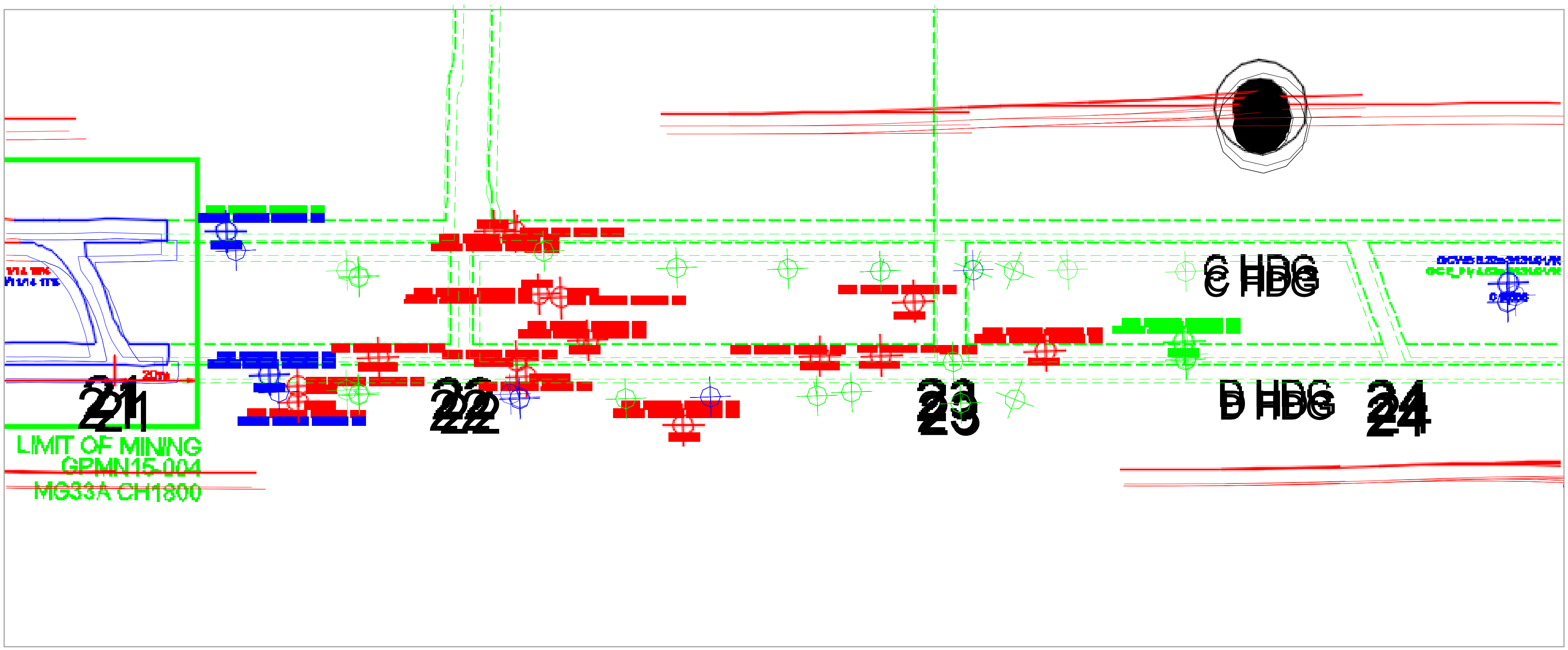
There were increased gas flows in some boreholes post fraccing, but generally low and sporadic.

Abandoned planned fracc ahead of D heading

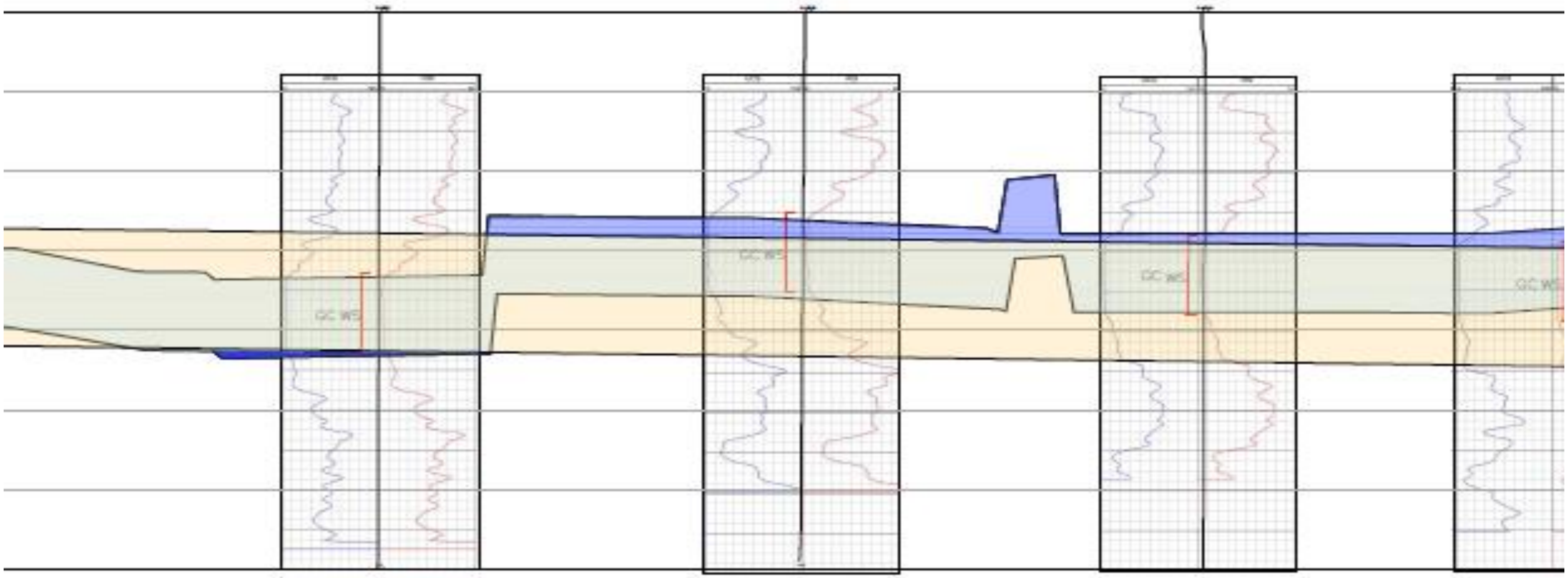
- The fraccing process ahead of C heading did demonstrate connectivity with flanking boreholes.
- Gas flows from adjacent holes did show increases, but never to the expected magnitude and not sustained.
- Decision made to halt the fraccing programme once the C heading hole was completed.
- Meanwhile, the initial flow data ahead of D heading suggested that mining could recommence there in the short term.

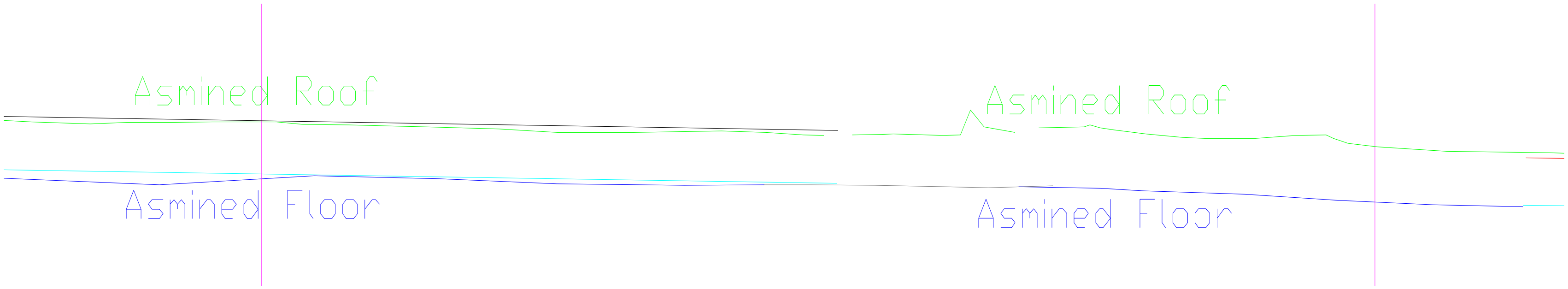
Compliance story

9 July – 3 August 19 August – 27 August – full compliance



Mining completed: Section view of as-mined grade plan





D22A C/T +49m Horst Pillar Rib

Learnings - why did the zone fail to drain?

- **SIS design had some weaknesses which the excellent drainage time (>2 years) could not compensate for.**
- **Down-dip cross-block UIS pattern struggled to de-water the seam.**
- **Geological mapping revealed less jointing, no change in cleat angles or frequency.**
- **No real indications that joints or cleats were infilled with minerals**

Summary:

- **Original drainage had flaws, replacement patterns still inadequate.**
- **Ground tighter than normal – locally lower perm(?)**
- **Low pressure CO2 and low flow rates unable to self de-water in an area where several grade changes complicated the de-watering process.**

Learnings – Fraccing experience with sand proppant

- The water pressure certainly opened up paths through the seam.
- Water travelled from the fracc hole across to the furthest flanking borehole on the very first fracc, and rapidly.
- Sand also travelled into adjacent boreholes despite attempts to halt the injection flow as soon as the sand exited through the fracc sub.
- The whole process was managed by mine personnel and drilling contractors after training by an external expert.

Acknowledgements:
CSIRO
Radco Technologies
ACIM – Ground Breaking Technology
Weisstech

THANK YOU