



Paper 520: Reservoir design of a shallow LP-SAGD project for *in situ* extraction of Athabasca Bitumen

Acknowledgements

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Reservoir design requires the combined industry knowledge and oil sands experience of numerous experts in a variety of subsurface disciplines

Athabasca Bitumen at Clearwater Project

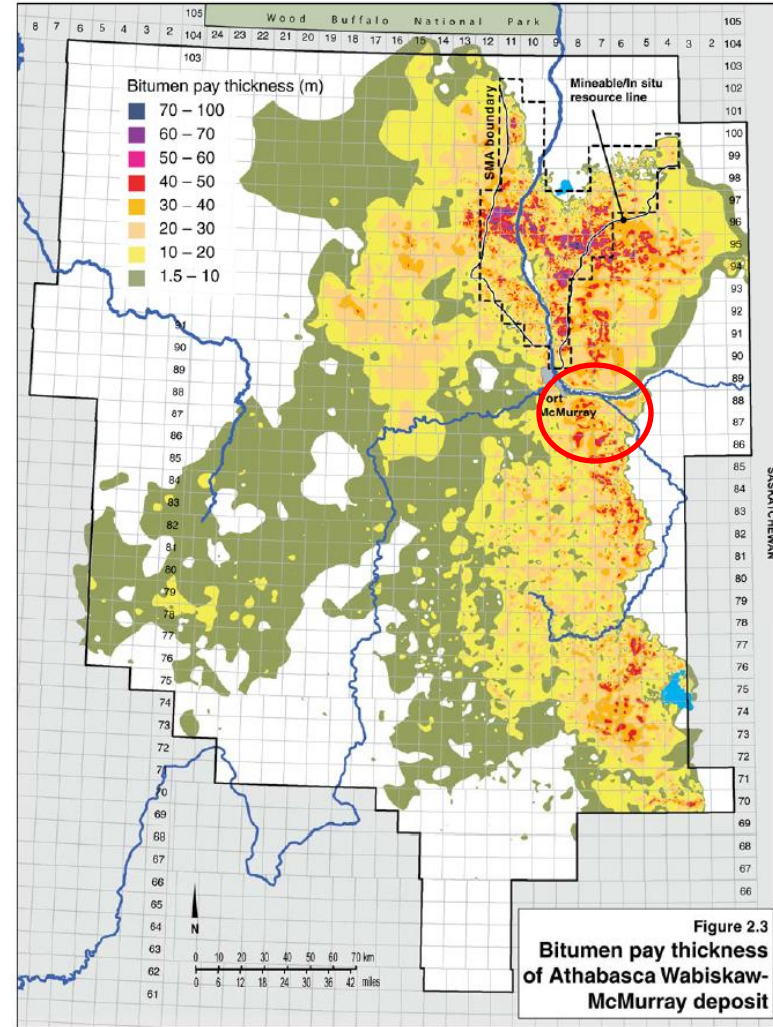
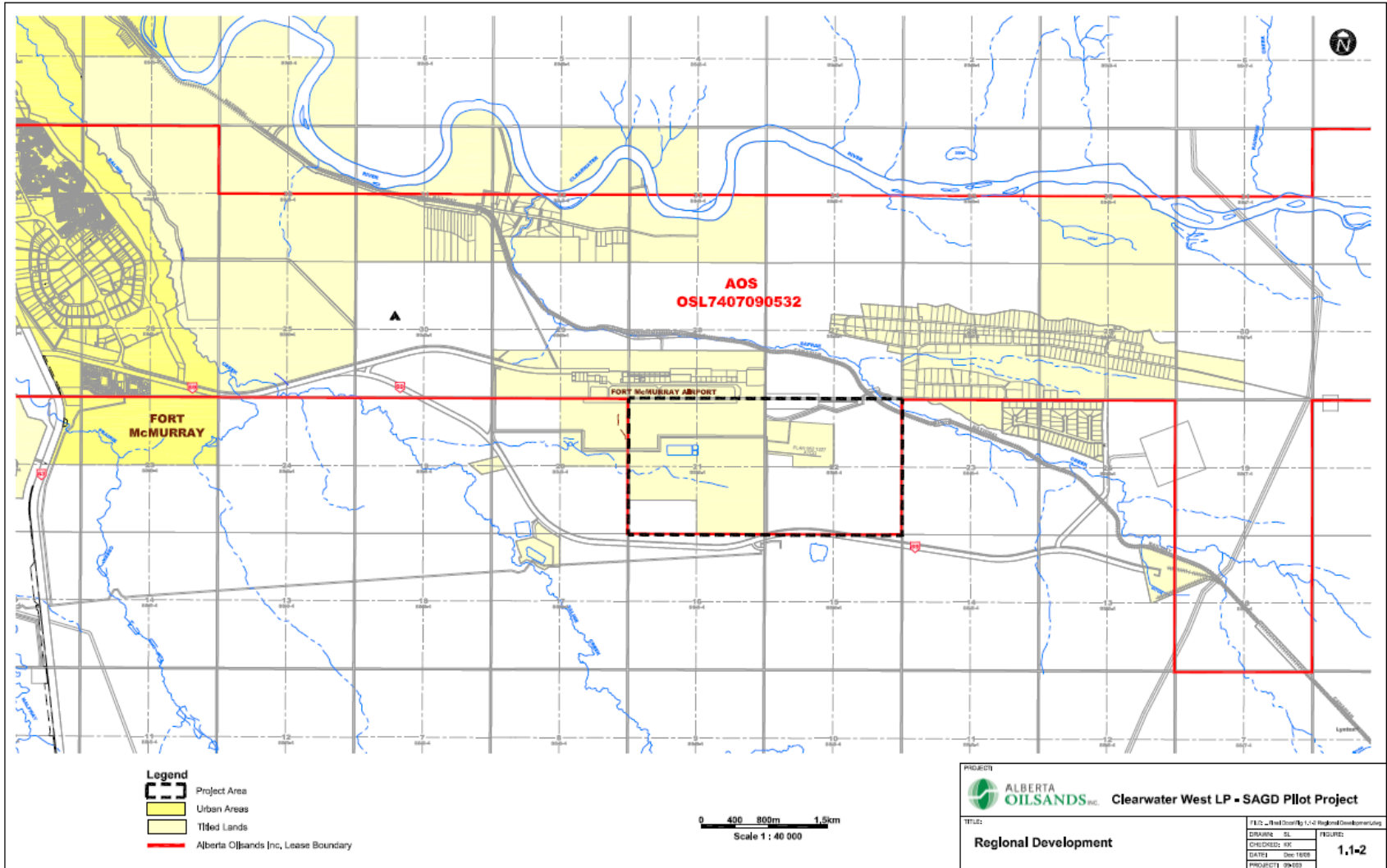


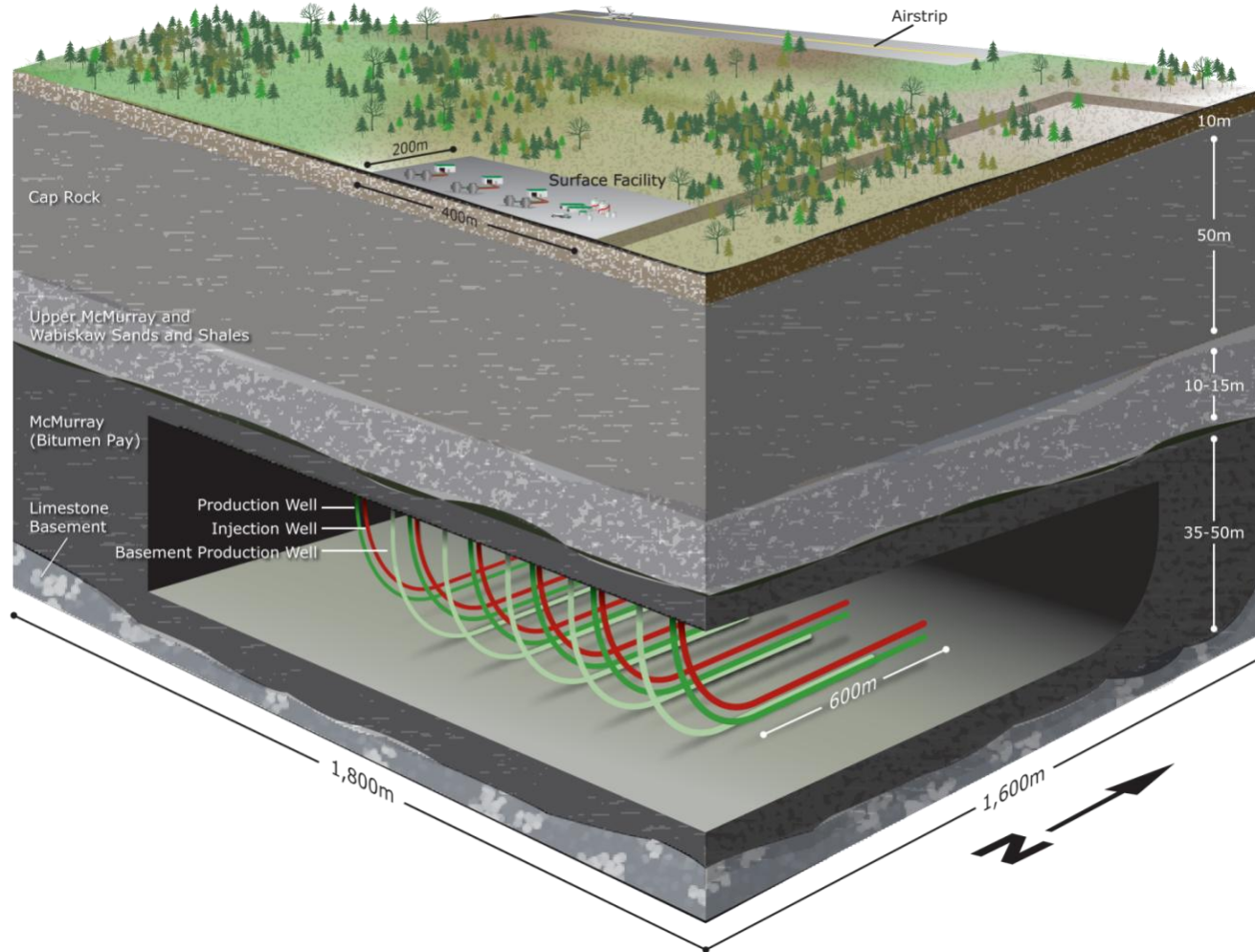
Figure 2.3
Bitumen pay thickness
of Athabasca Wabiskaw-
McMurray deposit

Clearwater Phase I presents an excellent reservoir

Clearwater Phase I location

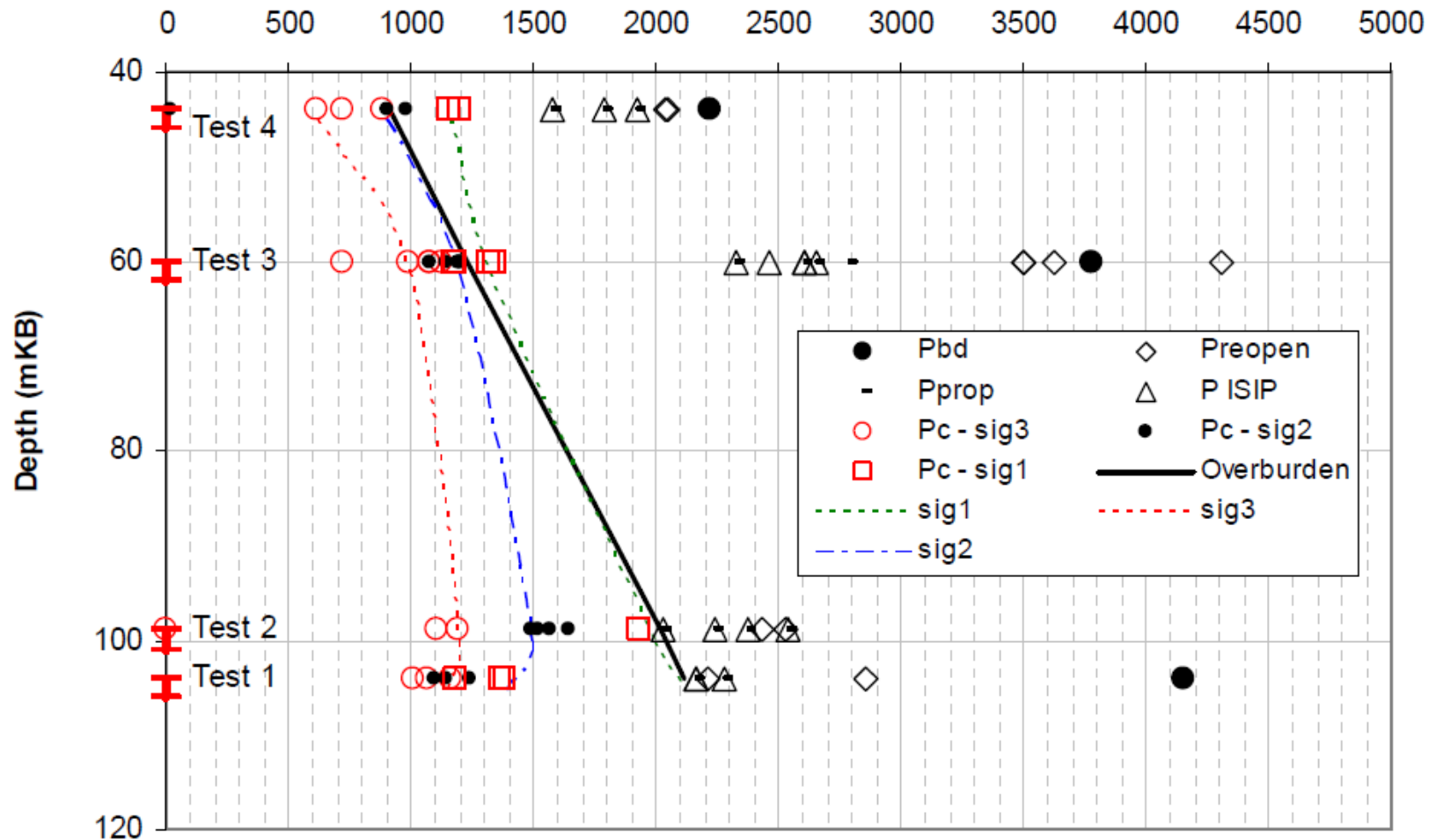


Production scheme: SLP-SAGD with basement wells



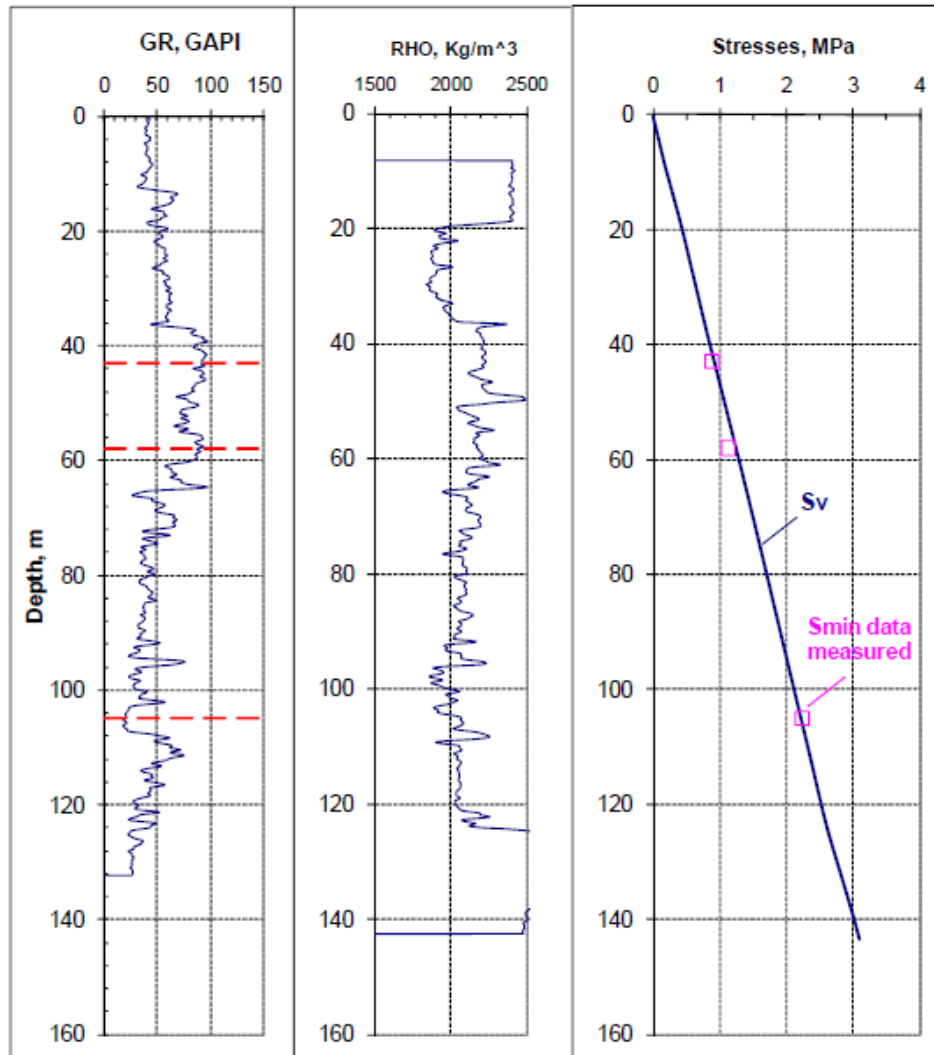
Analysis of AA/05-22 mini-fracs

Pressure, Top Perfs (kPaa)



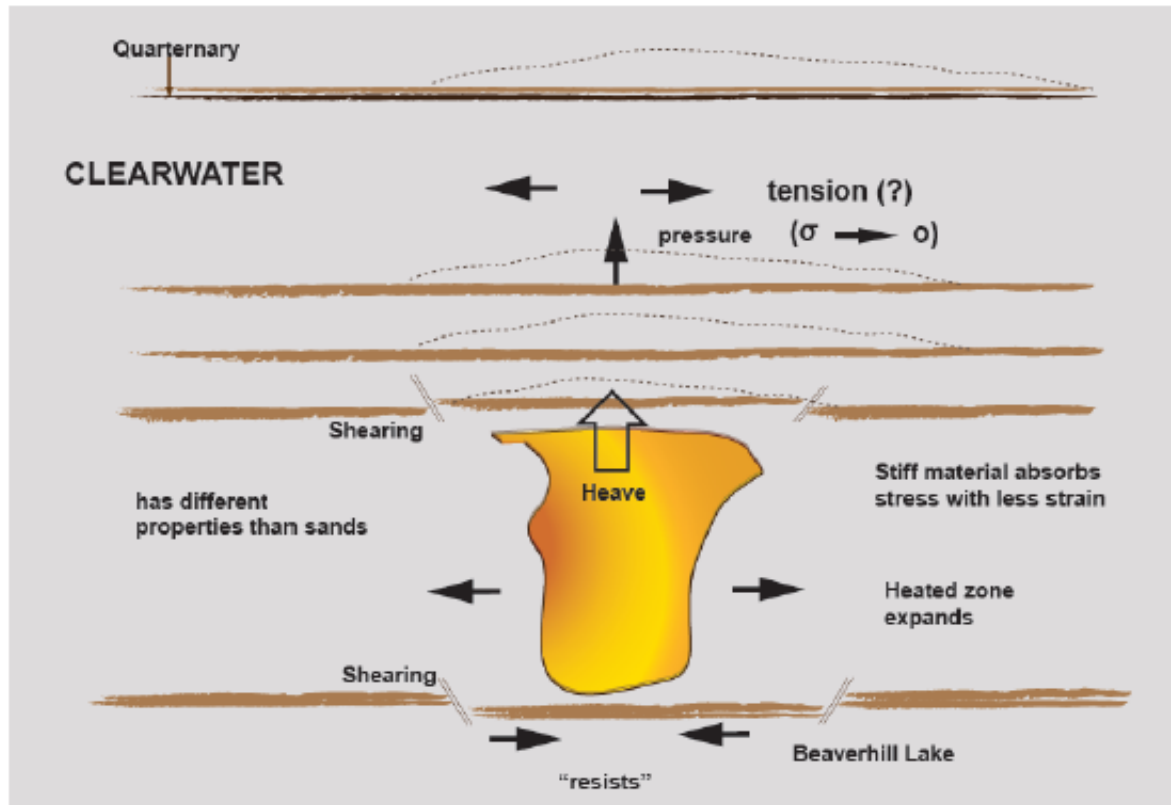
Petroleum Geomechanics Inc.

Analysis of AB/09-21 mini-fracs



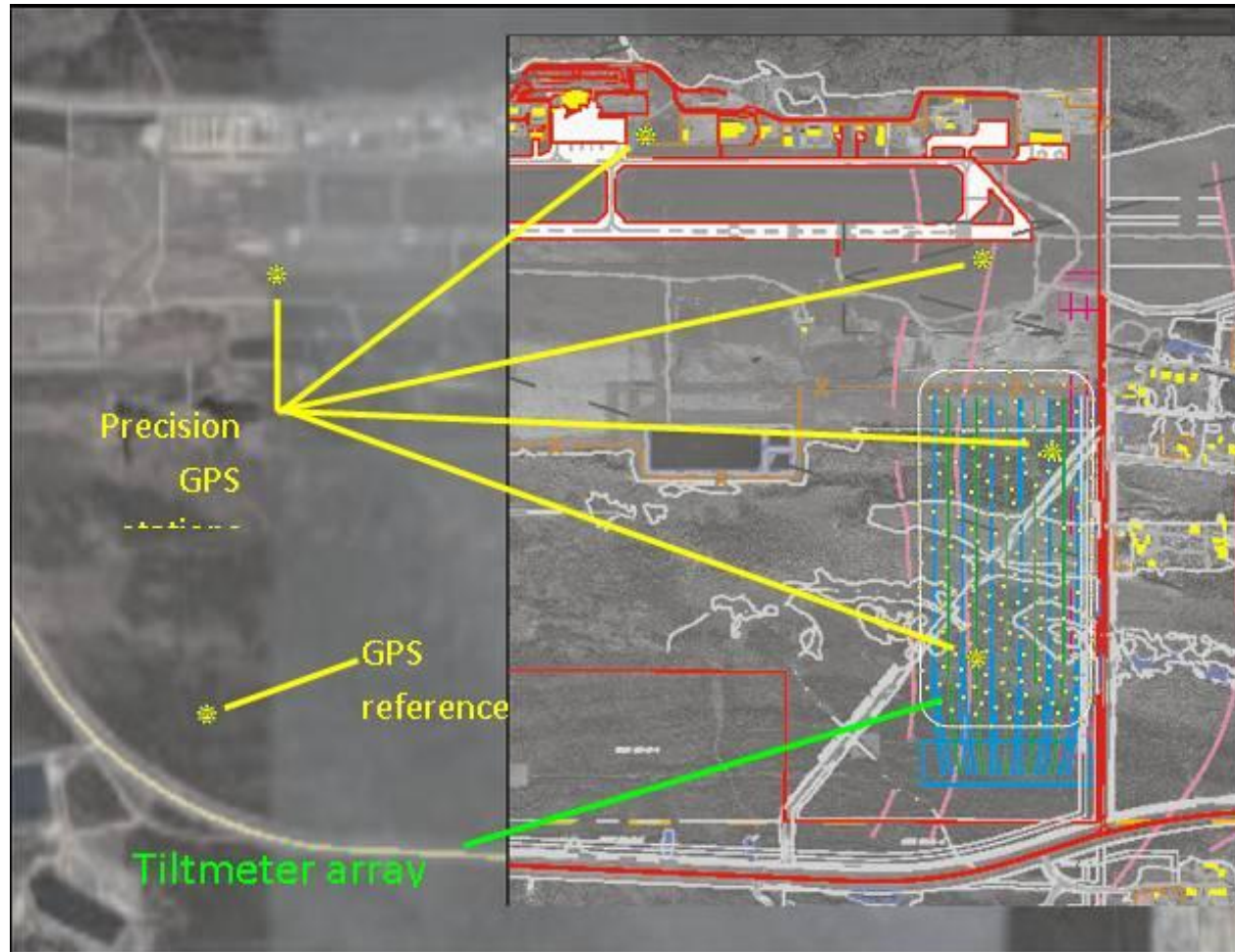
Bitcan Engineering

Maximum operating pressure



A conservative, geomechanical simulation study conducted indicate that an operating pressure of 1,000 kPaa should maintain the integrity of the AOS' asset throughout the life of the pilot project

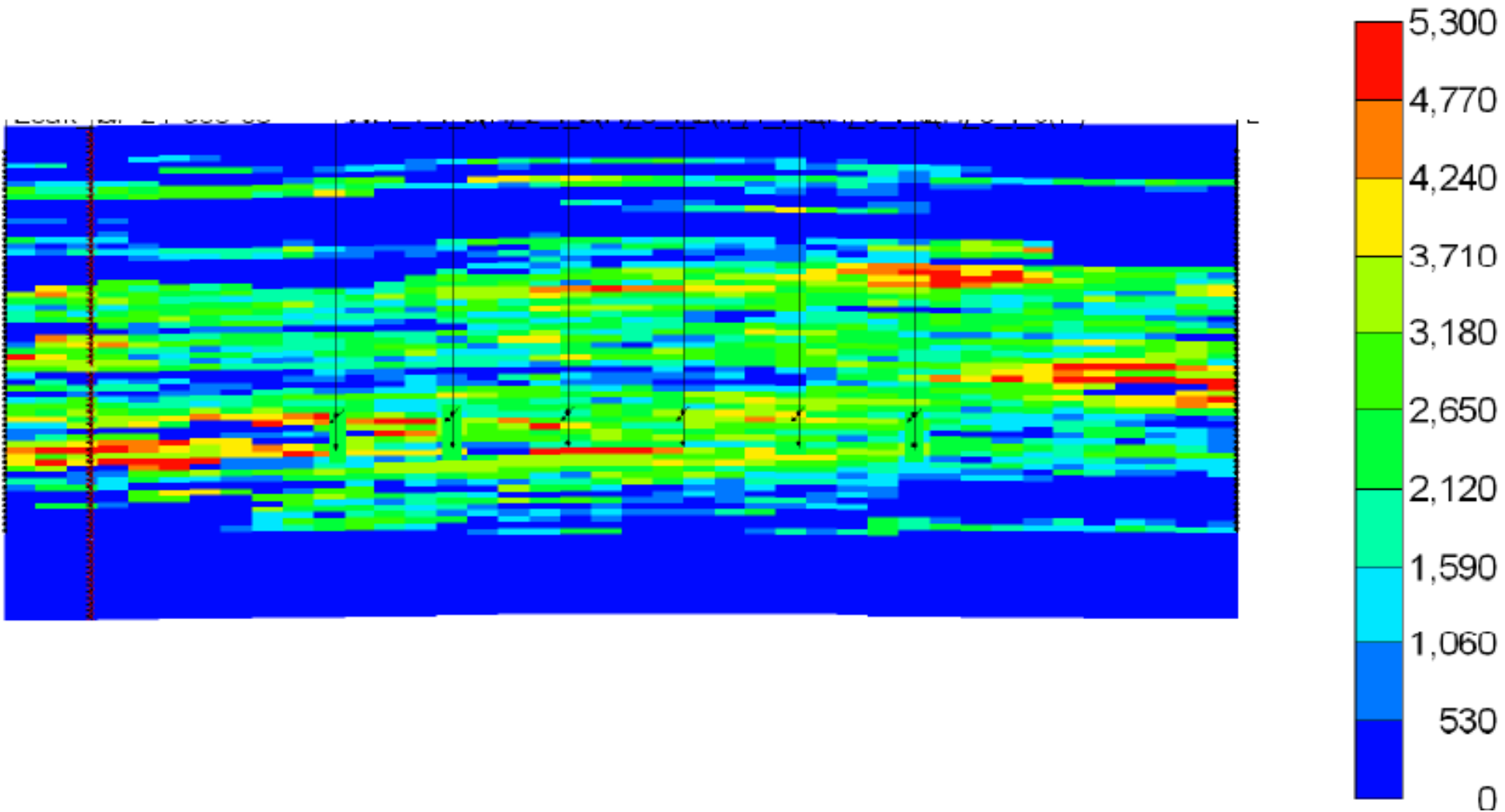
Diagnostic heave monitoring



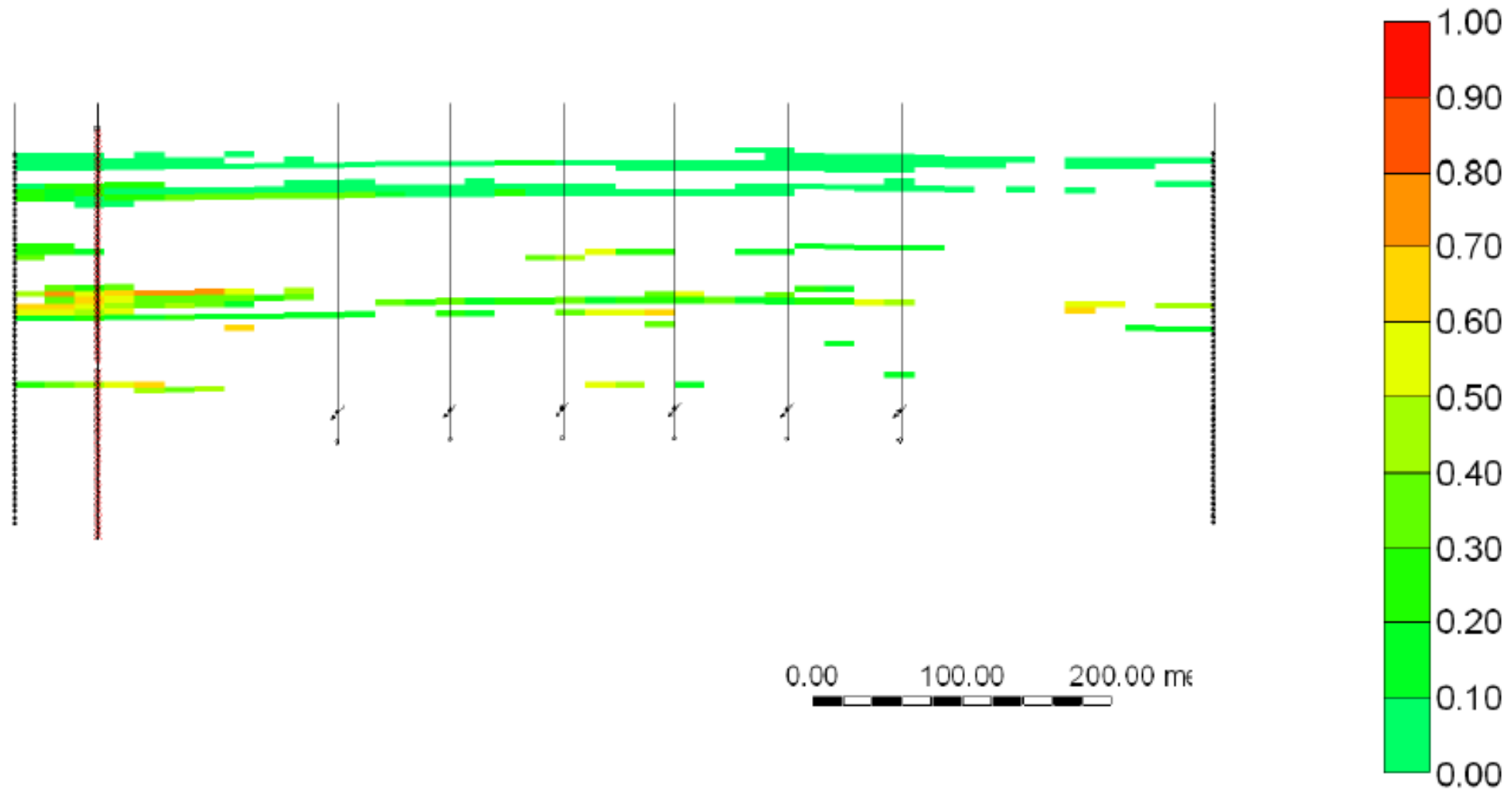
Halliburton
Pinnacle
Technologies

A reservoir monitoring scheme has been developed to enable direct and continuous feedback to ensure safe operations.

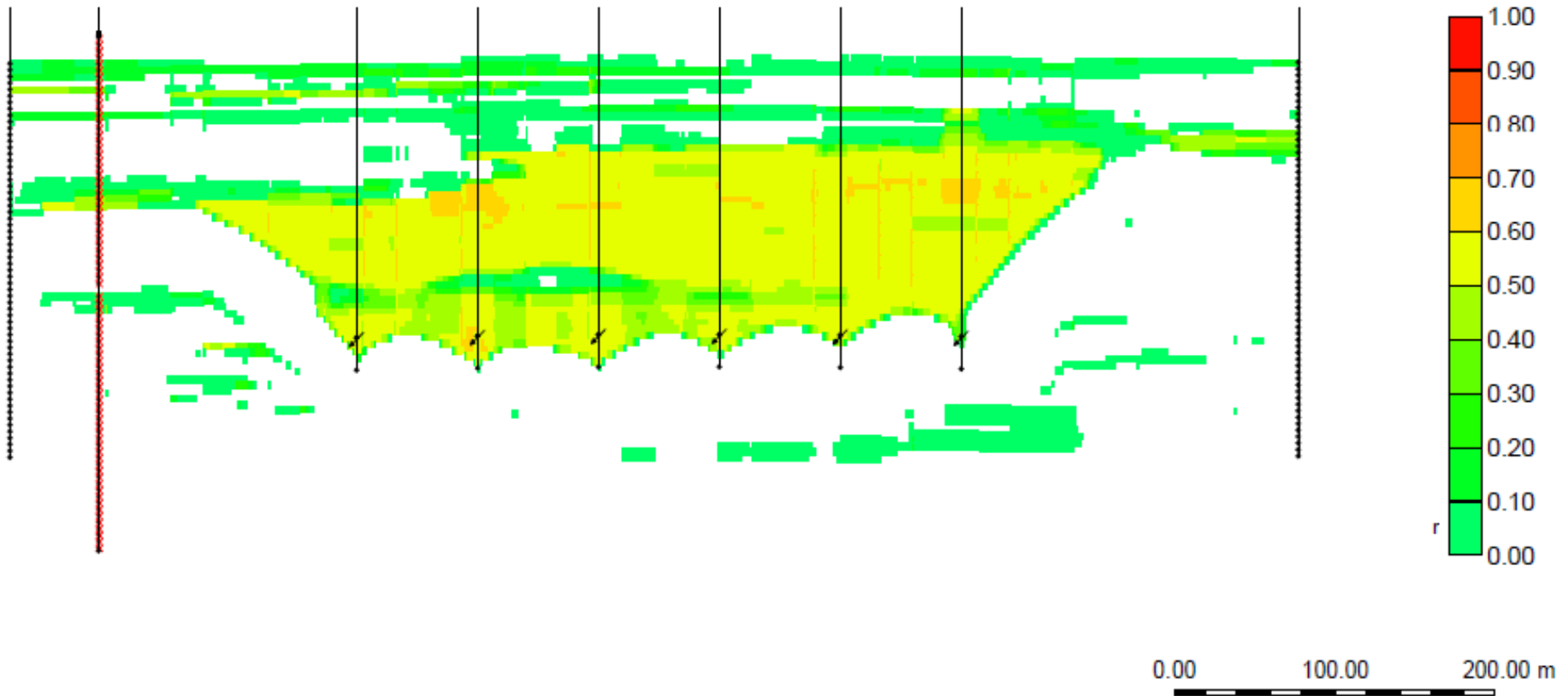
Reservoir model – vertical permeability distribution



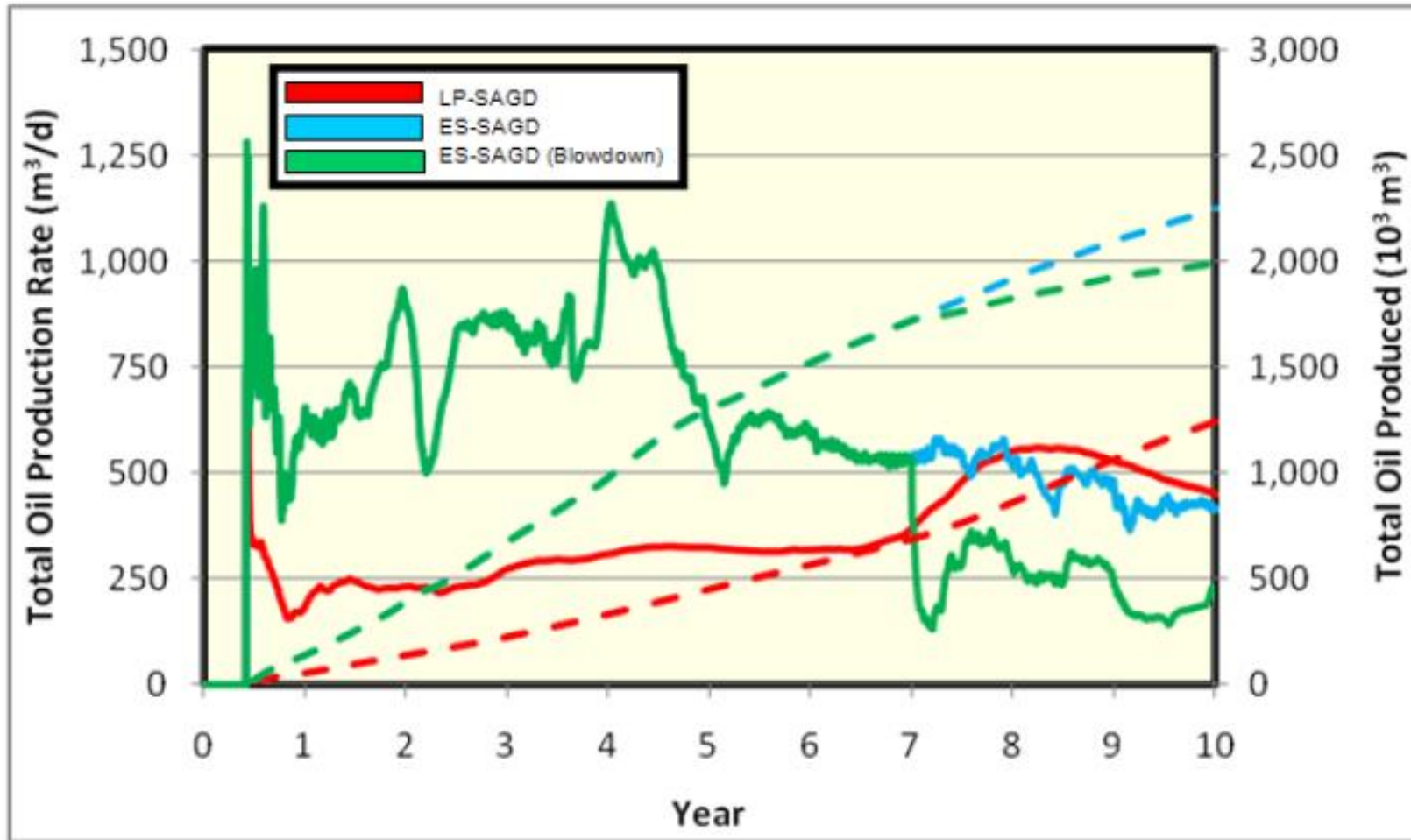
Gassy zone distribution – subsurface connection



Steam chamber conformance after 10 years of production

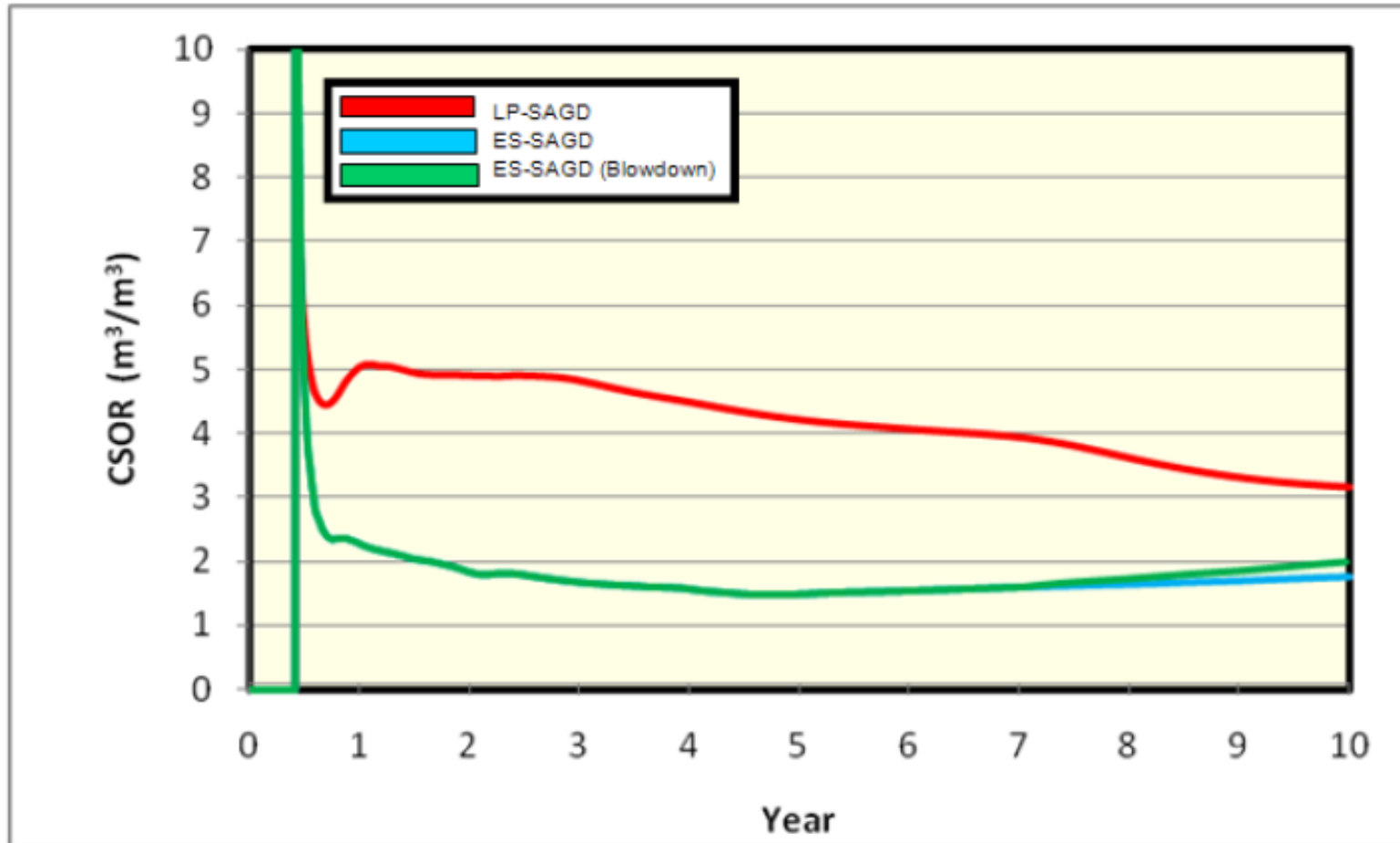


Oil production rate and recovery



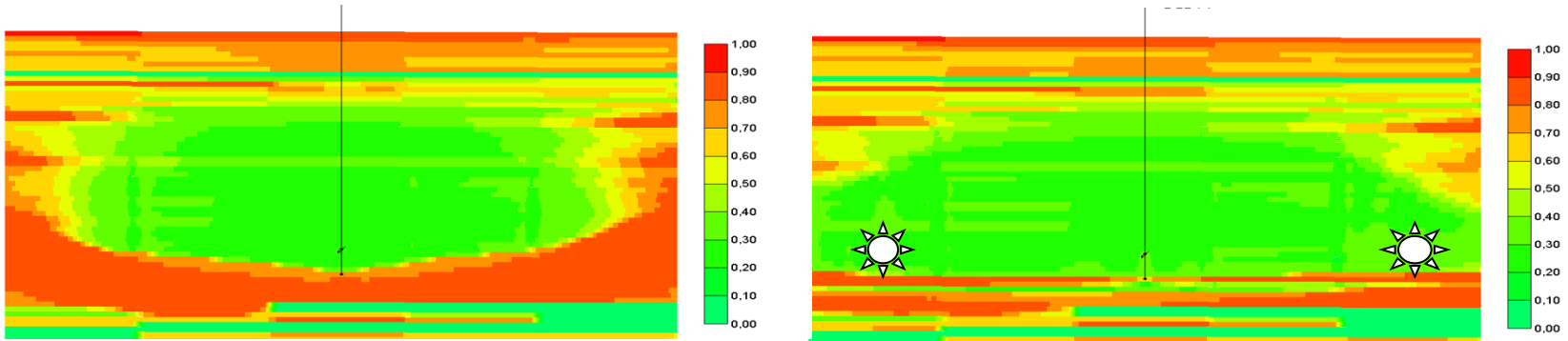
LP-SAGD some 2,000 BOPD and 48% recovery after 10 years
SLP-SAGD some 4,500 BOPD and 87% recovery after 10 years

Cumulative steam oil ratio



LP-SAGD CSOR some 3.2 after 10 years
SLP-SAGD CSOR some 1.8 after 10 years

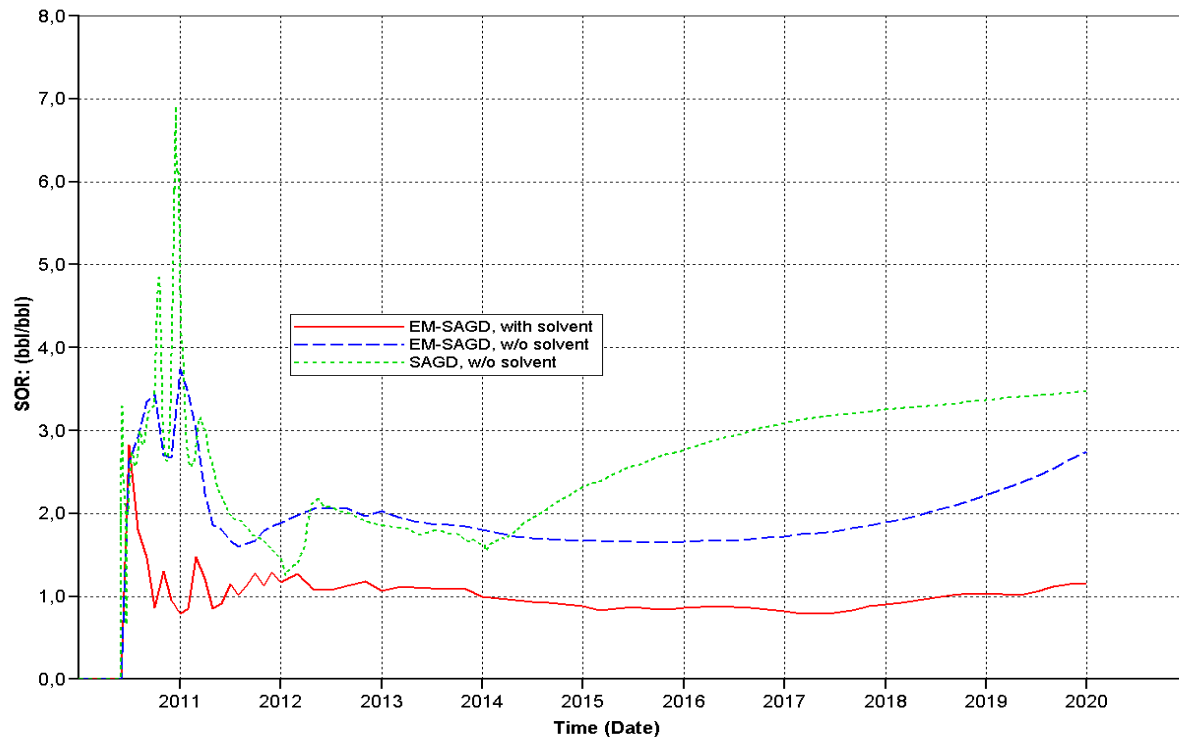
The potential of EM-SAGD



CSOR: SAGD
only is around 3

EM-SAGD is
around 2

and with solvent
co-injection
around 1



Conclusion

- Reservoir design requires the combined industry knowledge and oil sands experience of numerous experts in a variety of subsurface disciplines.
- Clearwater Phase I presents an excellent reservoir
- The 05-22 mini-fracs combined with detailed geomechanical modeling showed that an operating pressure of 1,000 kPaa should maintain the integrity of the AOS' asset throughout the life of Clearwater Phase I. The 09-21 mini-fracs support the initial results for the safe maximum operating pressure.
- A reservoir monitoring scheme has been developed to enable direct and continuous feedback to ensure safe operations. The measurements can be used to align predictions with field behavior.
- The simulation analysis shows that solvent co-injection is capable of significantly increase the injection rate and the recovery in the drainage area while at the same time reducing the CSOR from 3.2 for SAGD to 1.8 for SLP-SAGD which in turn significantly improves project economics from \$148 million dollars to \$219 million dollars.
- The EM-SAGD process needs field testing but initial analysis indicates a further reduction of the CSOR to 1.