

Coal Seam Gas Development Environmental Impacts



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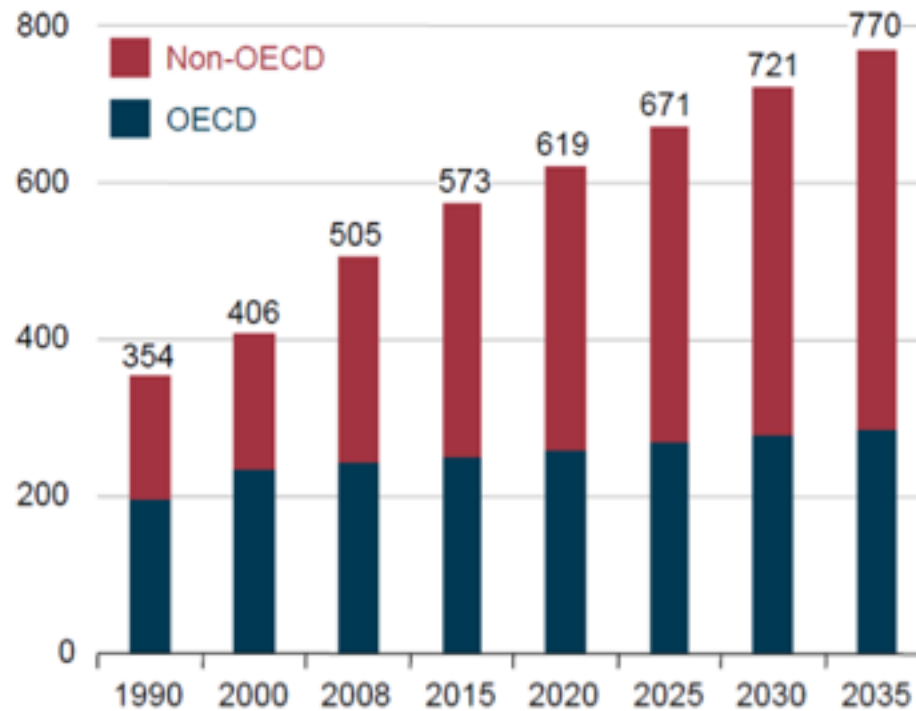
Outline

- Unconventional gas resources and CSG
- Resource management in Queensland and elsewhere
- Environmental authorities
- Environmental impacts
- Hydraulic fracturing
- Other issues

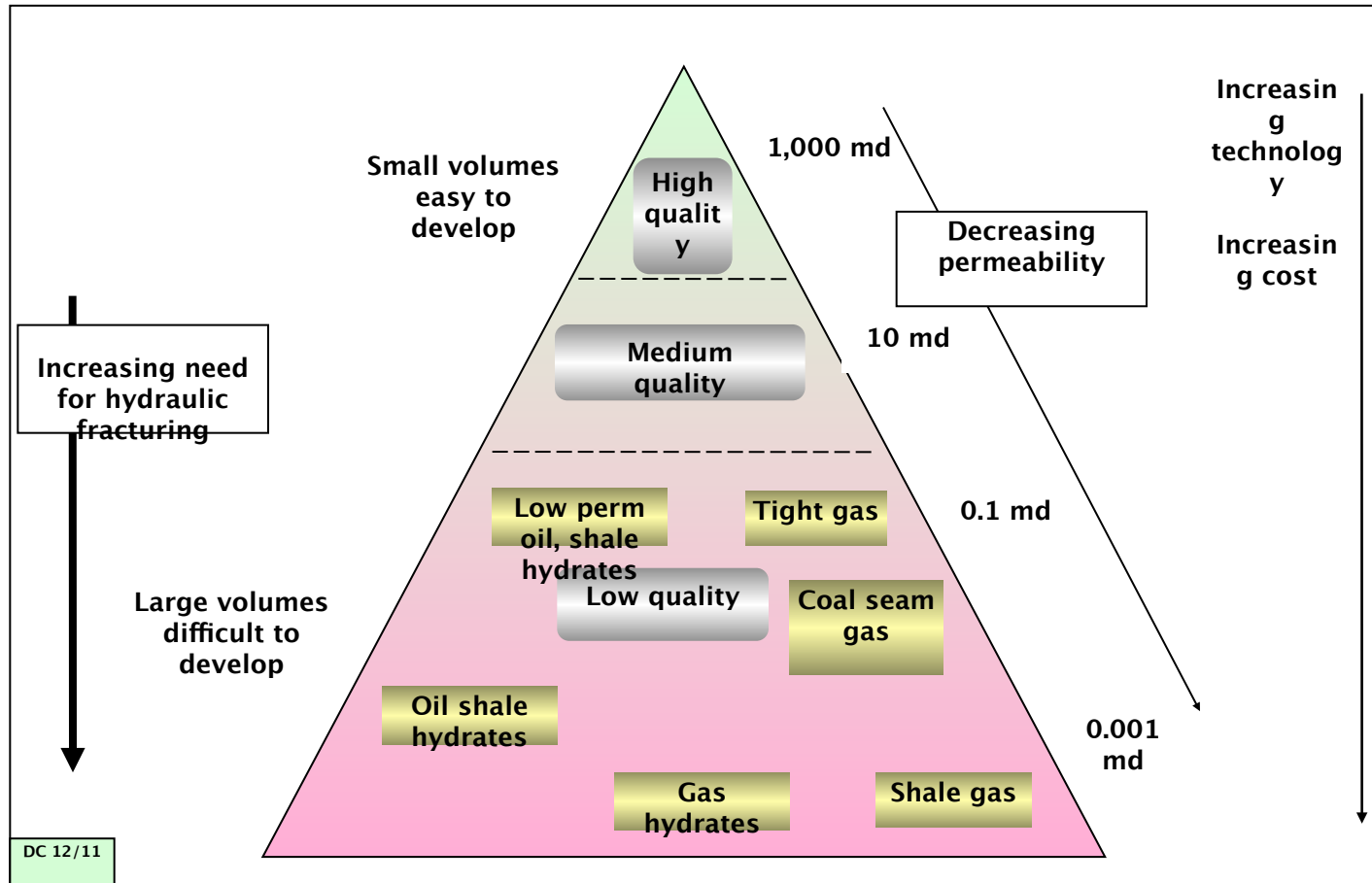
Unconventional gas resources and CSG

World Energy Consumption

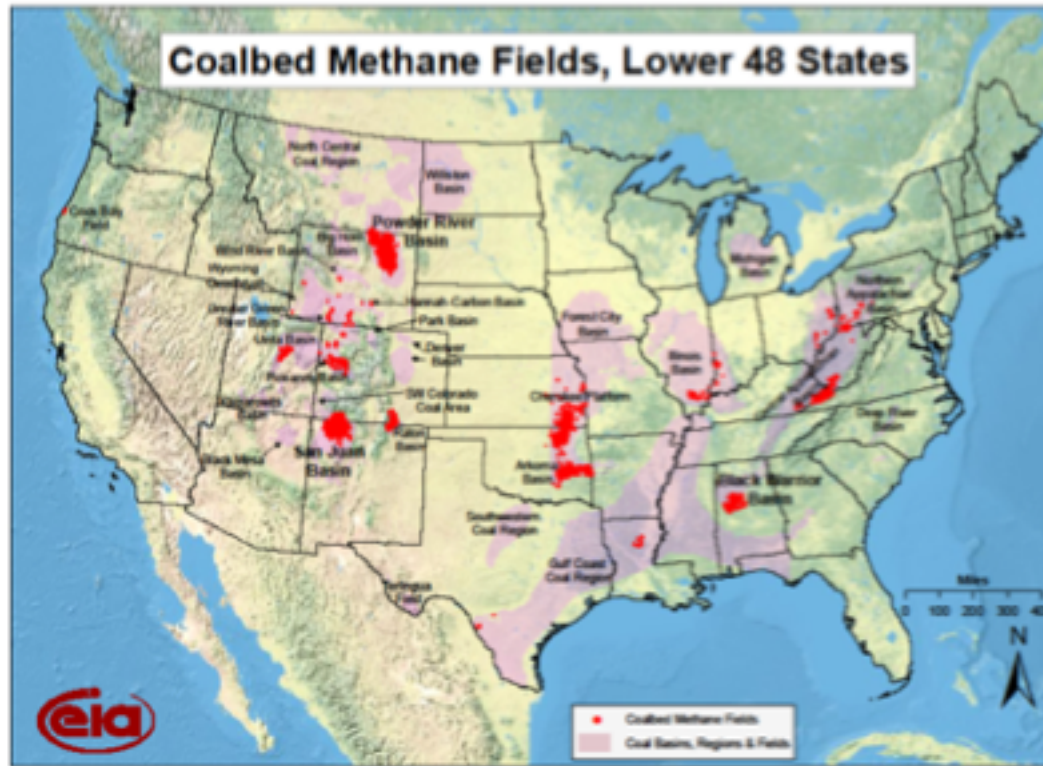
(Quadrillion Btu)



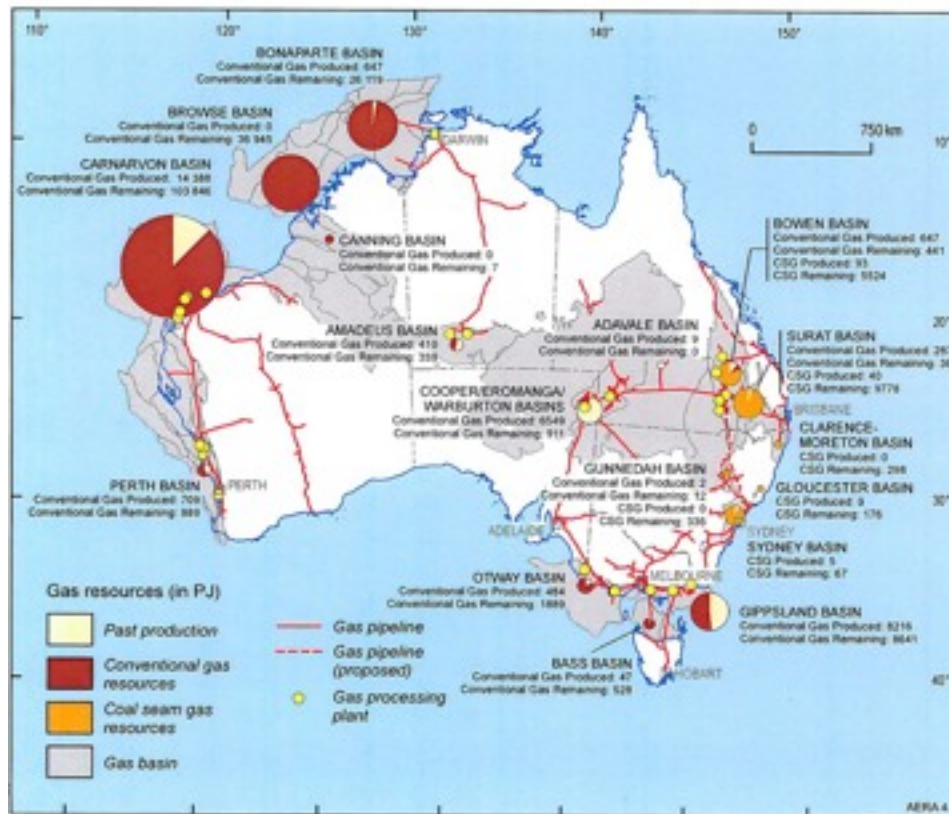
Hydrocarbon resource triangle



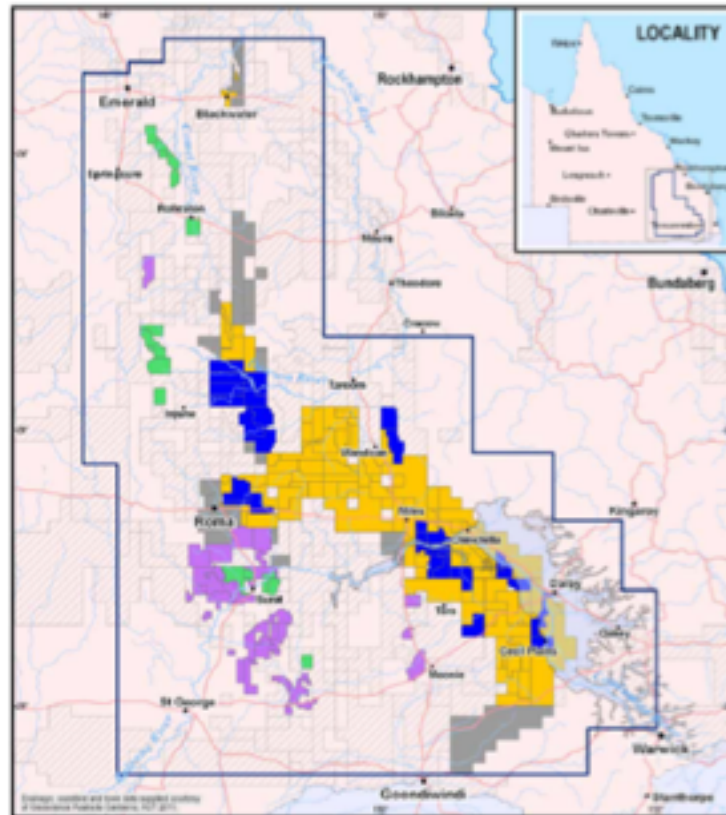
US Coal Seam Gas Basins



Australia Conventional Gas and CSG



Petroleum Tenures



Resource management in Queensland

Queensland Legislation and functions

- Petroleum and Gas (Production and Safety) Act
 - Department of Mines and Energy
 - Tenure
 - Process safety
 - Front line management
- Environmental Protection Act
 - Department of Environment and Heritage Protection
 - Environmental protection
 - Audit/compliance

Tenure



Environmental authority

CSG regulation in the US (Wyoming)

- Oil and Gas Conservation Commission
- State Engineers Office
- Department of Environmental Quality
- Bureau of Mines and Geology
- Environmental Protection Agency (Fed)
- Bureau of Land Management (Fed)

Environmental authorities

Environmental Authority Model Conditions

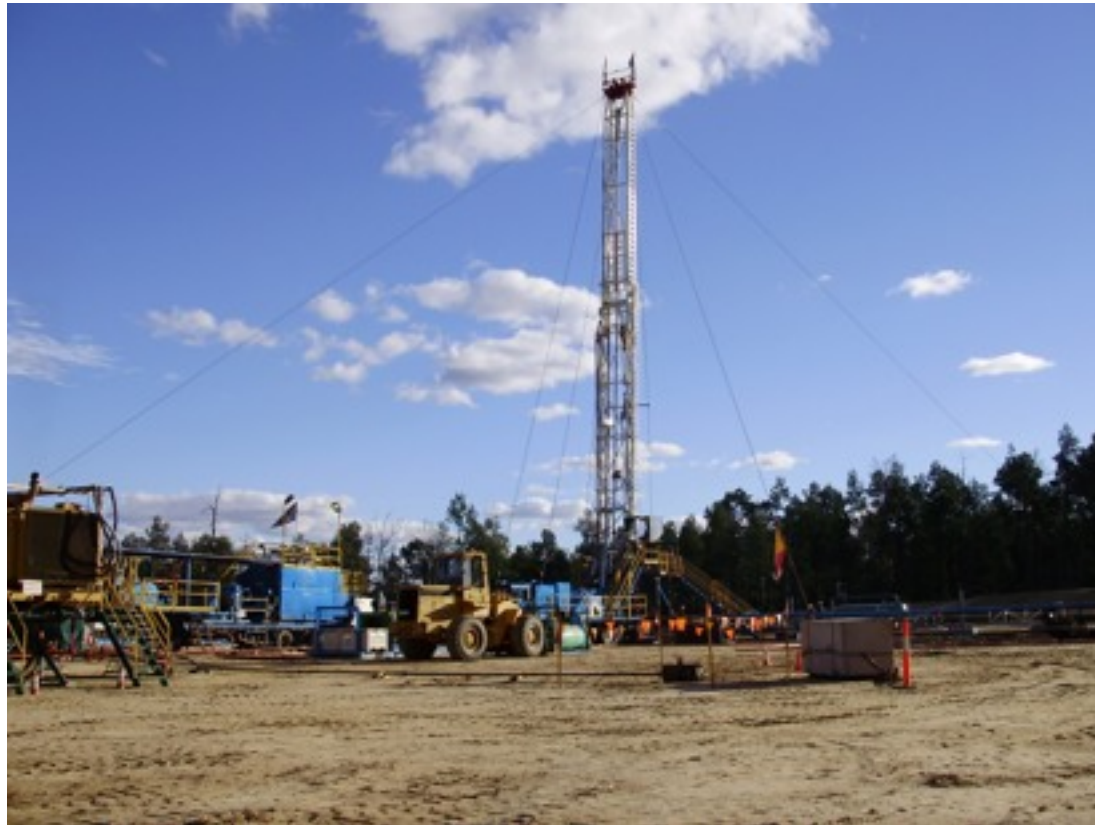
- General conditions
- Water
- Groundwater
- Regulated structures
- Land
- Disturbance to land
- Environmental nuisance
- Air
- Waste
- Rehabilitation
- Well construction, maintenance and stimulation activities
- Community issues
- Notification
- Sewage treatment
- Release to water of good quality CSG water
- Disturbance to land with biodiversity values

Environmental impacts

Seismic line



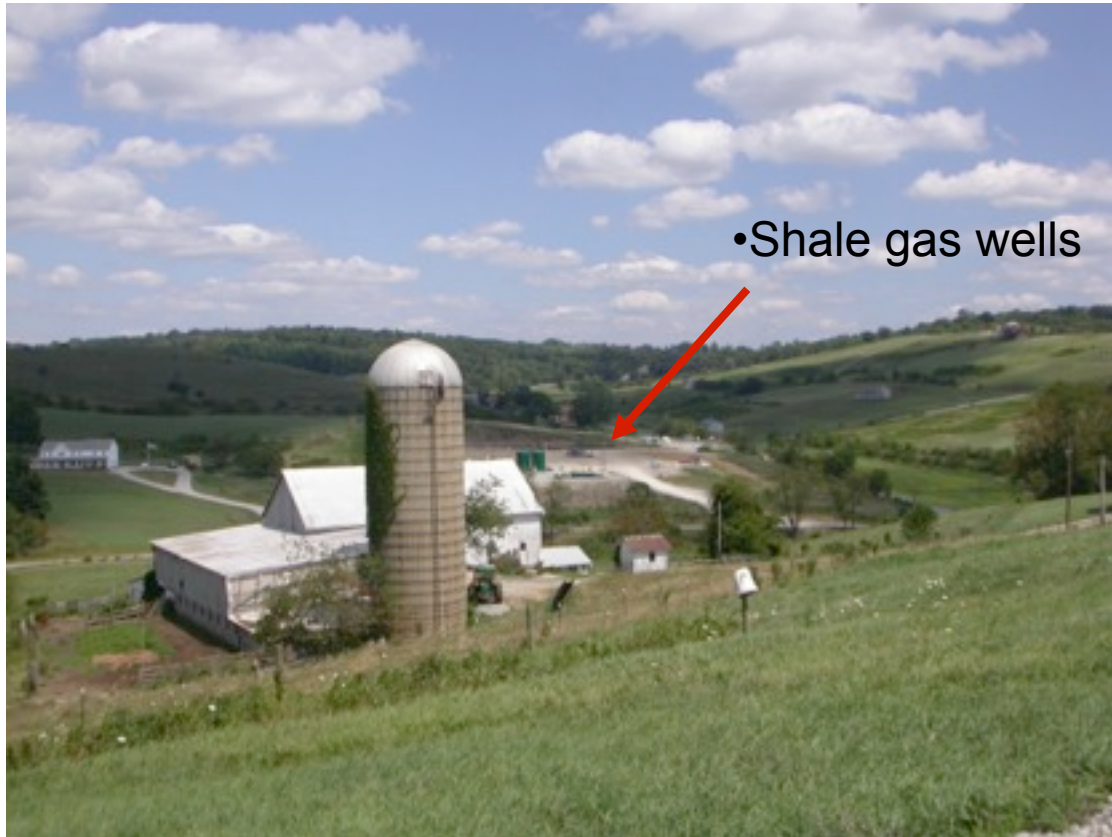
Light weight vertical drill rig



CSG well, power supply and water



Pennsylvania countryside



Instant tank



Aggregation dam



Severe erosion to dam wall



Pivot irrigation, Wyoming



Pipeline and cattle crossing



Condamine River crossing



Compressor station



Compressor station



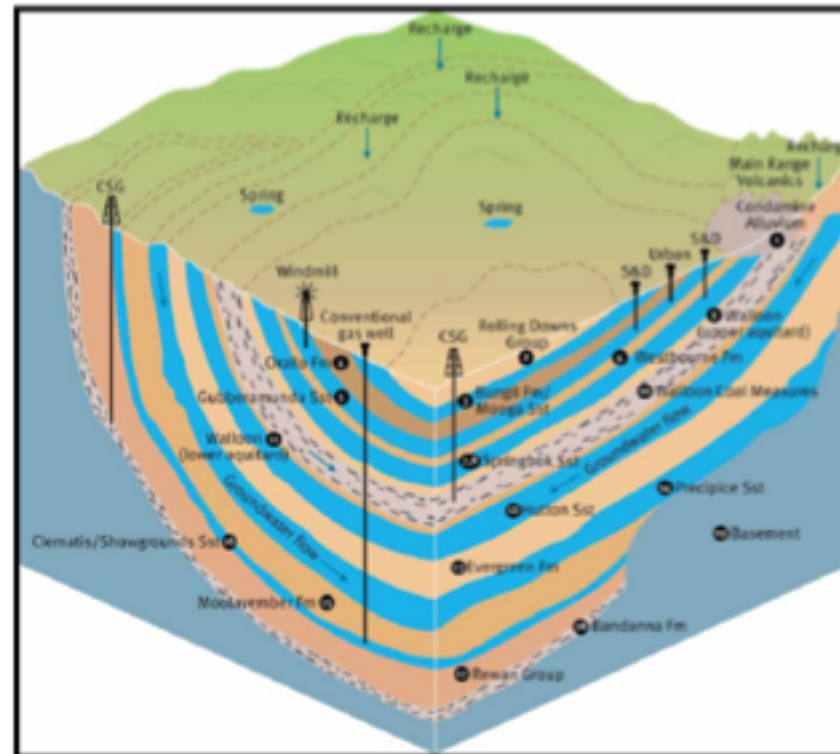
Main line compressor



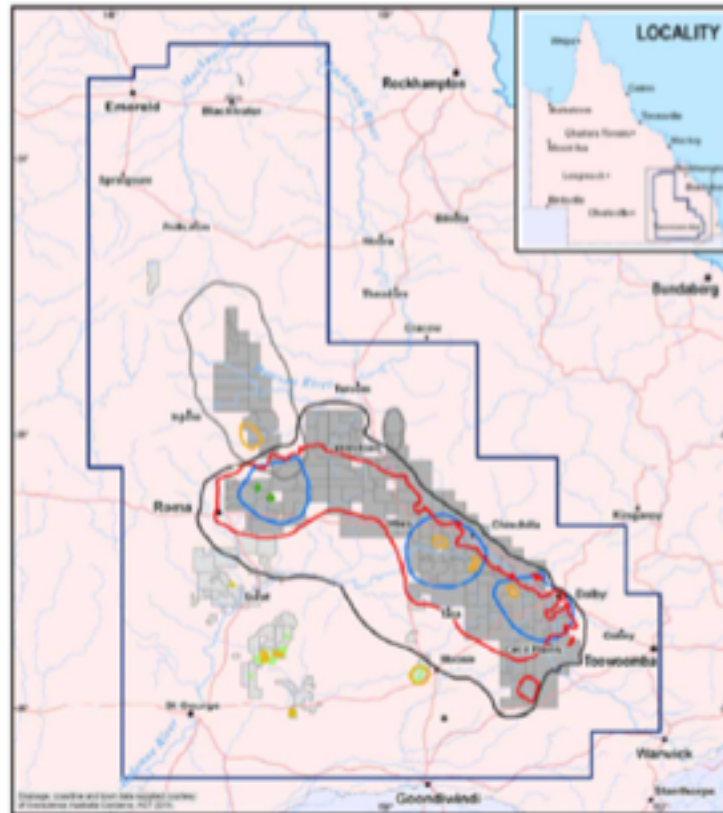
Well integrity problem



Surat Basin Hydrogeological Model



Cumulative Management Area



Hydraulic fracturing

FRACKING: *the debate*

THE UNBALANCED RESPONSE...



FRACKING: *the debate*

THE UNBALANCED RESPONSE...



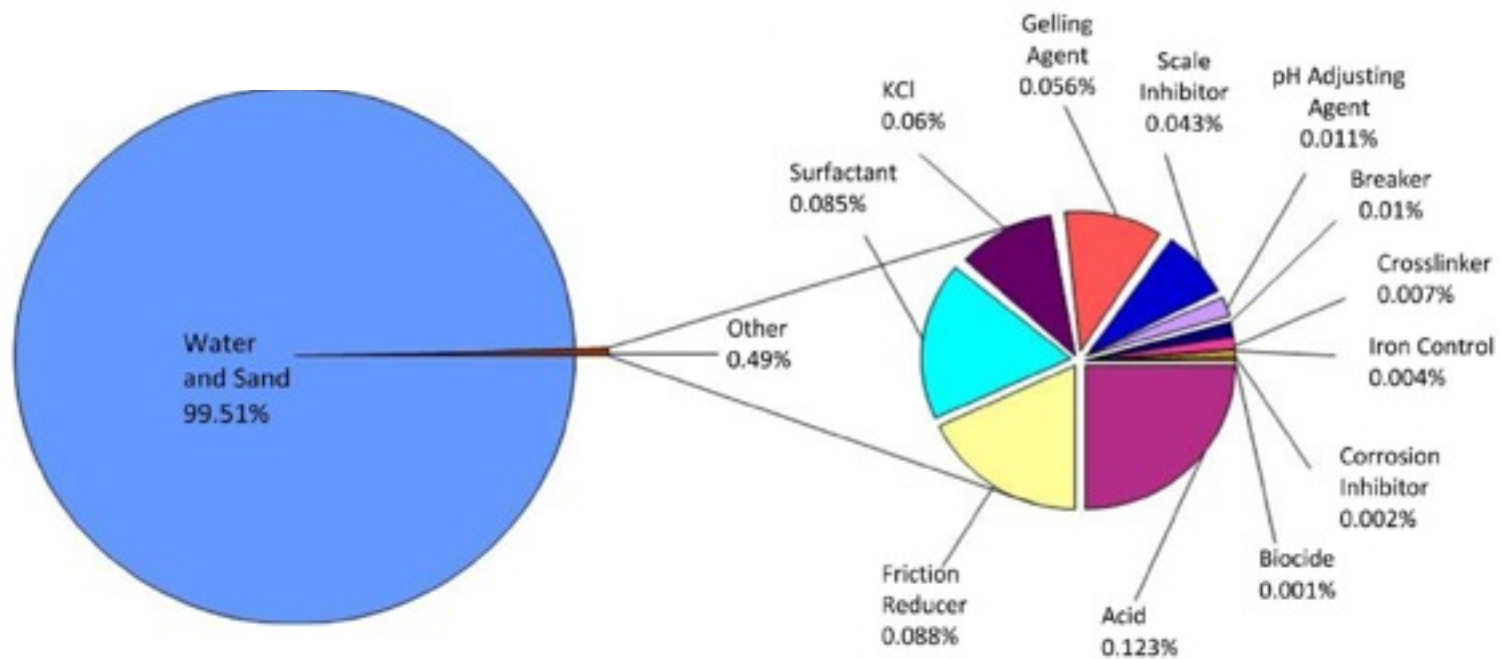
THE BALANCED RESPONSE...



Typical frac spread for shale



Frac Fluid Make-up



Source: ALL Consulting based on data from a fracture operation in the Fayetteville Shale, 2008

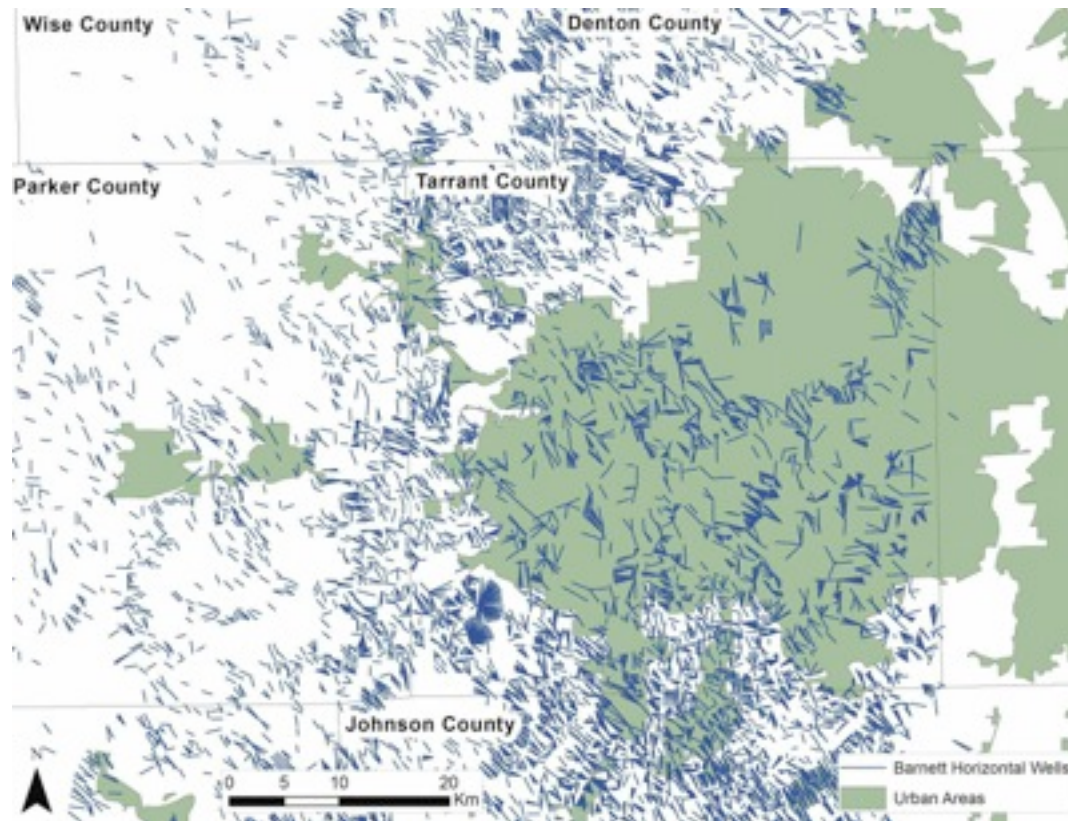
Hydraulic fracturing risk

- Detailed understanding of the local stratigraphy including aquifers, faults, linear features, hydraulic conductivity, porosity, seismic risk and groundwater dependent assets
- Installation of a multi-barrier casing string isolating hydrocarbon bearing formations from water resource aquifers and currently demonstrating internal and external mechanical integrity
- Requiring the presence of vertically

Hydraulic fracturing risk mitigation: 2

- Ensuring injected fluids have low human toxicity, eco-toxicity and contain no persistent, bio-accumulating constituents
- Applying advanced process control incorporating real-time analysis, fracture modelling and formation understanding utilising techniques such as microseismic measurements
- Detailed engineering understanding of the impacts of production drawdown on connectivity to aquifers above and below the fractured zone subsequent to the hydraulic fracturing activity
- To initiate and maintain a high level of effective

Barnett Shale gas wells, Texas



Other issues

Land access issues



Issues

- Strategic Cropping Land
- Health issues
- Competing tenures
- Salt
- International Network for Environmental Compliance and Enforcement

