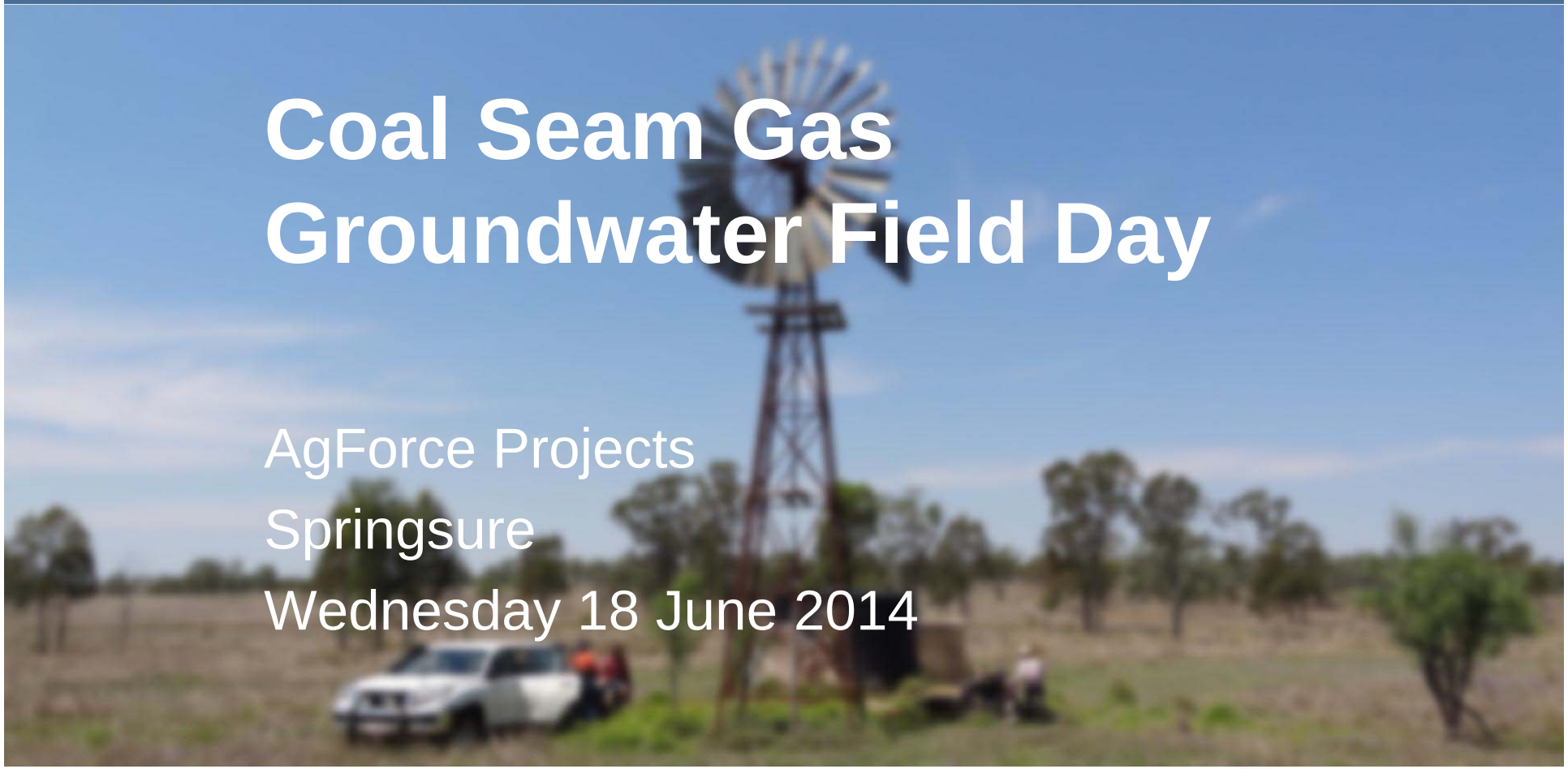


Coal Seam Gas Groundwater Field Day

AgForce Projects

Springsure

Wednesday 18 June 2014

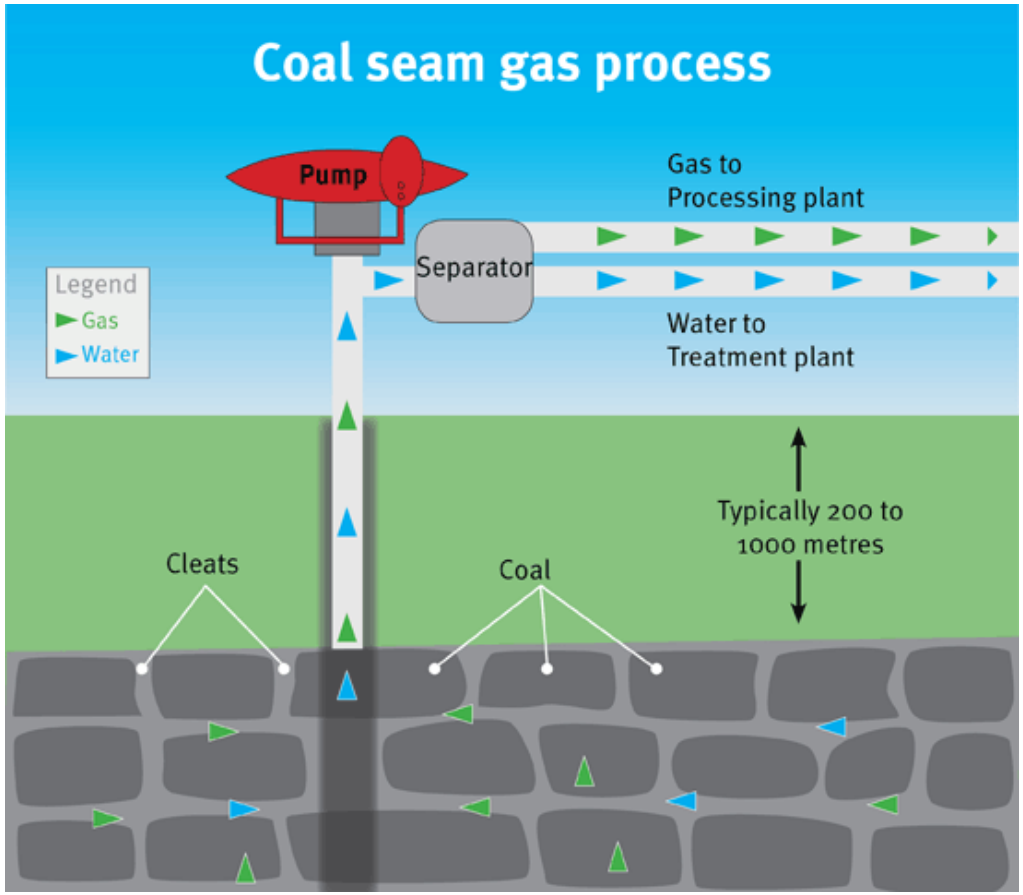
Today's presentation will cover:

- What is Coal Seam Gas (CSG)
- Hydrogeology Surat VS Bowen Basins
- CSG Development and Potential Impacts
- Groundwater Investigation and Assessment Team (GIAT) - What we do

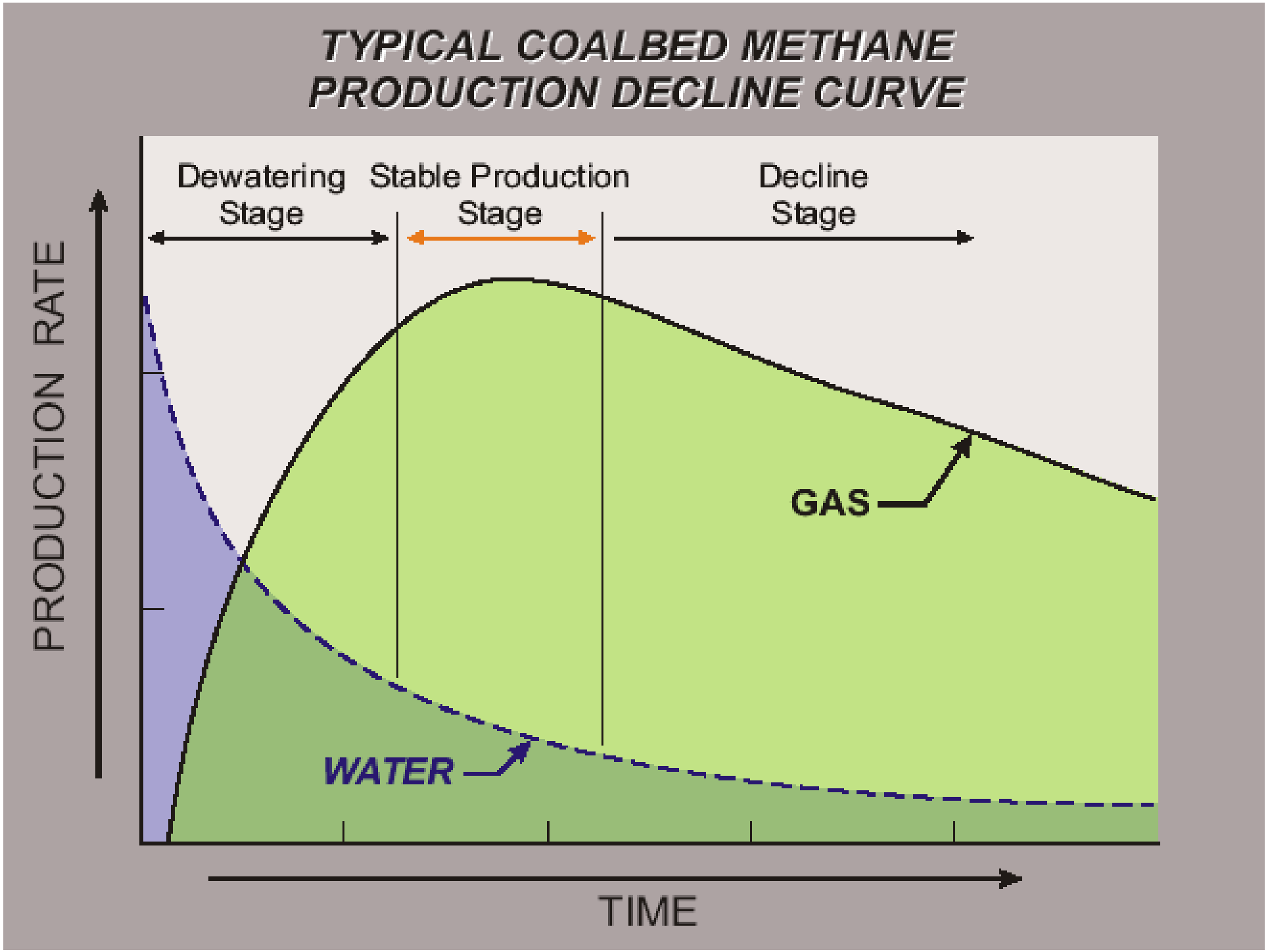
WHAT IS COAL SEAM GAS ?

- **Coal Seam Gas (CSG) is predominantly methane (CH_4)**
- **It is formed as organic matter is converted to coal (can be biogenic or thermogenic in origin)**
- **CSG is attached (adsorbed) along fracture surfaces (cleats) in the coal**
- **CSG is held in place by hydrostatic pressure**

How is CSG Extracted?

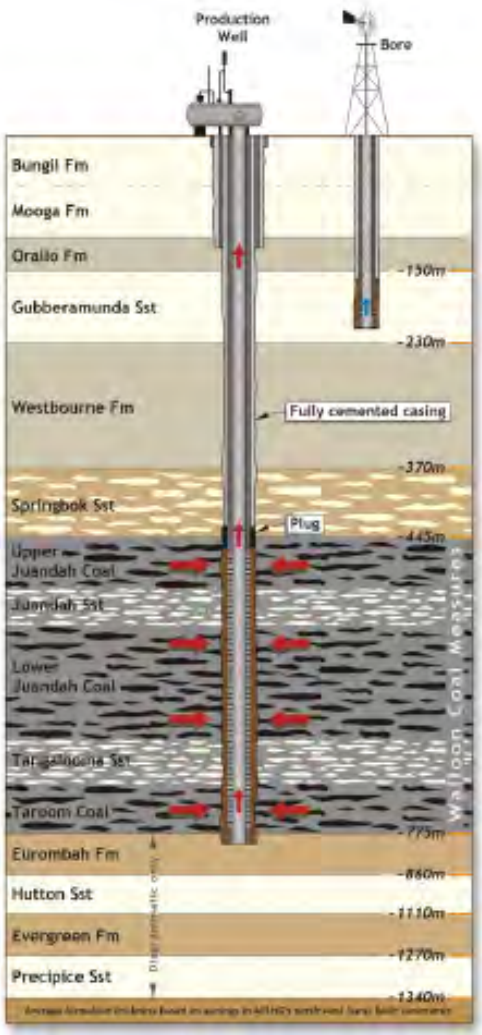


- Wells are drilled into the seam
- Formation water is pumped from the well to lower the pressure
- CSG is released from the coal as pressure on the coal is reduced
- Water is separated from the gas at the surface


TYPICAL COALBED METHANE
PRODUCTION DECLINE CURVE
Dewatering Stage
Stable Production Stage
Decline Stage
PRODUCTION RATE
GAS
WATER
TIME

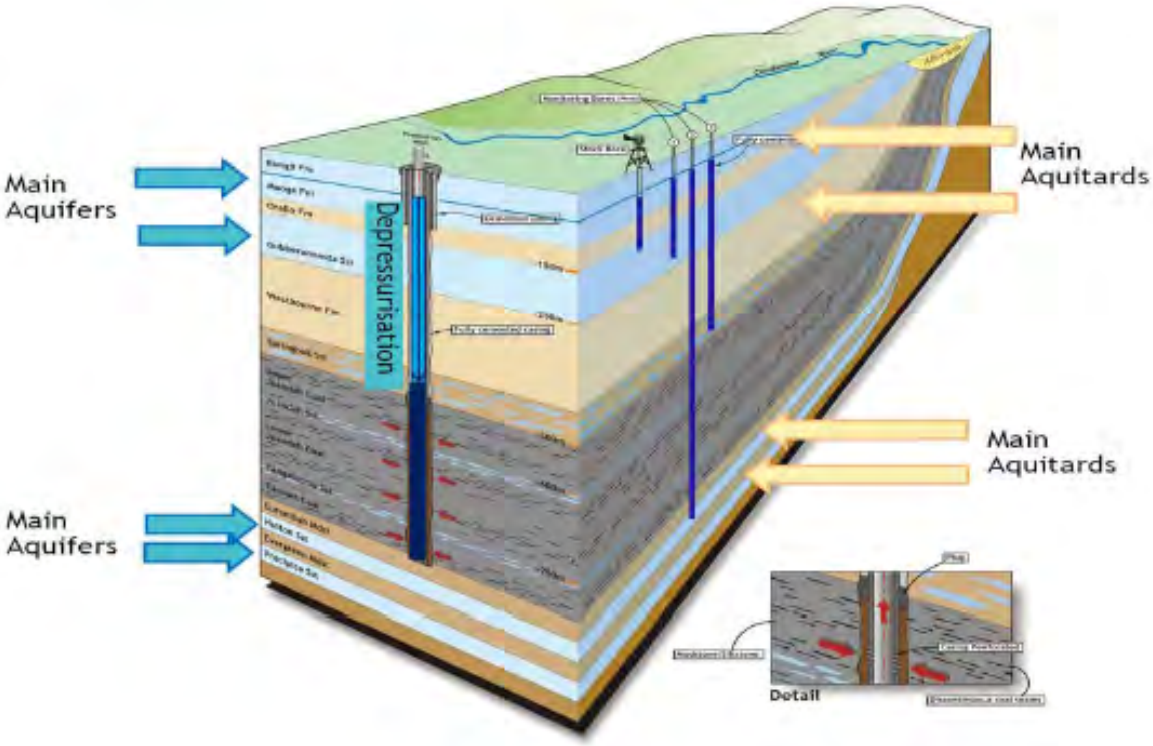
CSG well design

- Much deeper than most water bores
- Drilled with "mud" or air
- 216mm (8.5") hole
- 178mm (7") steel casing - pressure cemented in place
- Sometimes "openhole" over coal seams
- Aquifers used by farmers and communities are protected by cemented steel casing

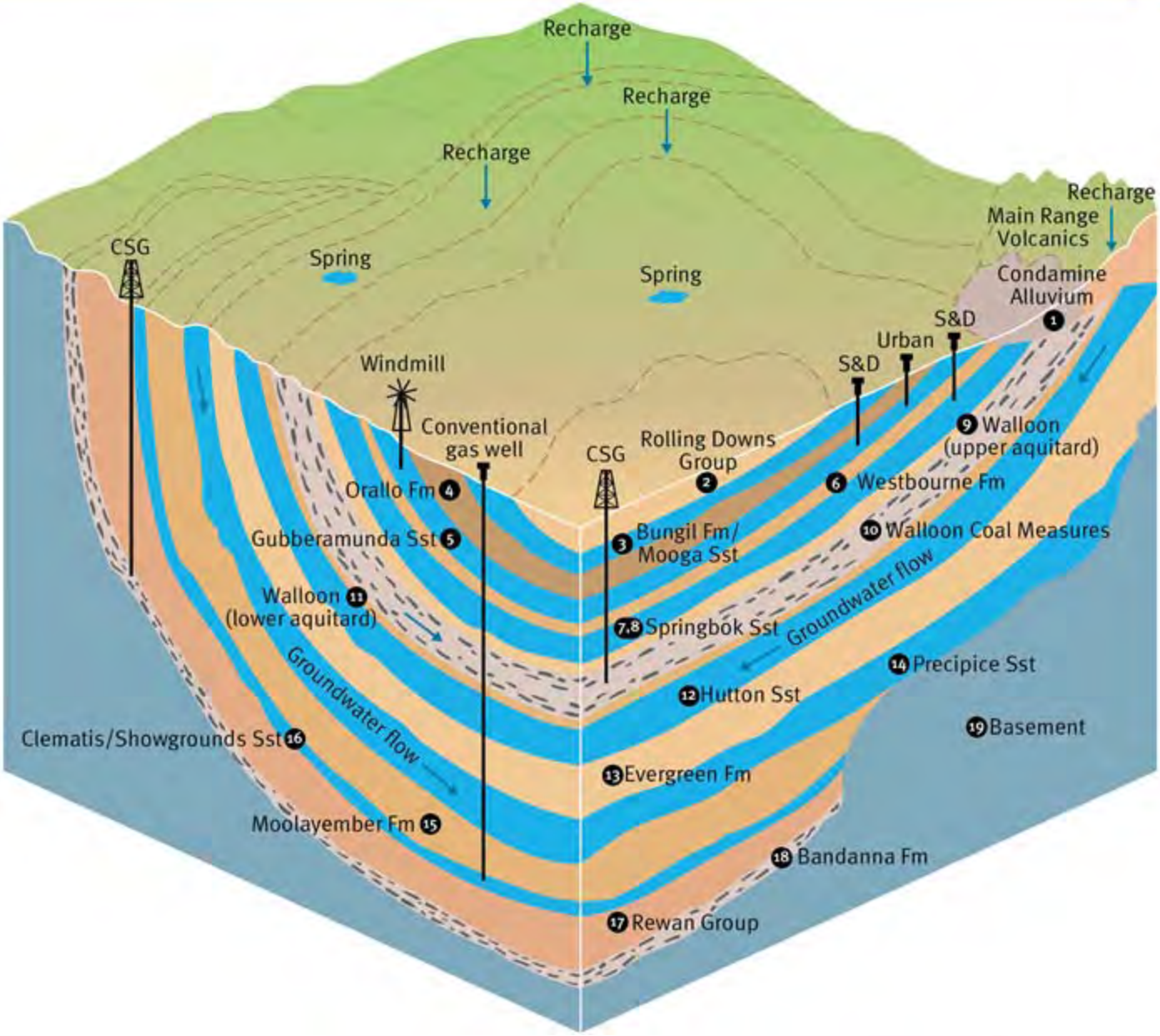


CSG Production and Hydrostratigraphy

Surat Basin



Aquifers and Aquitards in the CSG area



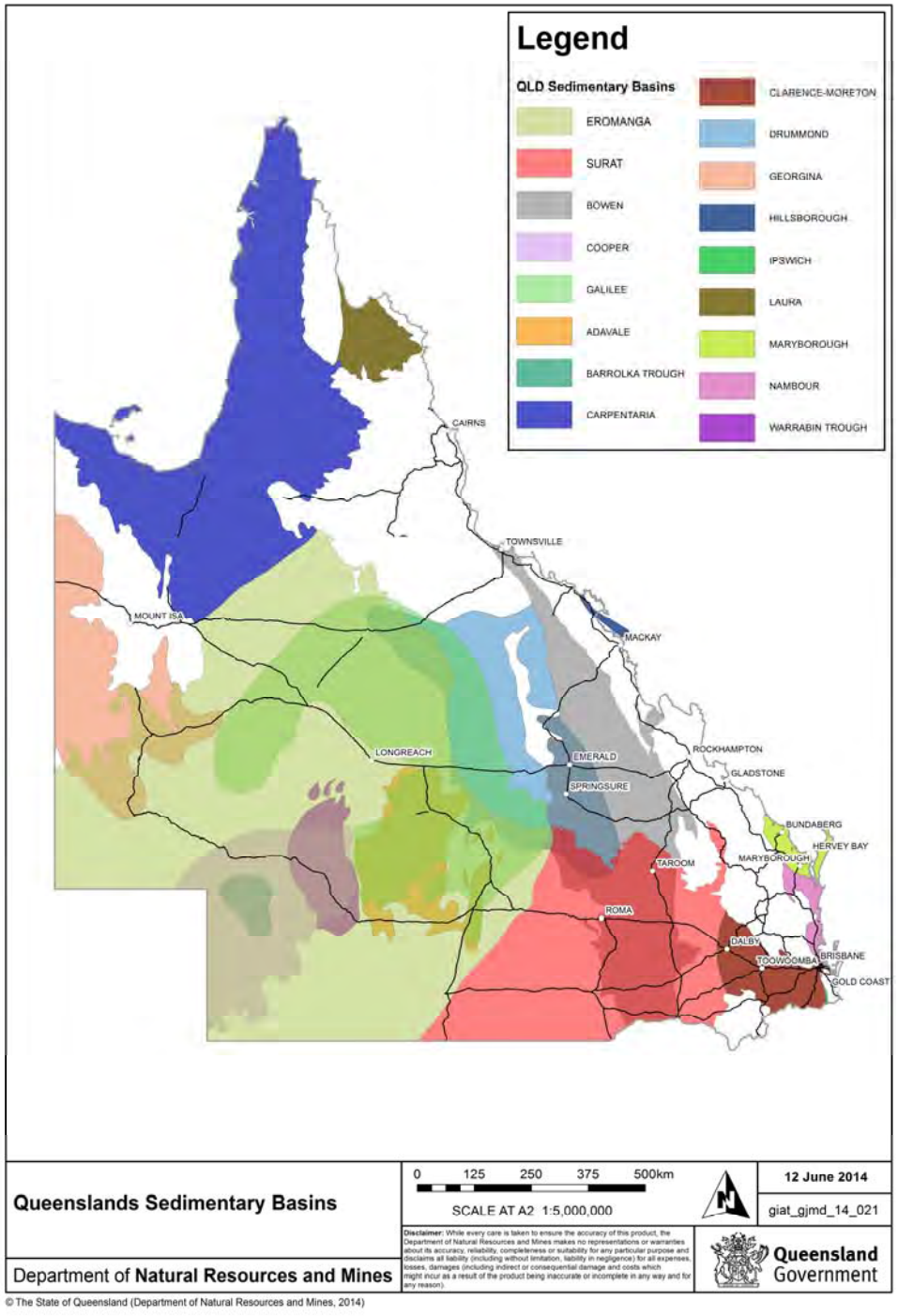
CSG Exploration History

Exploration commenced 1976 in Bowen Basin
Technical difficulties / lack of markets
Commercial production

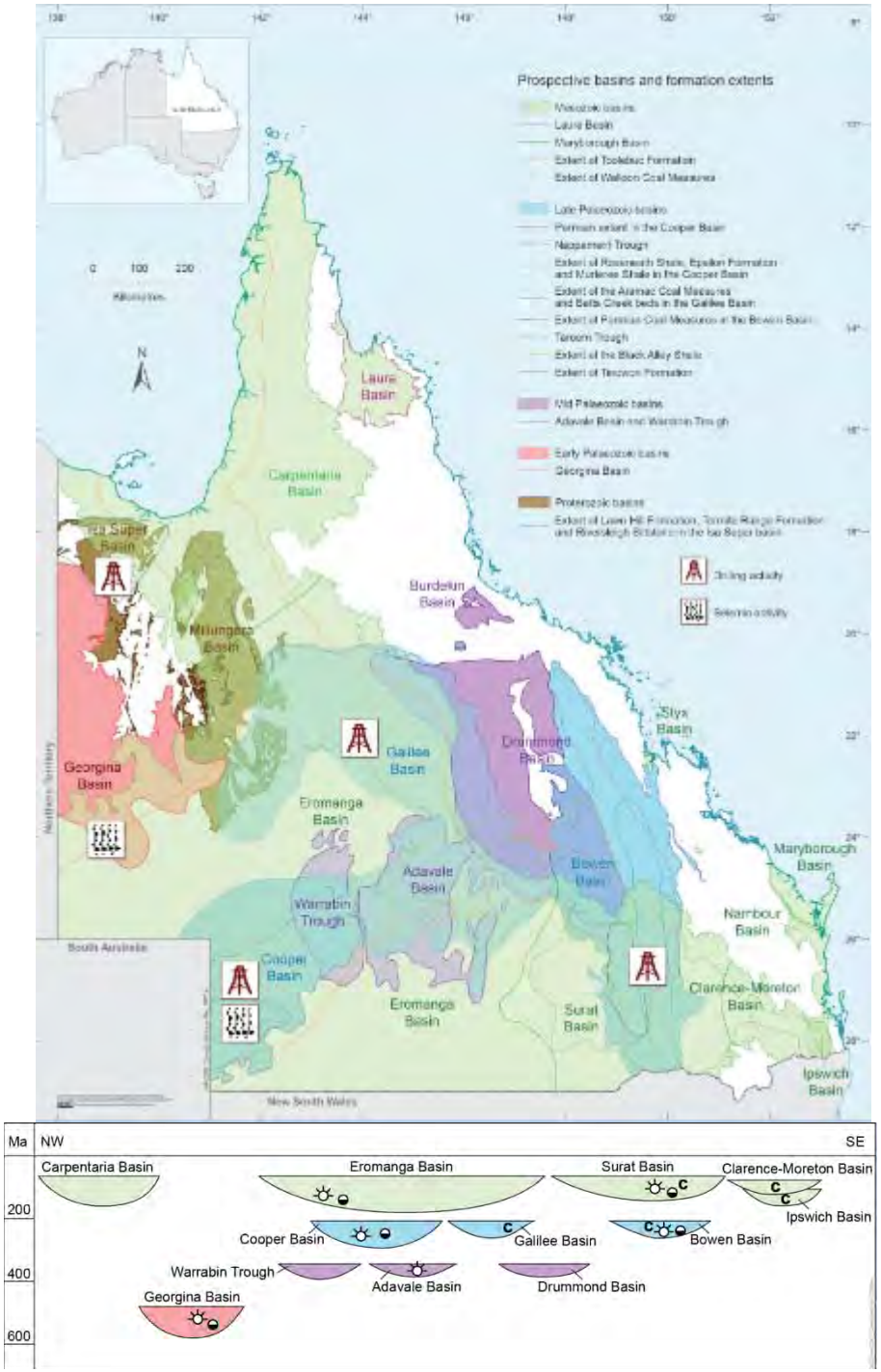
- Bowen Basin
  - Dawson Valley 1996
  - Injune 1998
  - Moranbah 2005
- Surat Basin
  - Kogan North 2006
  - Berwyndale 2006
  - Dalby to Roma

Hydrogeology
Surat Vs Bowen Basins

Geological Basins in Queensland



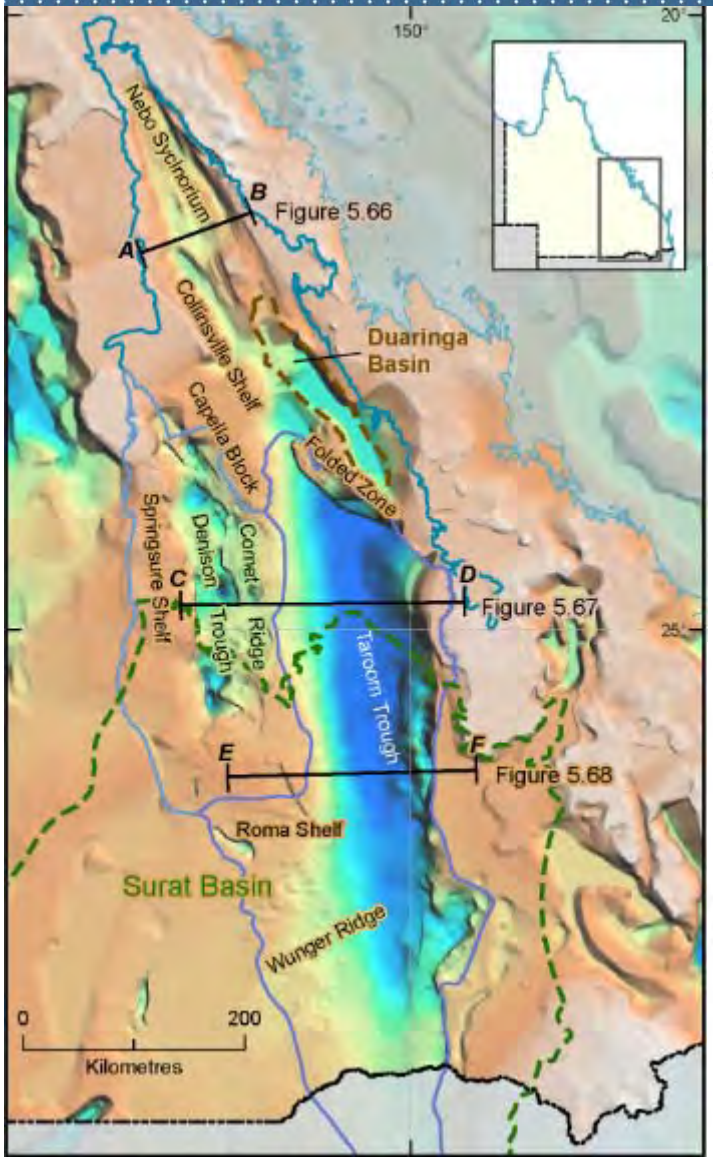
Geological Basins in Queensland

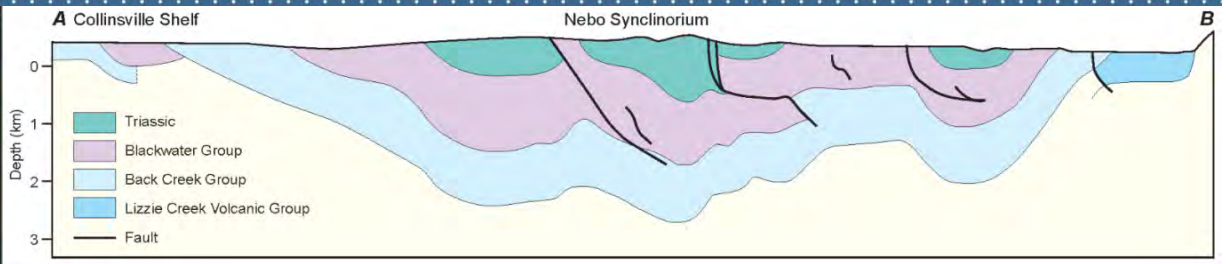


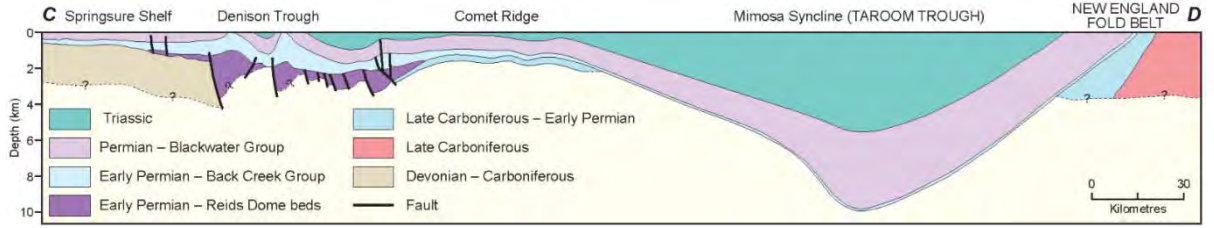
Surat and Bowen Basin stratigraphy

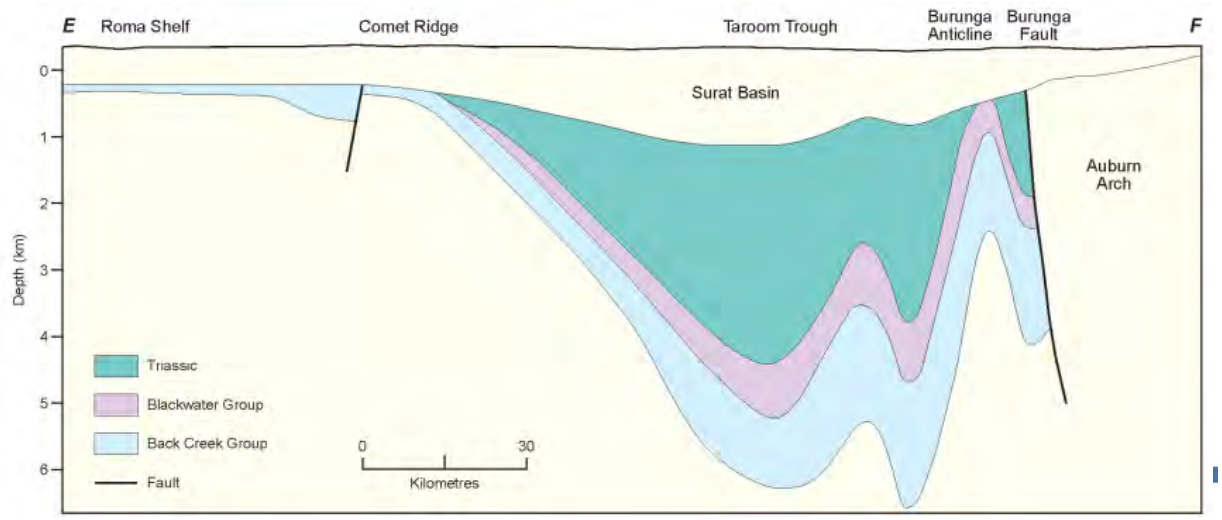
	Age	Lithostratigraphic Unit		Hydrogeologic Deisgnation
SURAT BASIN	Cretaceous	Rolling Downs Group	Griman Creek Formation	Aquitard
			Surat Siltstone	
			Wallumbilla Formation	
	Jurassic (144 – 213 Ma)	Kumbarilla Beds	Bungil Formation	Aquifer
			Mooga Sandstone	Aquifer
			Orallo Formation	Aquitard
			Gubberamunda Sandstone	Aquifer
		Injune Creek Group	Westbourne Formation	Aquitard
			Springbok Sandstone	Aquifer
			Walloon Coal Measures	Aquifer (coal seams)/ Aquitard (siltstone/mudstone)
		Eurombah Formation		Aquitard
		Hutton Sandstone		Aquifer
		Evergreen Formation		Aquitard
		Precipice Sandstone		Aquifer
BOWEN BASIN	Triassic (213 – 248 Ma)	Wandoan Formation	Moolayember Formation	Alternating Aquifers and Aquitards
			Clematis Sandstone	Aquifer
		Rewan Formation		Aquitard
	Permian (248 – 297 Ma)	Blackwater Group	Bandanna Formation (coal measures - west Baralaba Coal Measures - east	Aquifer (coal seams)/ Aquitard (siltstone/mudstone)
			Kaloola Member	Aquitard
		Back Creek Group	Black Alley Shale	Aquitard
			Tinowon Formation	Aquitard
			Muggleton Formation	Aquifer
		Early Permian Undifferentiated		

Bowen Basin Cross Sections – Northern – Central - Southern

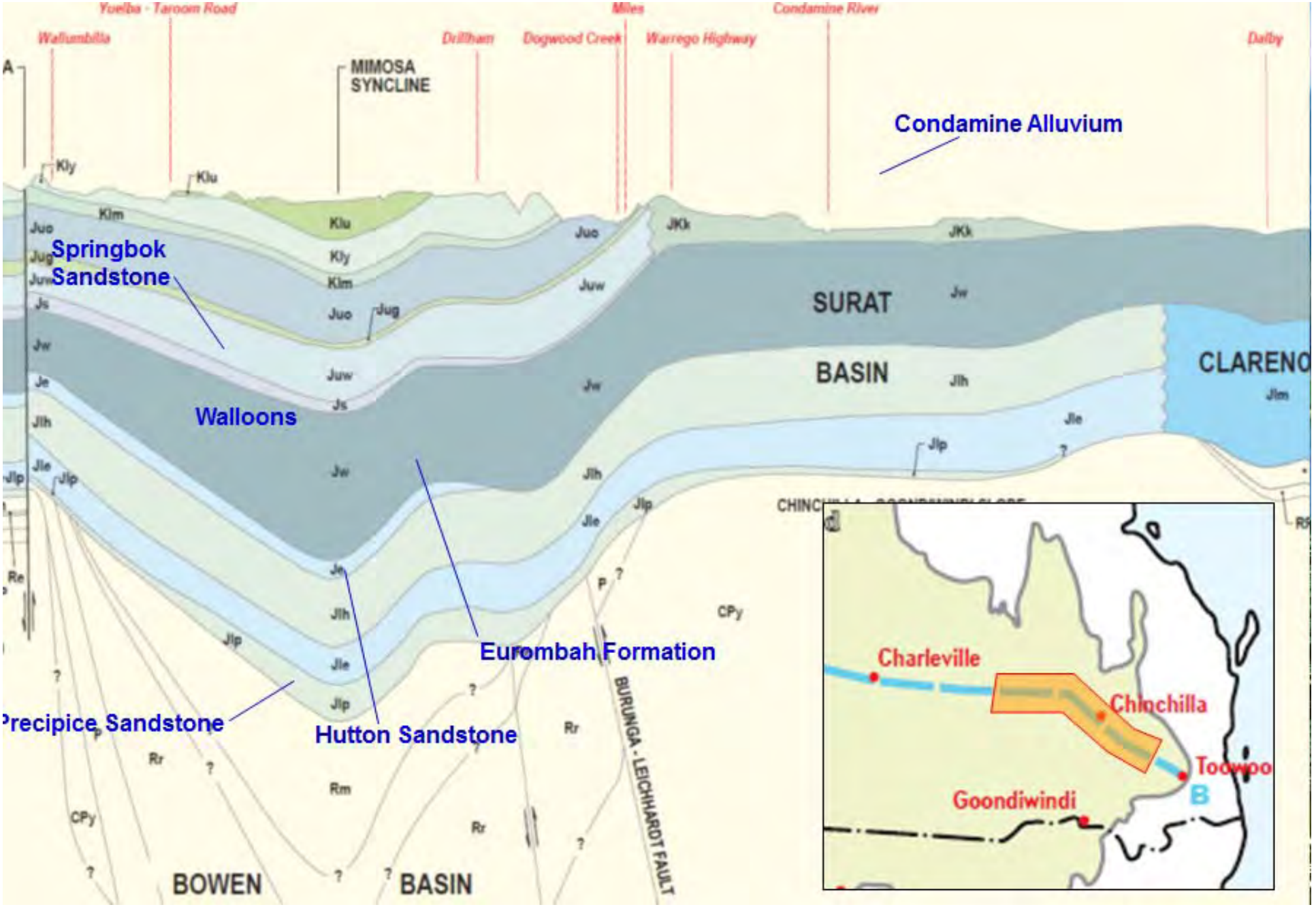


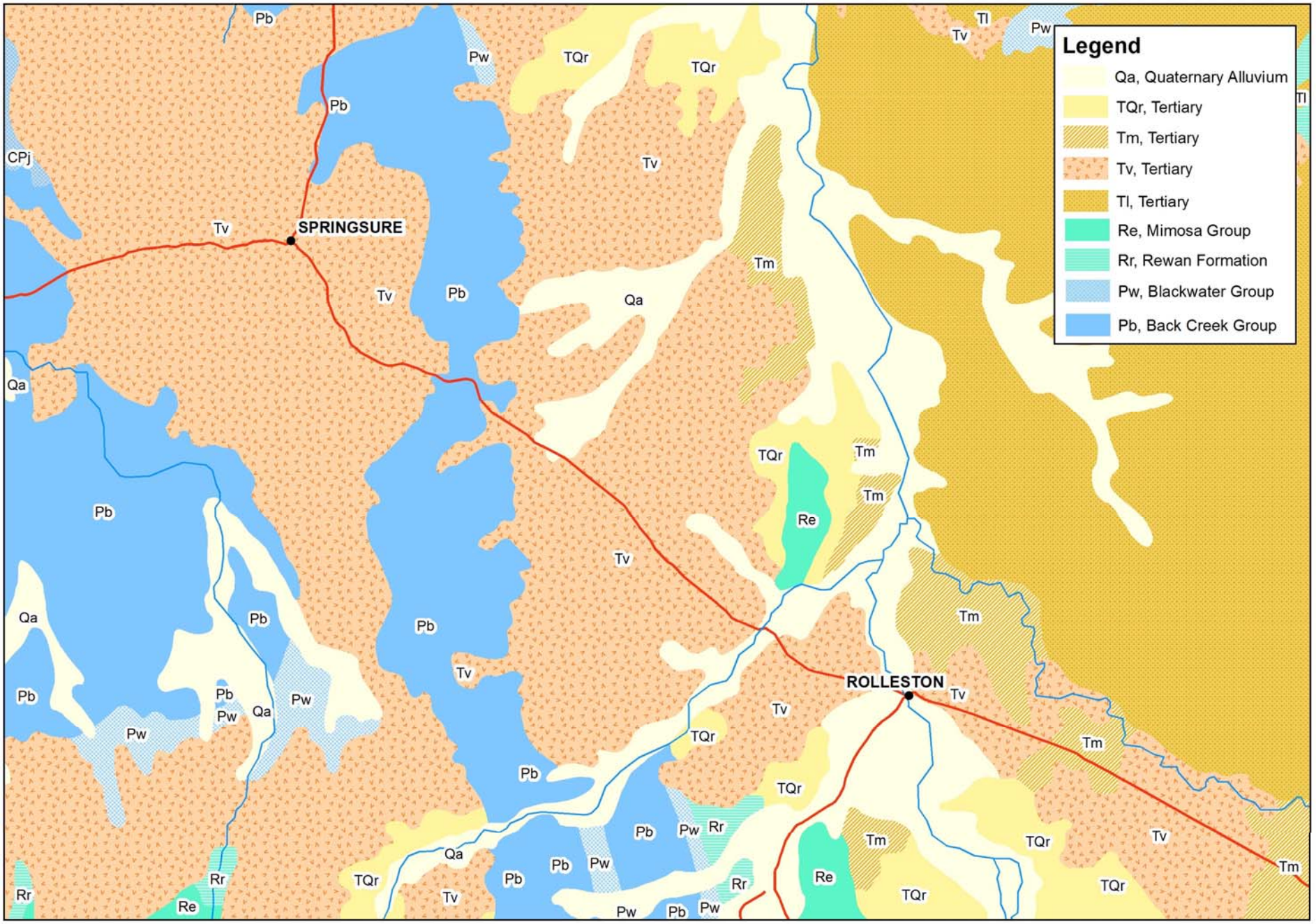




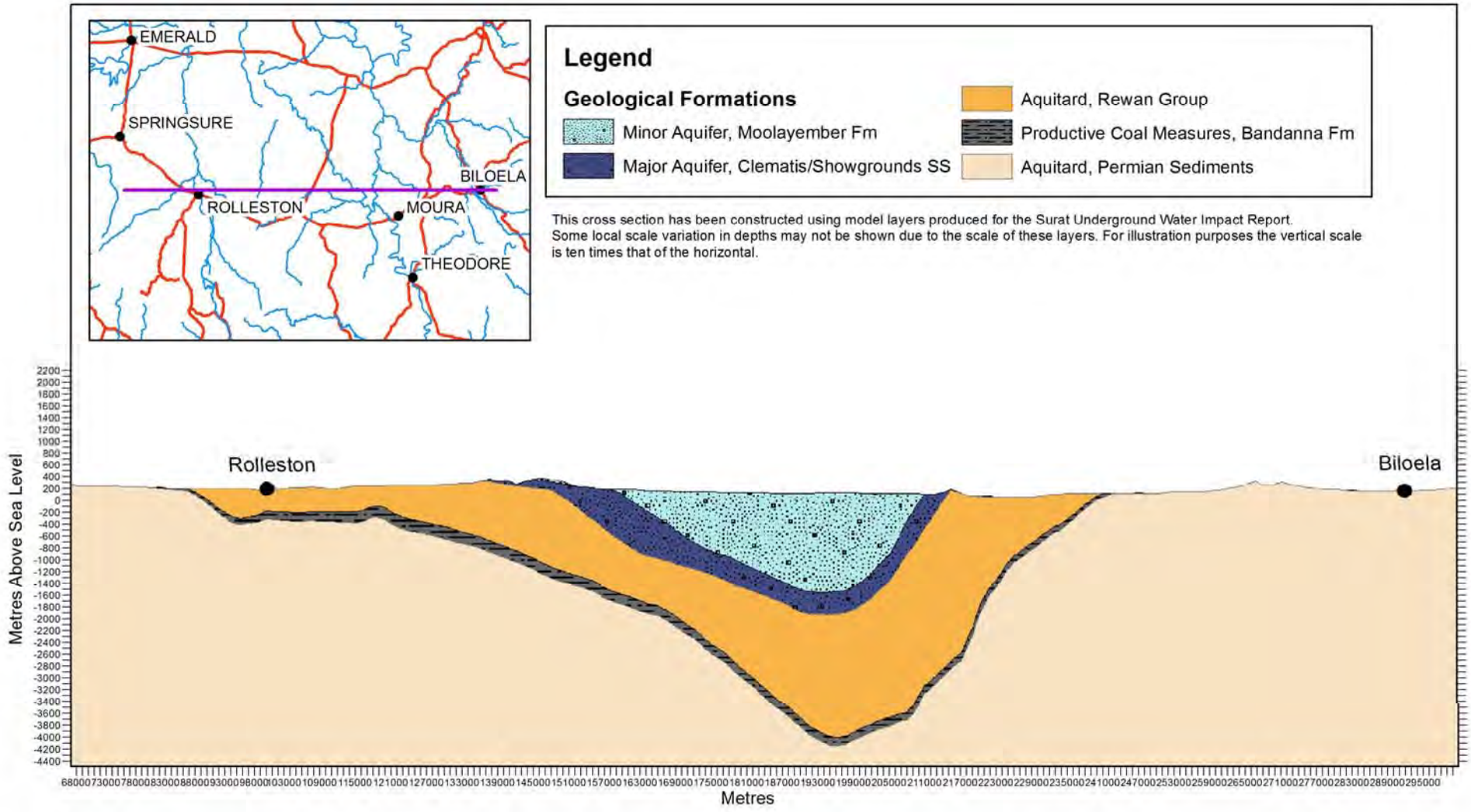


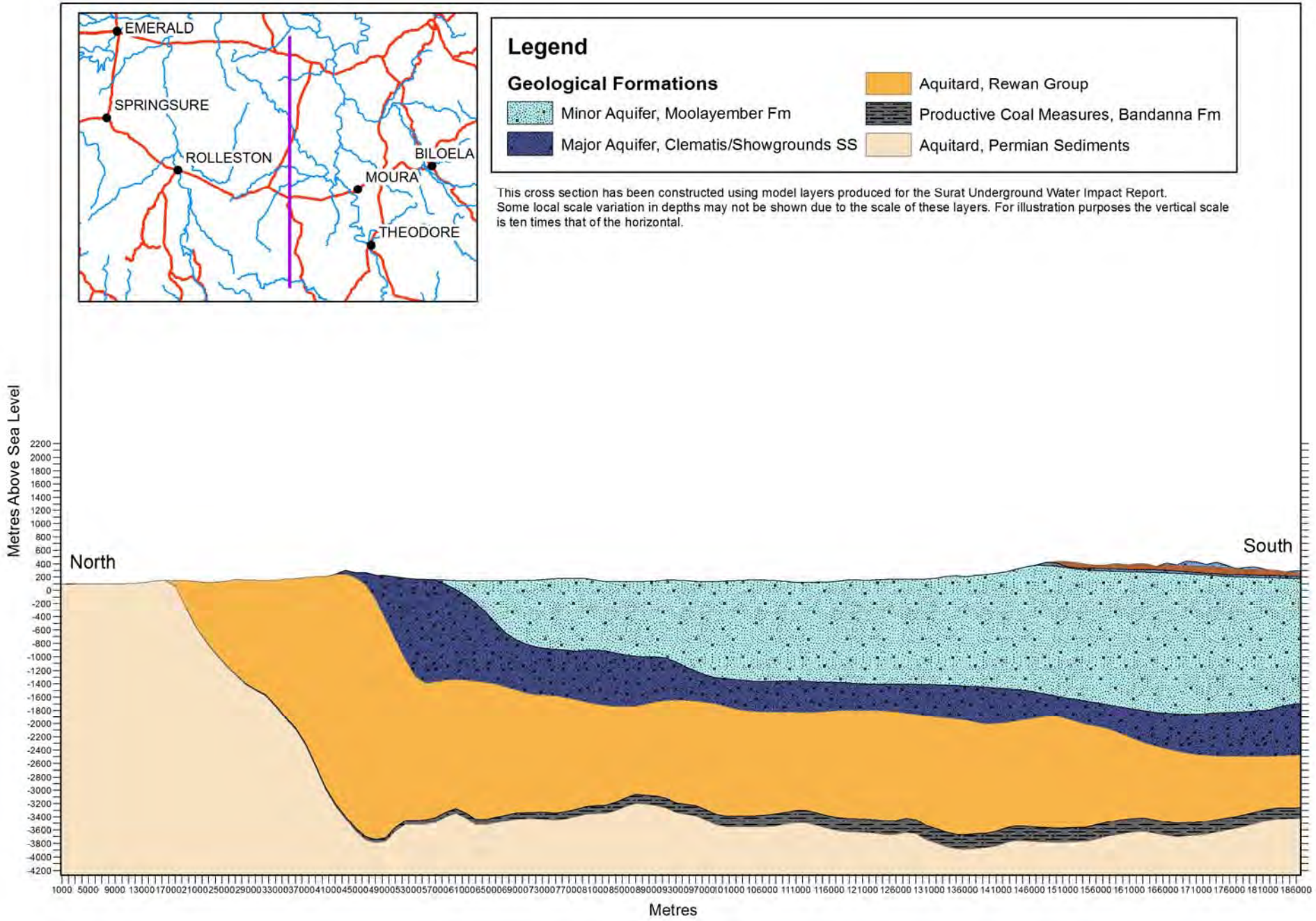
Surat Basin overlying Bowen Basin





Surface Geology Springsure - Rolleston


EMERALD
SPRINGSURE
BILOELA
ROLLESTON
MOURA
THEODORE
Legend
Geological Formations
Minor Aquifer, Moolayember Fm
Major Aquifer, Clematis/Showgrounds SS
Aquitard, Rewan Group
Productive Coal Measures, Bandanna Fm
Aquitard, Permian Sediments
This cross section has been constructed using model layers produced for the Surat Underground Water Impact Report.
Some local scale variation in depths may not be shown due to the scale of these layers. For illustration purposes the vertical scale is ten times that of the horizontal.
Rolleston
Biloela
Metres Above Sea Level
Metres


EMERALD
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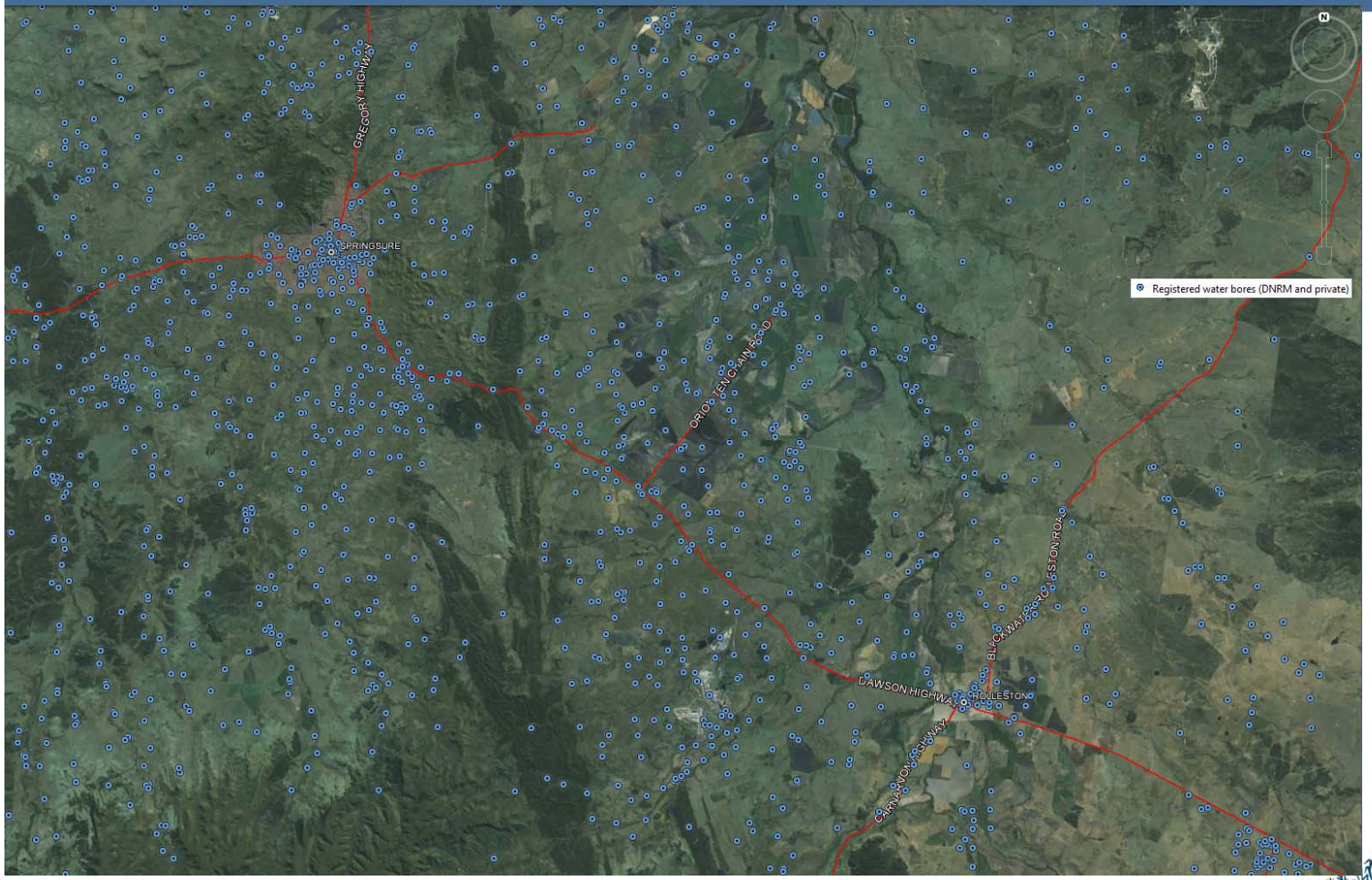
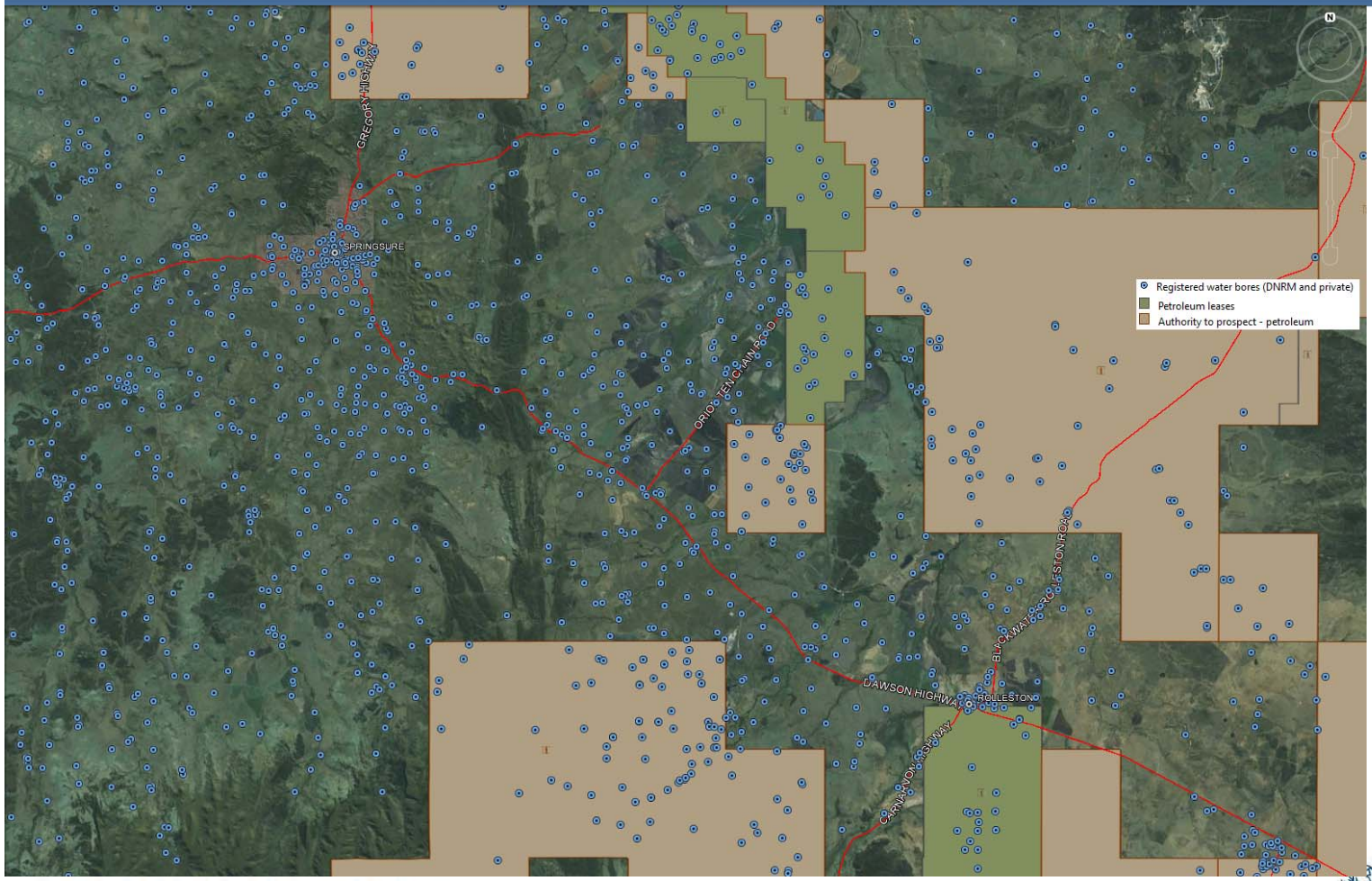
Metres Above Sea Level
2200 2000 1800 1600 1400 1200 1000 800 600 400 200 0 -200 -400 -600 -800 -1000 -1200 -1400 -1600 -1800 -2000 -2200 -2400 -2600 -2800 -3000 -3200 -3400 -3600 -3800 -4000 -4200
North
South
1000 5000 9000 13000 17000 21000 25000 29000 33000 37000 41000 45000 49000 53000 57000 61000 65000 69000 73000 77000 81000 85000 89000 93000 97000 101000 106000 111000 116000 121000 126000 131000 136000 141000 146000 151000 156000 161000 166000 171000 176000 181000 186000
Metres

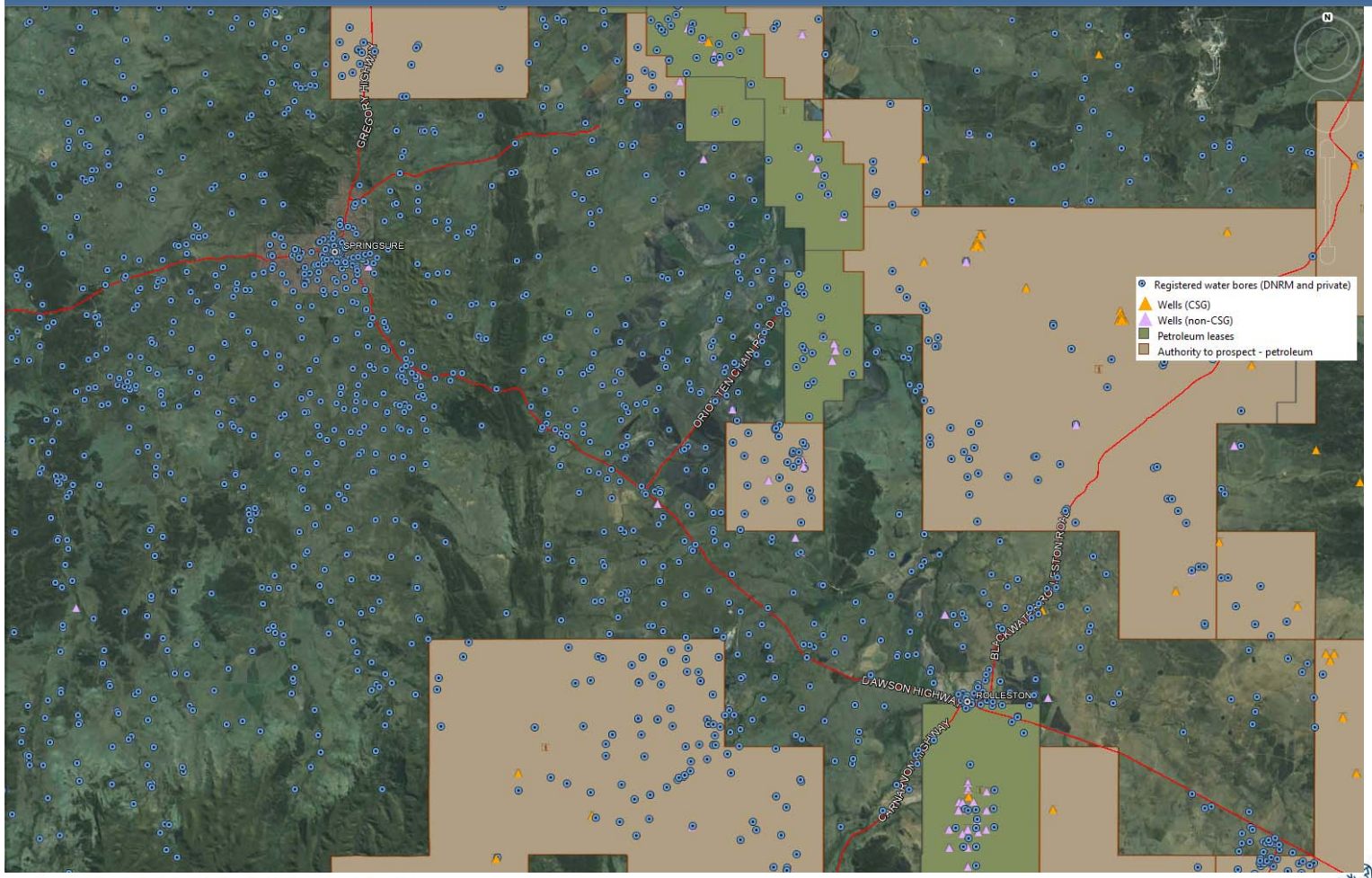
Springsure area



Springsure area With water bores



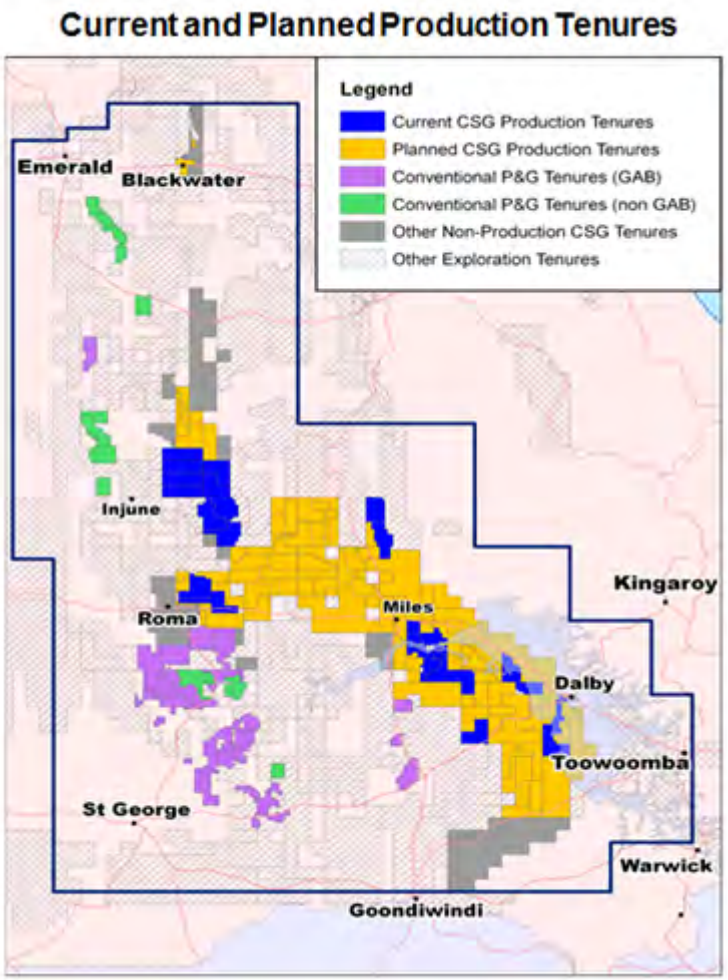
Springsure area
With water bores
plus CSG tenures

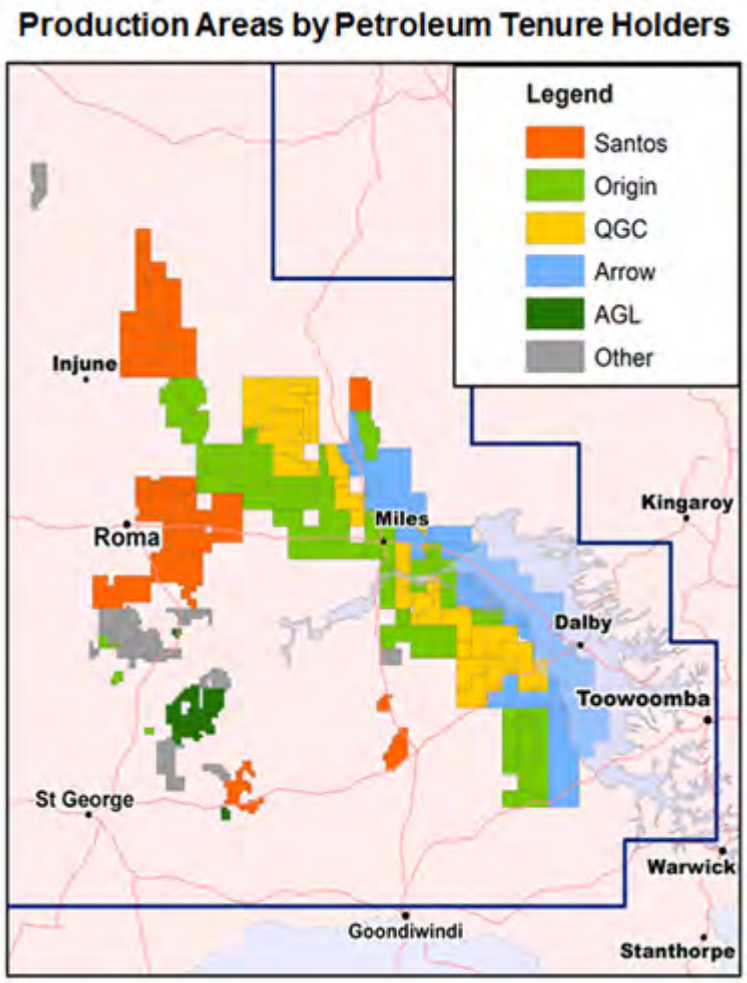


Springsure area
With water bores
plus CSG tenures
plus CSG exploration wells

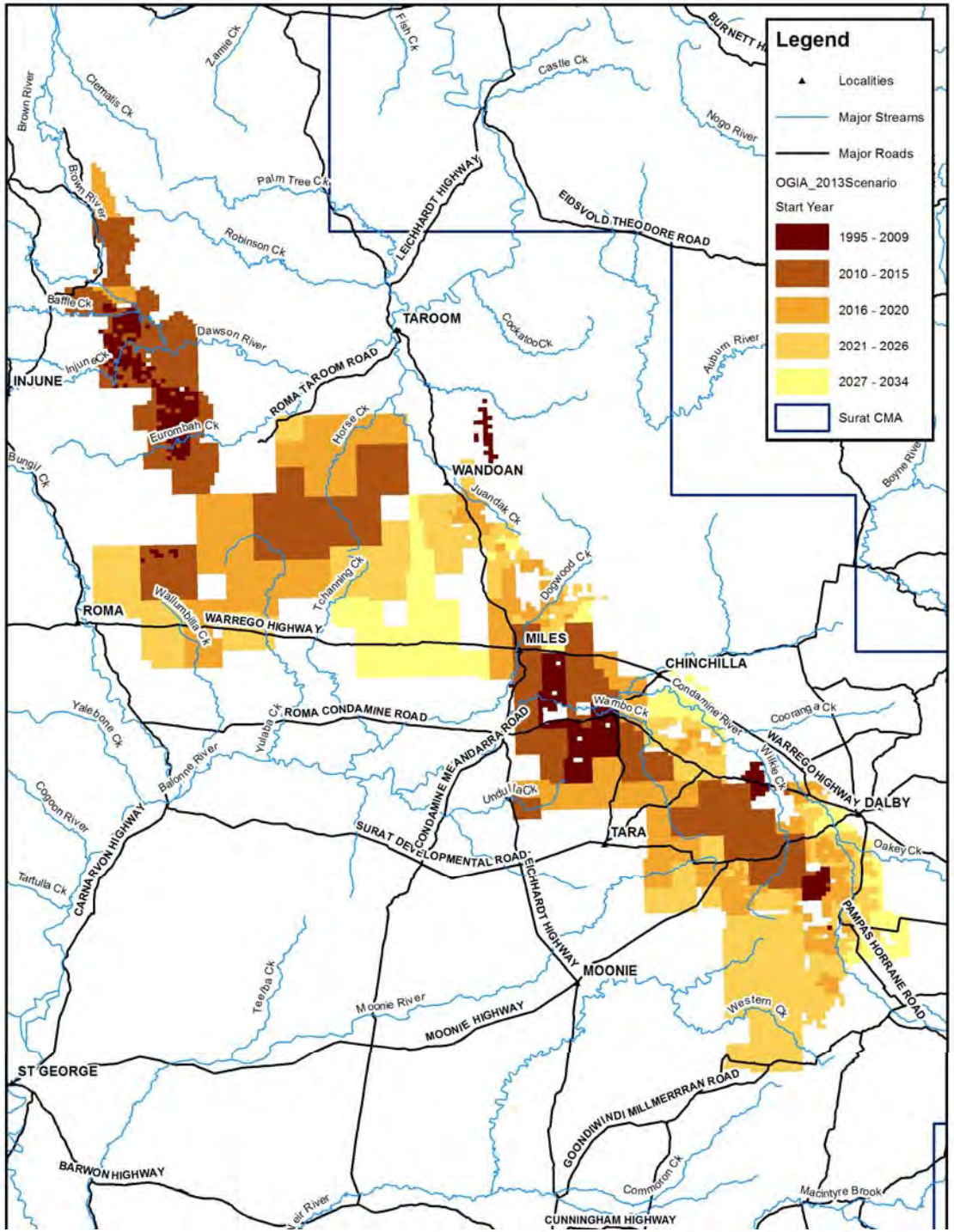
CSG Development and Potential Impacts

CSG Development Surat and Bowen Basins

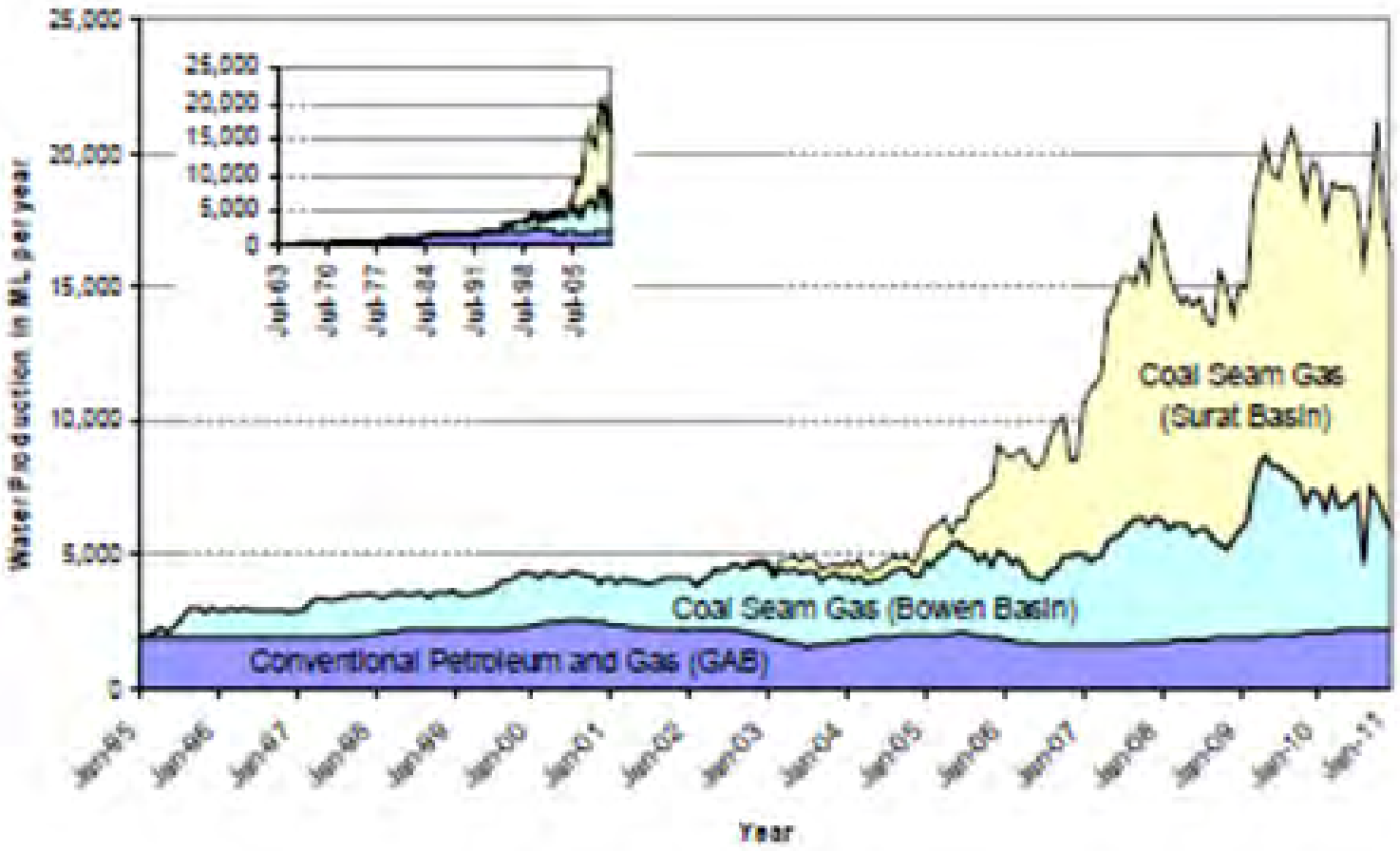




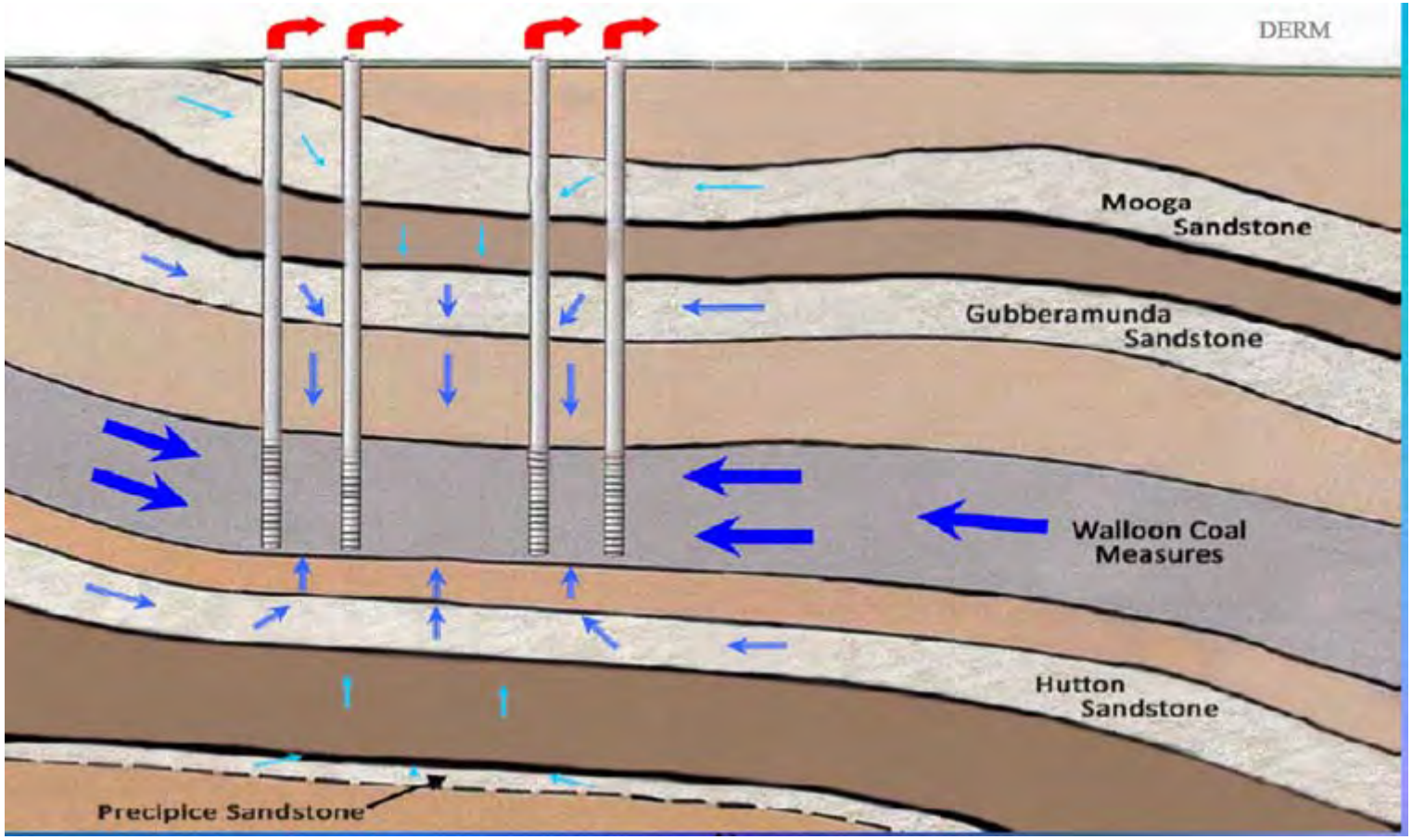
CSG PRODUCTION COMMENCEMENT



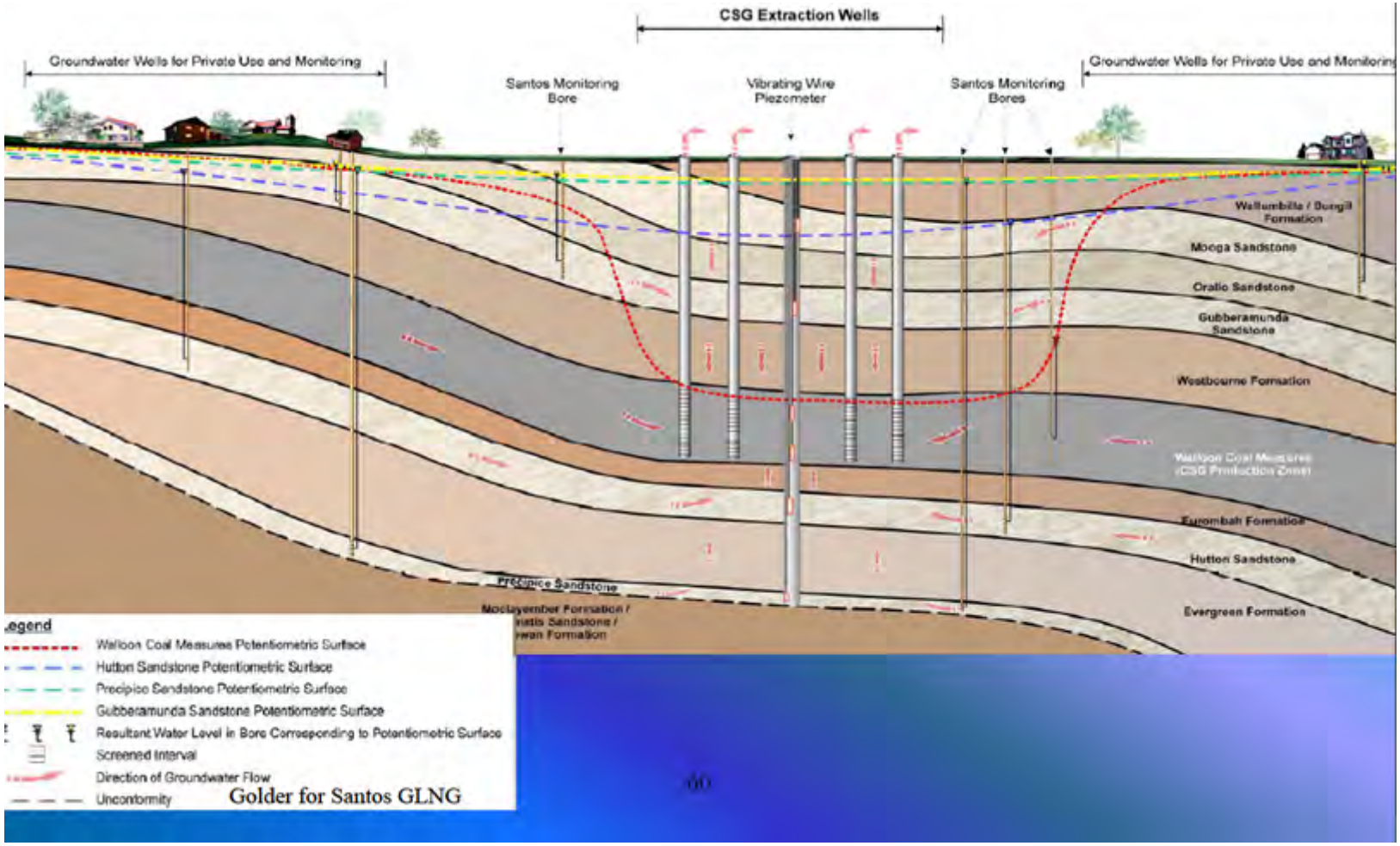
Water Production Rates



Lowering Heads in One Aquifer can Potentially Induce Water Flow from Adjacent Aquifers

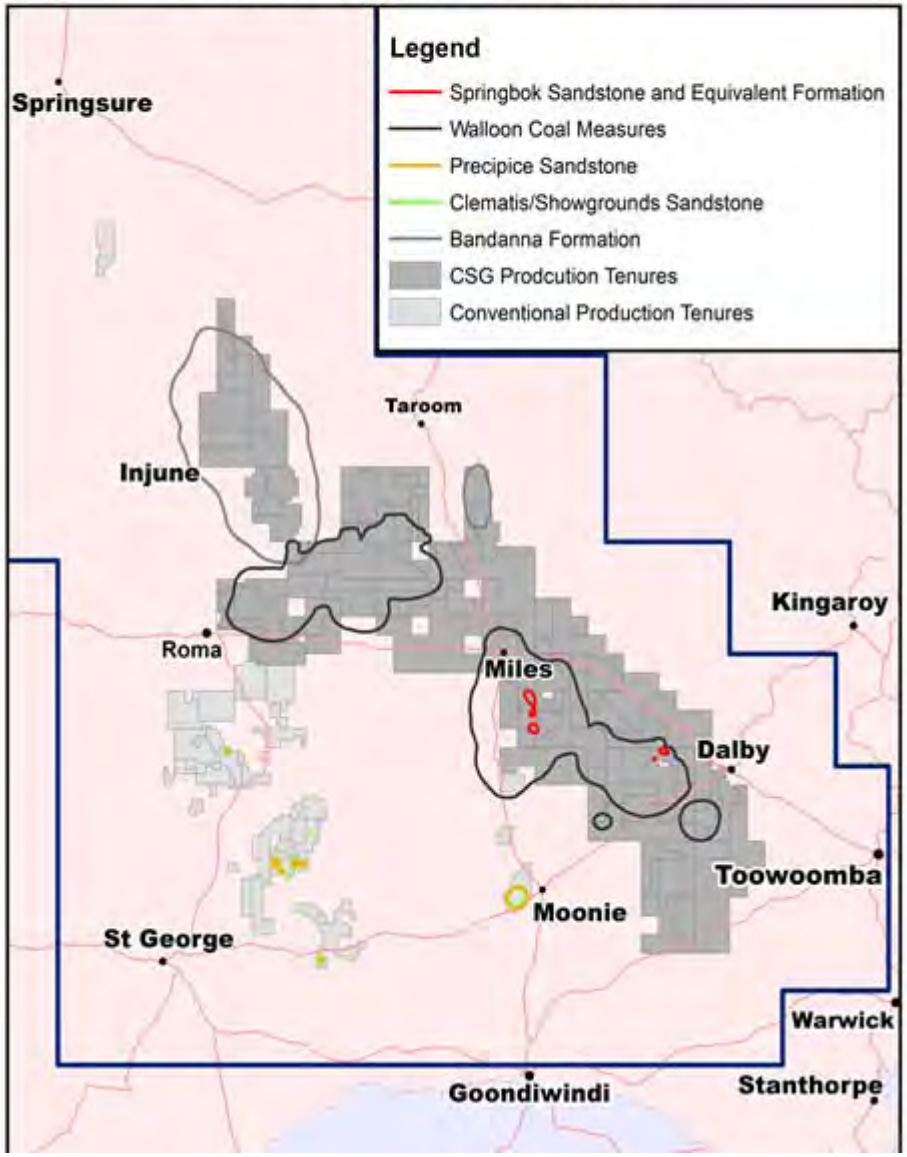


Conceptual Drawdown Impacts from Santos EIS

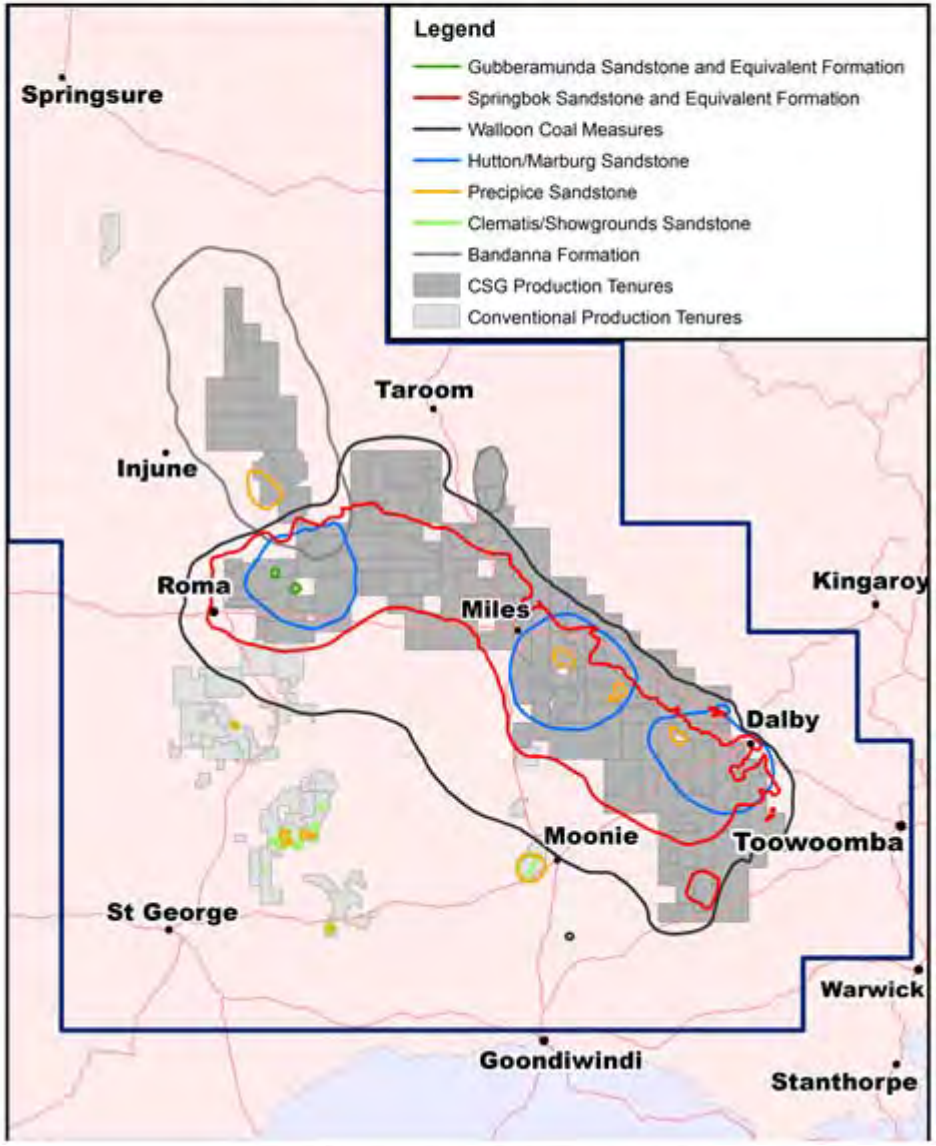


Results: Affected Areas

Immediately Affected Areas

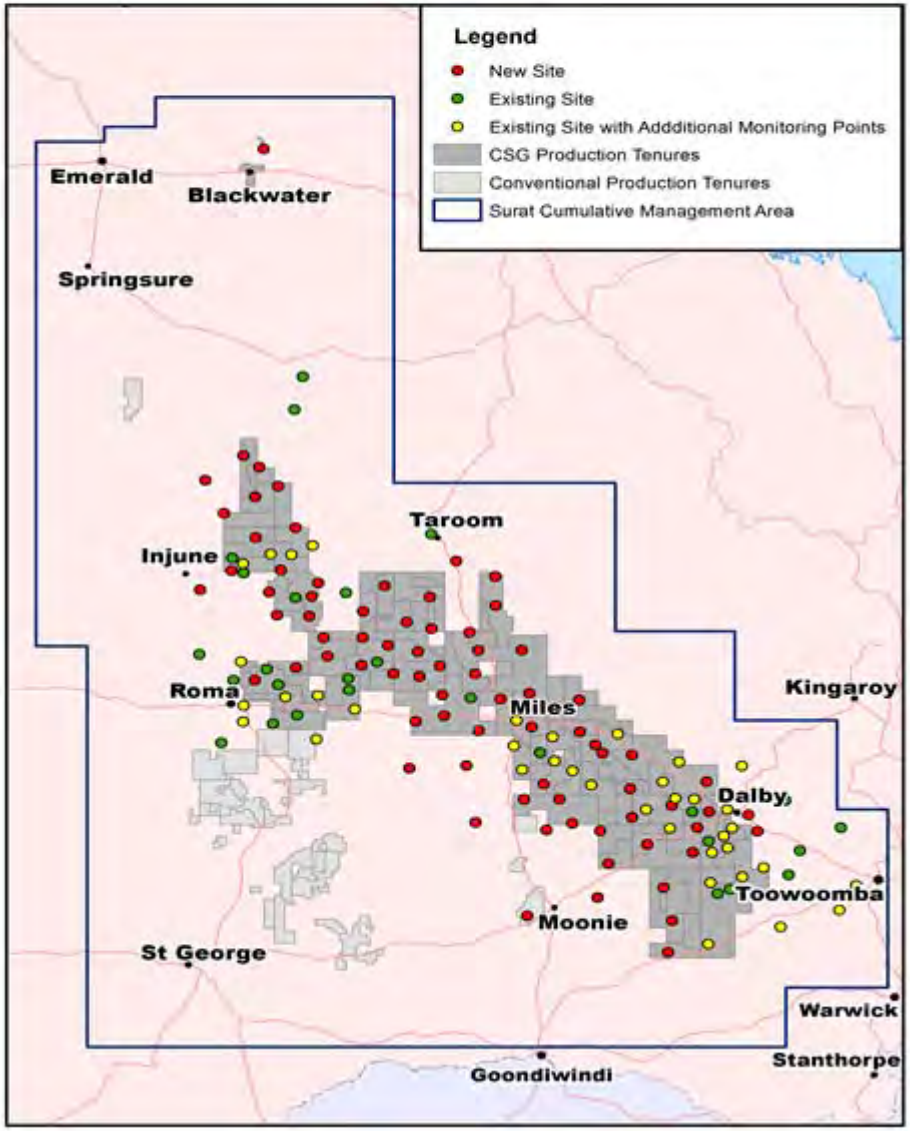


Long-term Affected Areas

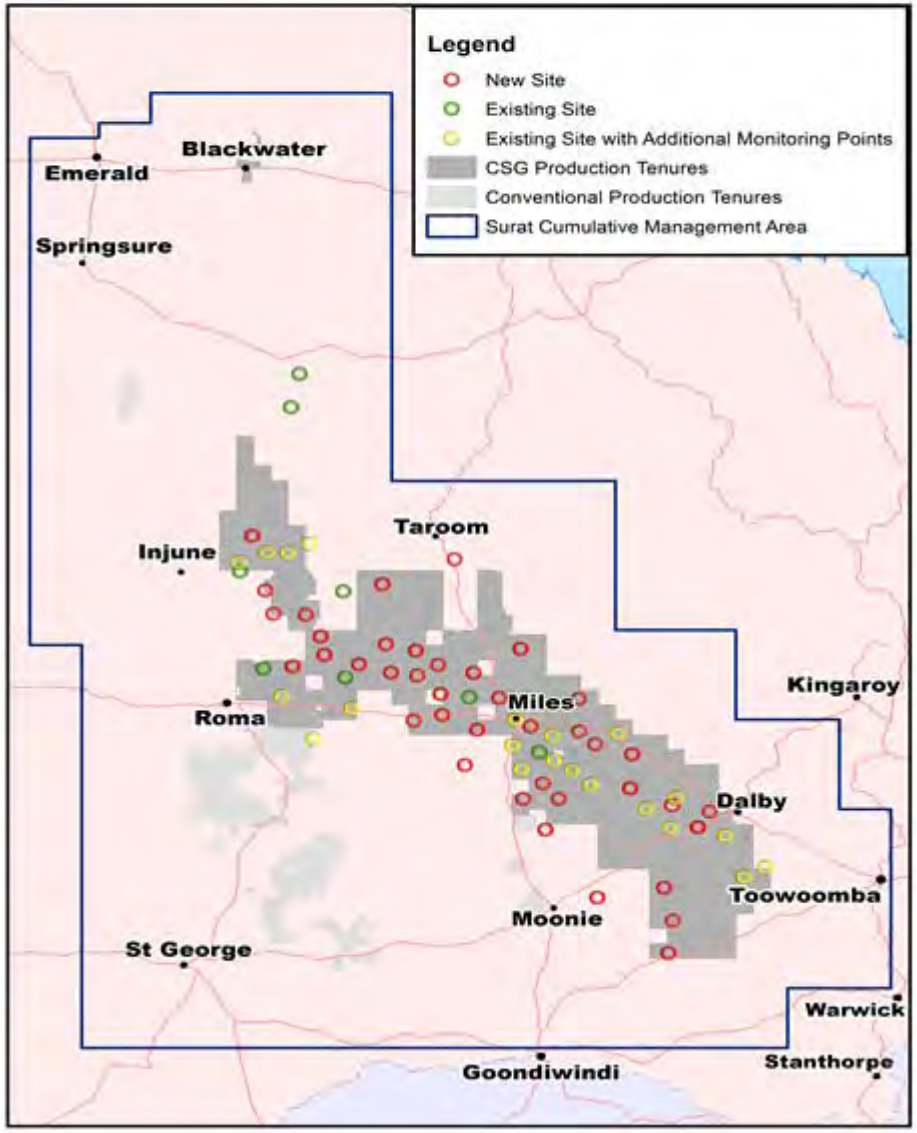


Monitoring Strategy

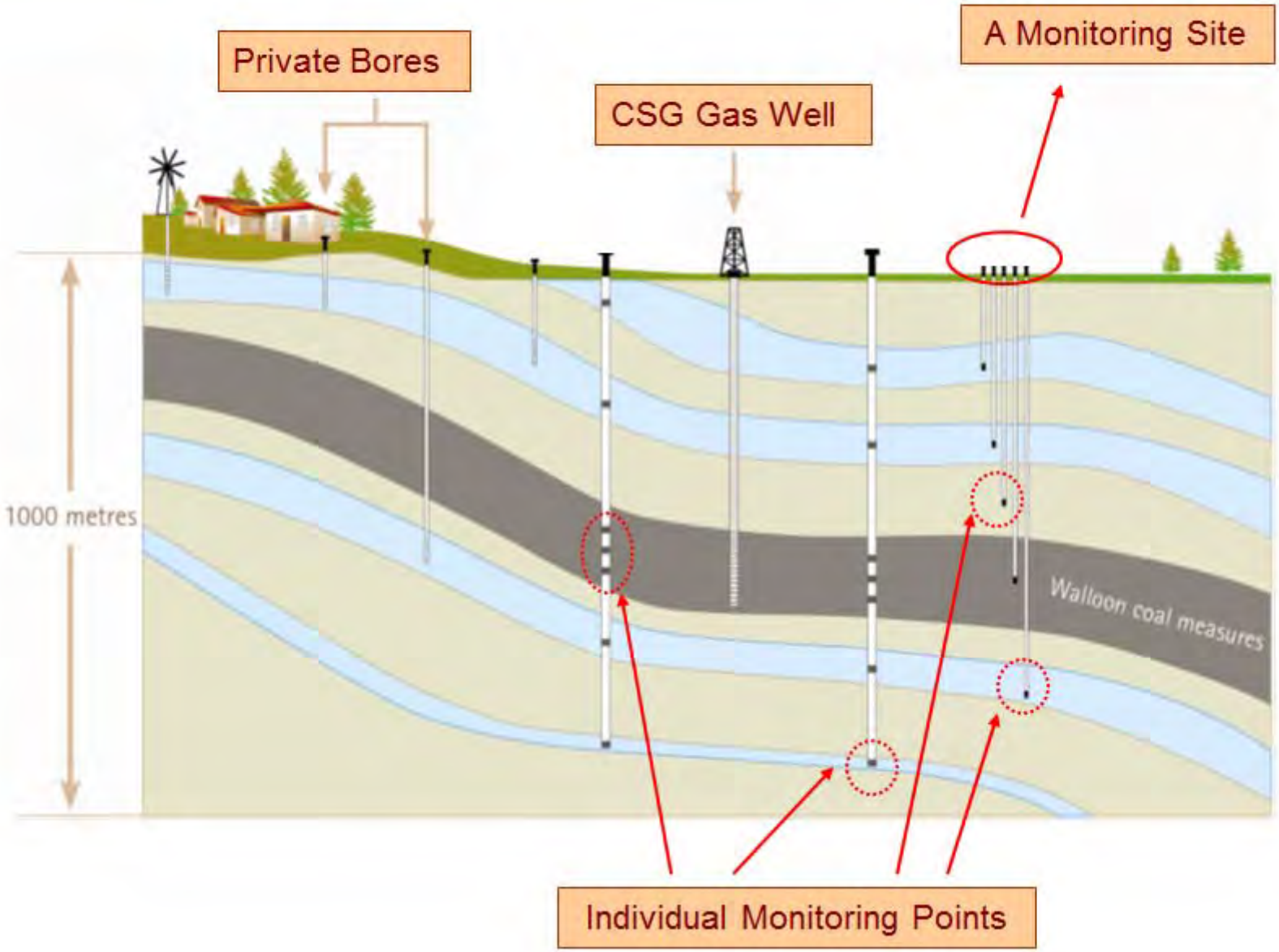
Water Pressure Monitoring Network



Water Quality Monitoring Network



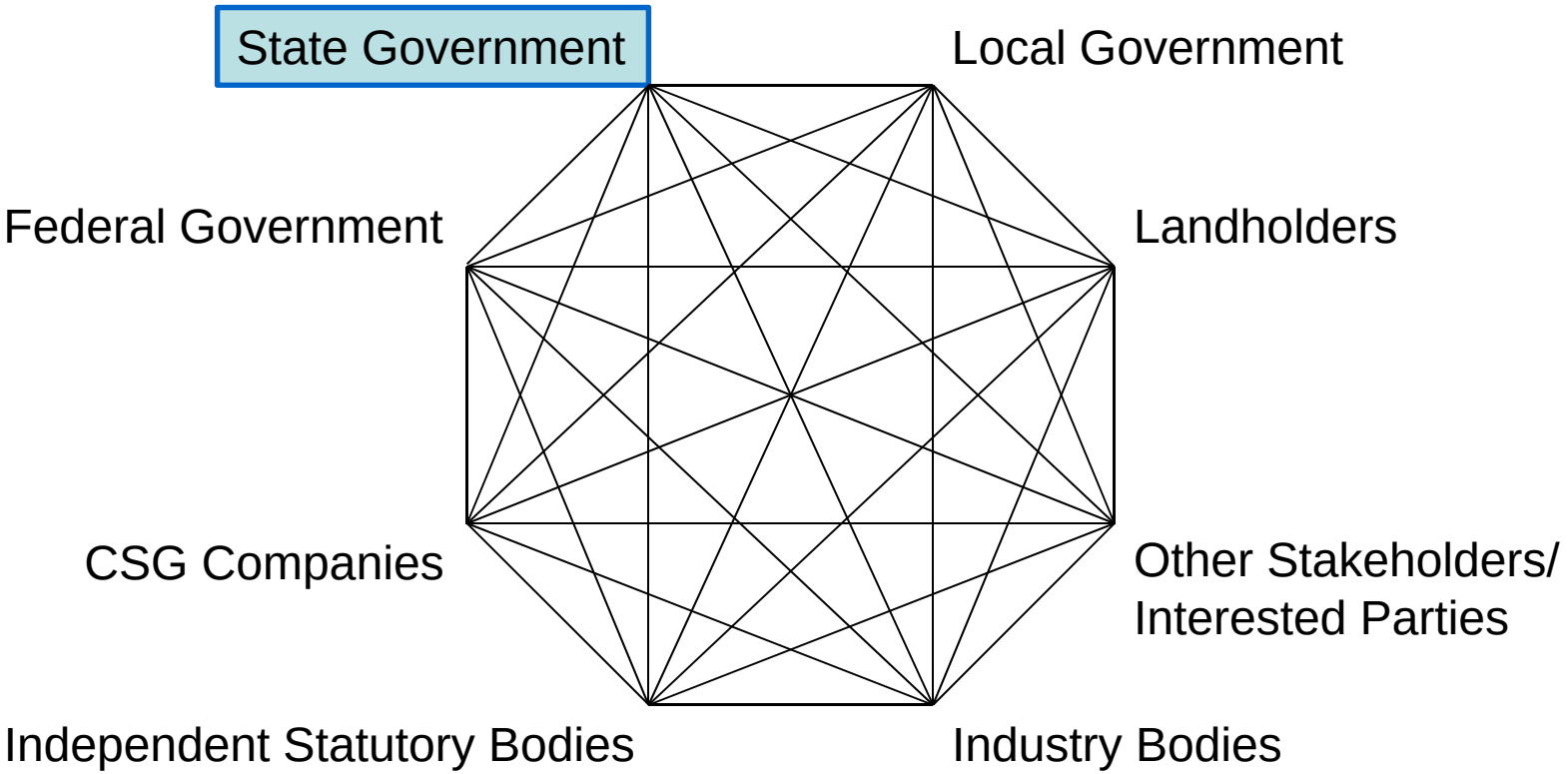
Monitoring Points and Monitoring Sites



Groundwater Investigation and Assessment Team (GIAT)

What we do

CSG the broader picture



This is for illustrative purposes only. As with everything, the *real* web would be much more complex!

State Government

- DNRM
- EHP
- Other Departments (DSITIA, Health)

- Office of Groundwater Impact Assessment

- GasFields Commission

Queensland Government

DNRM

Coal Seam Gas Compliance Unit

- Engagement Team
- Groundwater Investigation and Assessment Team (GIAT)

Other Work Units

- Water Licensing
- Petroleum and Gas Inspectorate
- Etc

Office of Groundwater Impact Assessment

Groundwater Impact Assessment Team (GIAT)

- Comprised of 8 staff
  - Individuals with over 40 years practical experience in groundwater assessment and water bore construction

GIAT Responsibilities

- Groundwater investigations of potentially impaired bores
- Implement and report on an independent monitoring program
- Audit water monitoring bore construction, well completion reports for water monitoring bores and water sampling procedures
- Engagement with industry and community stakeholders on CSG development and impacts

Coal Seam Gas
Engagement and Compliance Plan 2013

Groundwater investigations of potentially impaired bores

Common concerns

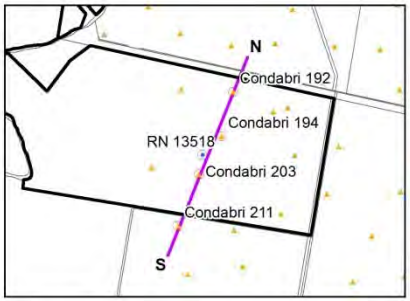
- Falling water levels
- Diminished supply
- Change in water quality
- Increased gas in bore

- Indirect issues
  - What aquifer is my bore targeting?
  - Is my bore registered/licensed?

Investigation into a report of diminished supply

- Compile and review available information in order to develop a conceptual understanding of:
  - The hydrogeology of the area
  - The construction of the bore in question
  - The CSG activities in the area
- Undertake site visit(s) in order to:
  - Take water level readings
  - Undertake pump tests
  - Confirm bore construction details and assess current condition (this may involve taking a downhole video)
- Consider:
  - History of regional declines
  - Water extraction from surrounding CSG wells and the potential for impacts to the bore in question
  - Water extraction from surrounding water bores and the potential for impacts to the bore in question
  - Potential problems with the bore construction

Investigation into a report of diminished supply



Legend

Geological Formations

- Aquitard, Griman Ck Fm Surat Siltstone and Wallumbilla Fm
- Major Aquifer, Bungil Fm and Mooga SS
- Aquitard, Orallo Fm
- Major Aquifer, Gubberamunda SS
- Aquitard, Westbourne Fm
- Major Aquifer, Springbok SS
- Aquitard, Springbok SS (lower)
- Aquitard, Walloon Coal Measures (upper)
- Productive Coal Measures, Walloon Coal Measures
- Aquitard, Walloon Coal Measures (lower)
- Major Aquifer, Hutton/Marburg SS

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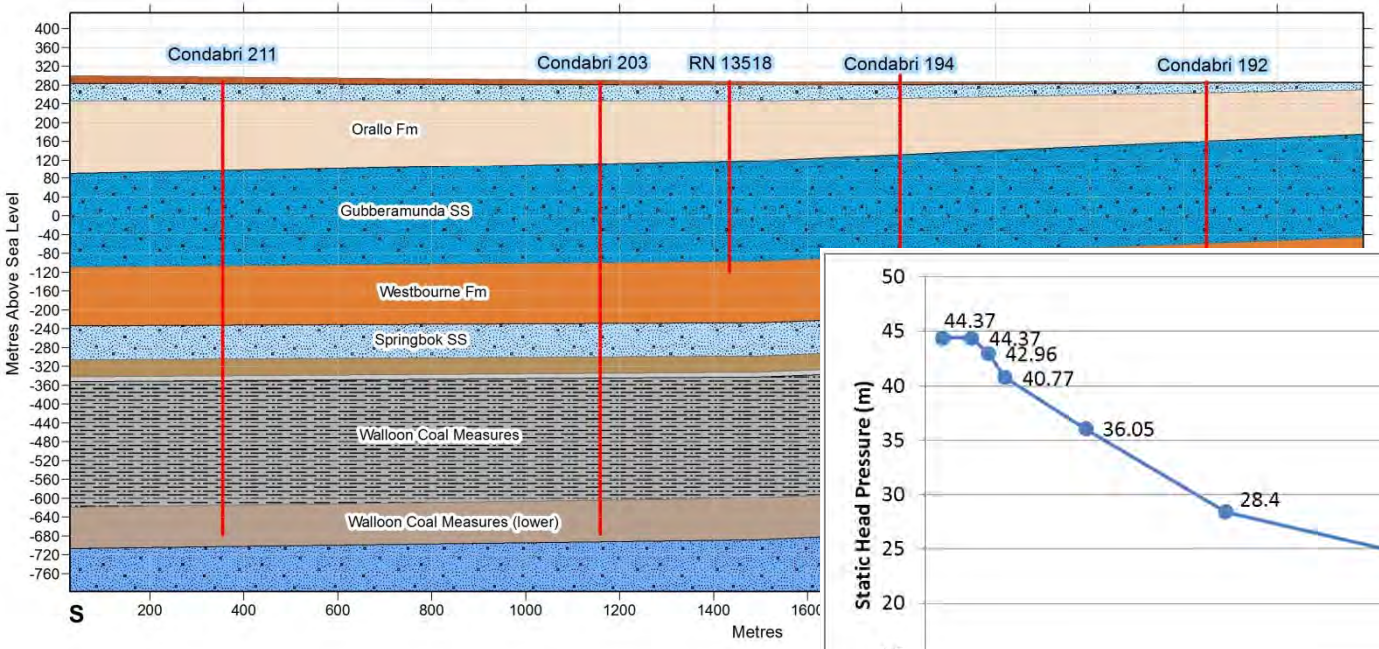
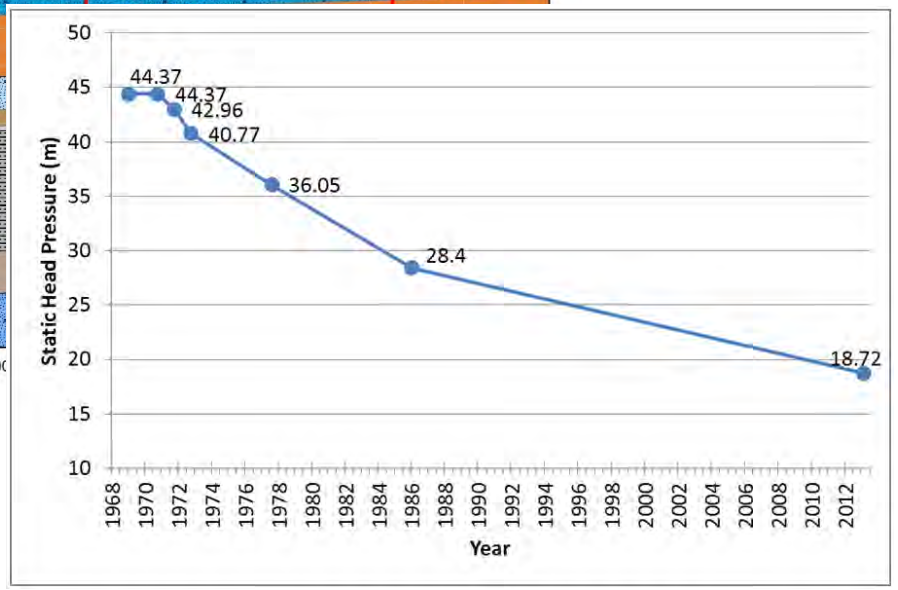
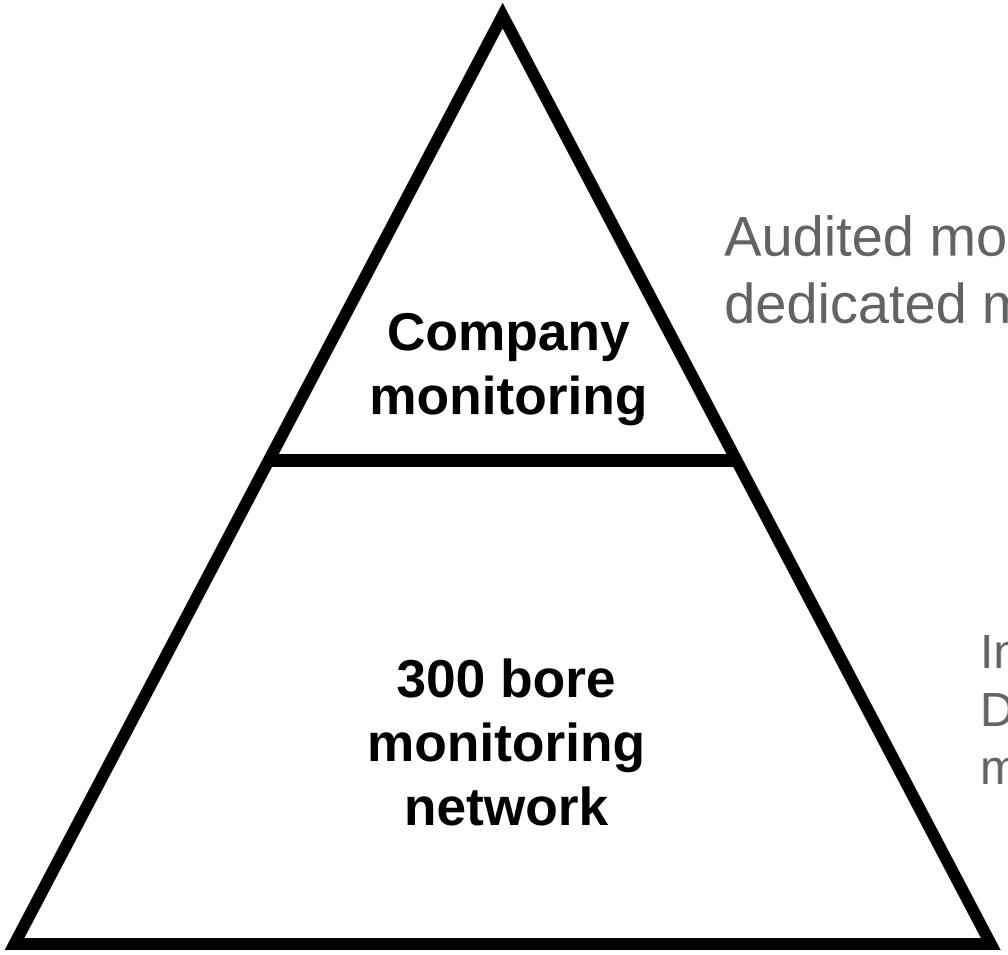




Investigation into a report of diminished supply

- Compile and review available information in order to develop a conceptual understanding of:
  - The hydrogeology of the area
  - The construction of the bore in question
  - The CSG activities in the area
- Undertake site visit(s) in order to:
  - Take water level readings
  - Undertake pump tests
  - Confirm bore construction details and assess current condition (this may involve taking a downhole video)
- Consider:
  - History of regional declines
  - Water extraction from surrounding CSG wells and the potential for impacts to the bore in question
  - Water extraction from surrounding water bores and the potential for impacts to the bore in question
  - Potential problems with the bore construction
- Action
  - Communicate findings to the landholder and relevant CSG company
  - Direct CSG company to make good
  - Recommend continued monitoring
  - Eliminate CSG activities as a potential cause

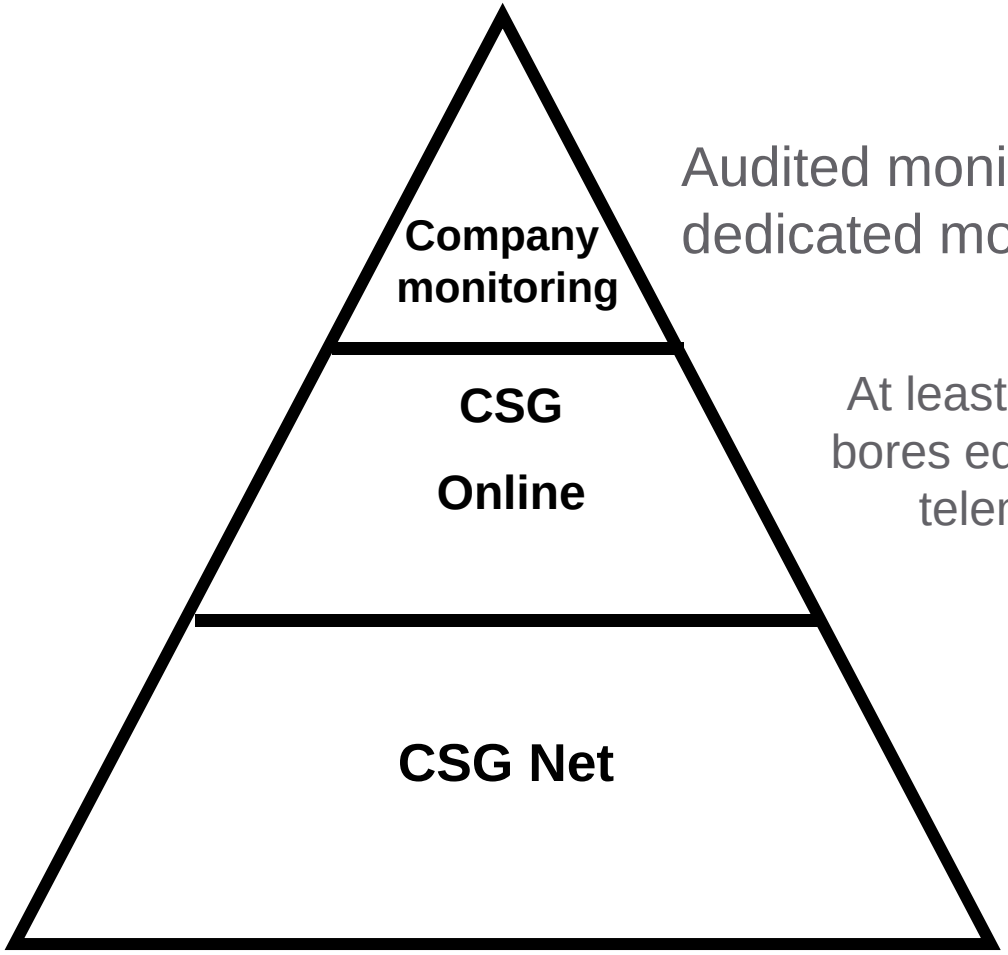
Current CSG Groundwater Monitoring Arrangements



Audited monitoring from dedicated monitoring bores

Independent monitoring using DNRM and private bores manually measured 1 – 4 times/yr

‘Renewed CSG Groundwater Monitoring Arrangements

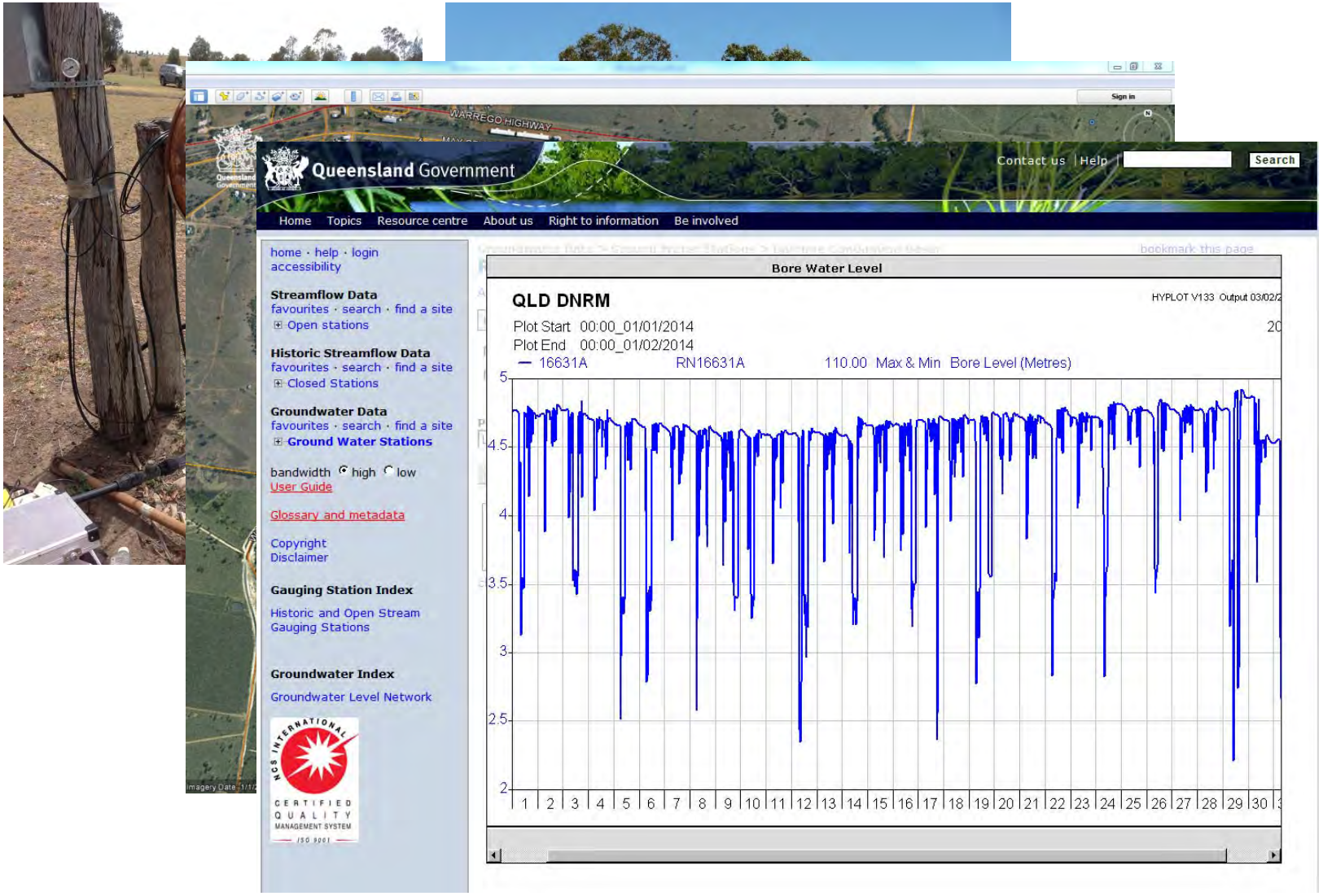


Audited monitoring from dedicated monitoring bores

At least 60 strategically located bores equipped with loggers and telemetry and monitored continuously

Broadscale monitoring of up to 500 private bores by landholders

CSG Online



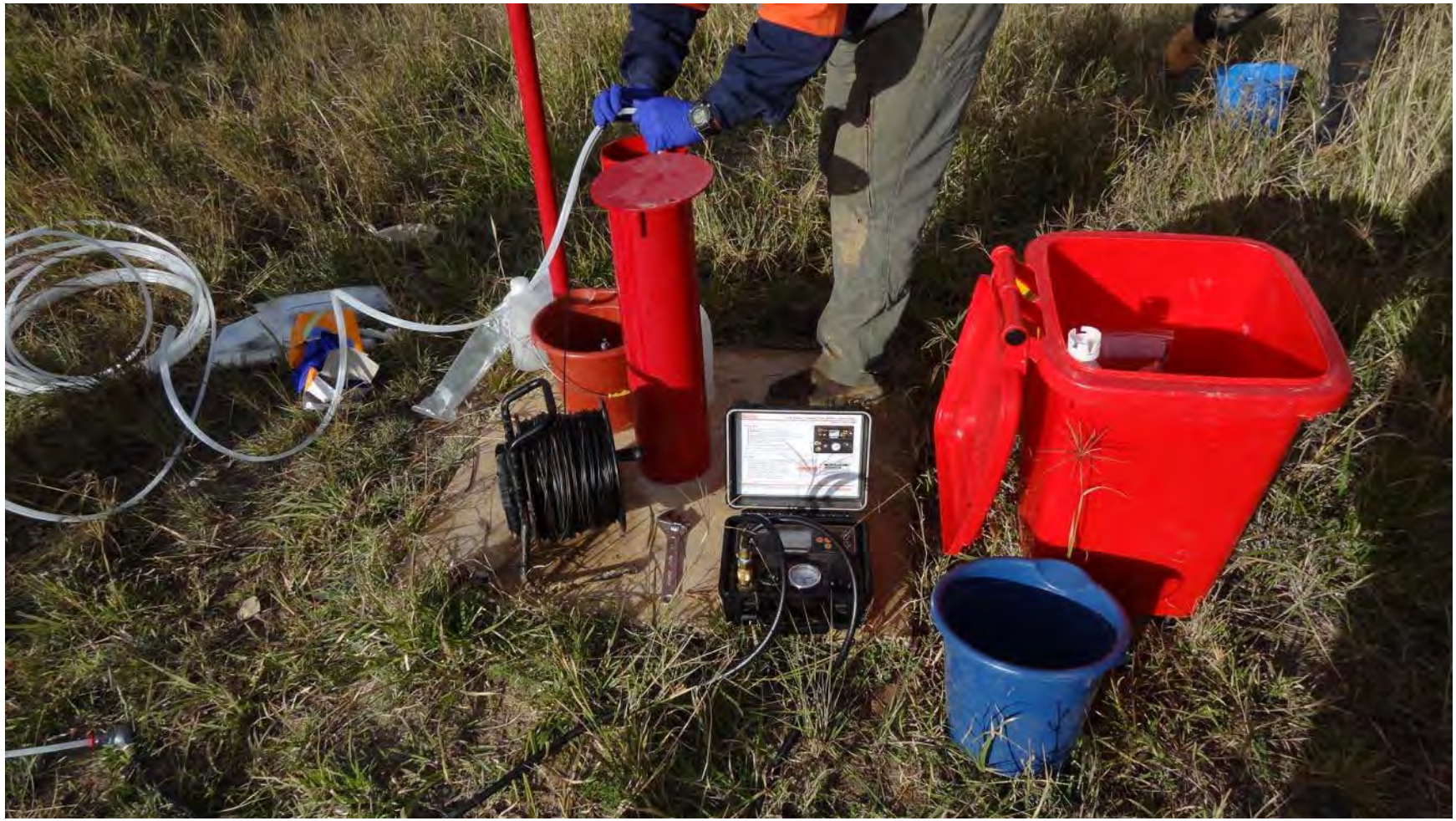
Audit CSG Company Monitoring Bore Construction and Monitoring Procedures

Ensure monitoring bores meet, Minimum Construction Standards or, Code of Practice for CSG wells

Ensure both Safe Work Practices (SWP's) and Standard Operating Procedures (SOP's) for all aspects of bore monitoring are best practice

Audit CSG Company Monitoring Bore Water Level / Pressure and Sampling Procedures

Audit CSG Company Monitoring Procedures



Audit CSG Company Monitoring Procedures

Audit CSG Company Groundwater Sampling, Preservation, Storage and Handling Procedures

Audit CSG Company Monitoring Bore Construction Techniques and Procedures

Audit CSG Company Monitoring Bore Construction Techniques and Procedures

Completed CSG Water Monitoring Bore

Completed CSG Water Monitoring Bore

Completed CSG Water Monitoring Bore ready for manual monitoring

Engagement with Industry and Stakeholders on CSG Development and Impacts