Reference document
Coal seam gas and water volumes

- Coal seam gas (CSG) is natural gas trapped in a coal seam by water pressure.
- Decreasing the pressure on the coals by pumping water frees the CSG for production.
- Water produced from CSG is a small percentage (0.03% or 3 parts in 10,000) of Australia's Great Artesian Basin.
- About 97% of the water produced is beneficially used: 59% by agriculture, 14% by industry and 24% by reinjection in aquifers.
- Regional aquifer depressurisation models predict the impacts on water supply aquifers. Continuous data capture and monitoring is used to validate and improve these predictions.

1. CSG and water production

All coals contain natural gas to some extent. In the early days of coal mining, removing gas from mines was a major challenge if mining was to proceed safely. In modern times, the gas in coal became seen as a potentially valuable new energy resource. However, finding a technically and commercially viable way to develop this was a challenge for the resource companies.

Natural gas is trapped on the surface of the coal – it is said to be 'adsorbed' onto the coal, and held there by pressure from the groundwater in the coal beds. To release the gas from the coal, the pressure must be decreased to the point where it is no longer sufficient to hold the gas on the coal. This is done by pumping water from the coals, which decreases the pressure and frees up the gas. A well will produce most of its water at the start of the pumping phase. As the water is pumped from the coal formation, the pressure is released from the seam, and the gas begins to flow.

Water production and gas production are inversely proportional. As water production declines, gas production increases. (Figure 1).

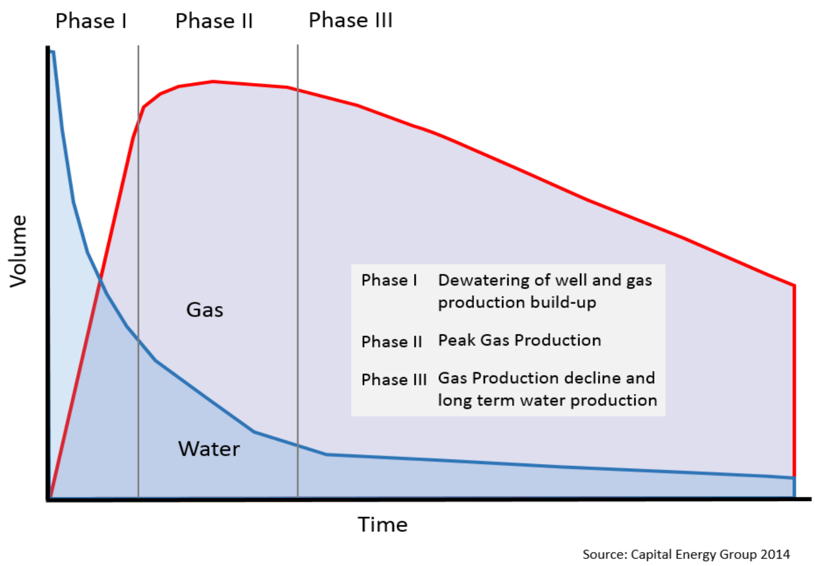


Figure 1. CSG Well Production Phases

The water pumping phase is unique to CSG. But the drilling techniques, surface equipment and gas compositions are not materially different from conventional gas production, which has been going on for decades in Australia.

Not all coals are suitable for CSG production. Commercial viability depends on the permeability of the coal, and its ability to flow gas, as well as the costs of drilling and proximity to infrastructure and customers.

Coal is naturally fractured. Cracks in the structure of the coal are referred to as "cleats". Water and natural gas are trapped in these cleats. Coals with more cleats are more permeable, which enhances the rate at which the water and gas can move through the coal's structure.

Coals with lower permeability do not require as much water to be pumped to reduce the pressure on the coal. This is why some CSG operations – for example in NSW and Queensland's Bowen Basin – produce lower volumes of water. Areas with higher permeability generally produce higher volumes of water. Different CSG operations produce differing amounts of water.

2. Water volumes

Concerns have been raised that the CSG industry could impair the availability of groundwater for domestic, agriculture and commercial uses.

The Great Artesian Basin (GAB) contains 65 million gigalitres (GL) of water.[1,2] Over the proposed life of the current projects, the CSG industry will produce 1,701 GL of water from the coal seams, or less than 0.03% (3 parts per 10,000) of the GAB's water.

Recent studies collating data from the major Queensland CSG producers, have found Surat Basin CSG operations' water production will average 55 gigalitres (GL) a year. By comparison, in Queensland 452 GL pa is used for agriculture, industry, urban, stock and domestic purposes.[3]

Table 1. Water use by industry / user in Queensland compared to CSG volumes [2]

Purpose	Queensland (GL/year)
Stock and domestic (pastoral)	302
Stock and domestic wastage	54
Total Stock & Domestic	**356**
Irrigation and intensive livestock industries	30
Town water use	32
Industrial, mining, commercial and other urban uses	24
Total non-S&D sum	**96**
Total Annual Water (Use)	**452**
CSG Annual Total Production	55
CSG Annual Total Non-Productive Use (3% Brine)	1.6*
CSG Production against Queensland GAB Production	12%
Total Consumption of Produced Water by CSG (brine)	0.37%

* Total Brine Production, of which 0.5GL pa is deducted due to brine re-injection projects

[1] Great Artesian Basin Coordinating Committee (2014) *Great Artesian Basin Strategic Management Plan - Progress & Achievements to 2008* - http://www.gabcc.org.au/images/DL_684_.pdf

[2] CSIRO, 2008. *Background report on the Great Artesian Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project.* Contributing author Herczeg, A.L. http://www.clw.csiro.au/publications/waterforahealthycountry/mdbsy/technical/S-GreatArtesianBasin.pdf

[3] Great Artesian Basin Coordinating Committee (2010) Great Artesian Basin Resource Study Update, 2010

Water produced from the coal seams is mildly salty (brackish). It comes from deeper geological layers, and is generally not usable for agricultural purposes without desalination treatment or blending with fresher (less saline) water.

Importantly, of the CSG water produced annually in Queensland:

- 97% is treated and desalinated
- 59% is made available for agricultural purposes
- 24% is reinjected into underground aquifers
- 14% is used for industrial purposes such as mining, roads and construction
- 3% remains as brine or salt.[4]

When treated and beneficially used, CSG production water can be an alternative supply to the water that is currently taken from the shallower, less saline aquifers of the GAB. This in itself will assist in recharging these shallow aquifers over time.

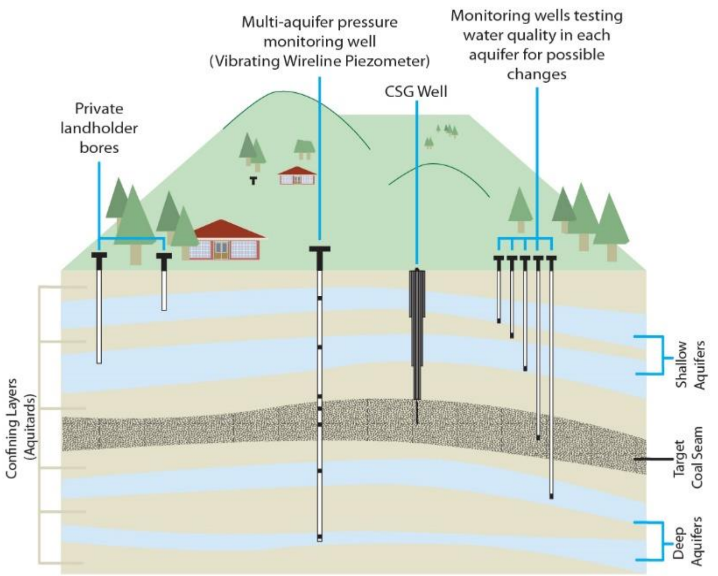
3. Domestic aquifers and CSG wells

When water is produced from a well, there is a decline in the water pressure in the deeper formations around the individual well.

In 2012, the Queensland Government commissioned the preparation of the *Surat Underground Water Impact Report*[5].

The report collated information on regional aquifers, existing water bores and petroleum wells, as well as the number and location of further wells to be drilled as a part of the CSG industry's development. It used this information to forecast the expected level of impacts. The report also identified "immediately affected areas" and "long-term affected areas".

Fig. 2 – CSG wells, landholder and groundwater monitoring bores



Source: Capital Energy Group, 2014

The immediately affected area is defined as the area where water level impacts will exceed a nominated threshold level within a three-year period.

Long-term affected areas are those that will be affected at any time in the future.

The threshold levels have been set at greater than five-metre decline in water level, in consolidated aquifers (i.e. sandstone aquifers) and three-metre decline in unconsolidated aquifers (i.e. sand aquifers).

This information was collated into one mega-model[5] to predict areas that may experience future groundwater impacts.

[4] Department of Trade and Investment Queensland, 2014. *Queensland Resources Under Construction: Queensland LNG*

[5] https://www.dnrm.qld.gov.au/ogia/surat-underground-water-impact-report

The cumulative model covers an area the size of Germany and is referred to as the Surat Cumulative Management Area.

Gas companies have installed monitoring wells to detect any changes in aquifer pressure (using vibrating wireline piezometers) or changes in the chemistry in the aquifers underlying their permit areas. This information is delivered to the Queensland Office of Groundwater Impact Assessment (OGIA[6]) on a six-monthly basis.[5]

Of the 21,000 existing private water bores in the Surat Cumulative Management Area, it was found that only 85 (0.4%) would be immediately effected, and another 528 bores (2.51%) would be affected in the long-term.[4] The main reason many of these wells are expected to be affected is because they are producing from the same coals that are to be used for gas production.

Tenement holders are required to "Make-Good" on any bore level decline by providing alternative water supplies to the landholders. This may include drilling new, deeper bores, or supplying treated water to the affected properties.[4]

4. Water monitoring strategy – is the modelling correct?

There is a chance that the impacts have been under, or over-estimated.

As part of the *Surat Underground Water Impact Report,* OGIA has prepared a Water Monitoring Strategy (WMS) to ensure that the predictions in the model are monitored. A network of observation bores has been established by the gas companies, which provide accurate feedback on the modelled predictions.

Under the *Water Act 2000*, Companies must complete baseline assessments of private water bores within their tenements before production commences. They must also test these bores annually in line with each company's Underground Water Impact Report (UWIR).

Major CSG to LNG companies have also been required to establish a further network of 498 monitoring points over 142 monitoring sites.[4]

The companies are required to report results to OGIA, which was established specifically to manage the WMS. The objectives of the WMS are as follows:

- **Establish the background trends** – obtain a baseline before any impact occurs.
- **Identify changes in aquifer conditions within and near areas of petroleum development –** use monitoring to detect early impacts.
- **Identify changes in aquifer conditions near critical groundwater use –** ensure that aquifers surrounding towns that rely on groundwater are monitored and protected.
- **Improve future groundwater flow modelling –** modelling of the existing and future groundwater flows rely on assumptions. The objective is to continually assess and correct these assumptions based on real data.
- **Improve understanding of connectivity between aquifers –** given the multitude of monitoring sites, the information collected will enhance scientists' understanding of how regional aquifers interact.

Landholders can search the results of the groundwater modelling and the potential impact on their registered bores. OGIA has established an online search tool whereby the *registered bore number* can be entered, and the results of the predicted impacts are made immediately available. [7]

[6] https://www.dnrm.qld.gov.au/ogia/role

[7] OGIA – Bore Search https://www.dnrm.qld.gov.au/ogia/surat-underground-water-impact-report/bore-search

The Queensland Government has also established *Queensland CSG Globe*[8] an interactive, Google Earth™ based product. This lets landholders visualise the location of their property and bores, against current CSG production, and other infrastructure (Figure 3 and Figure 4).

Fig. 3 – Queensland CSG Globe showing CSG wells and water well locations

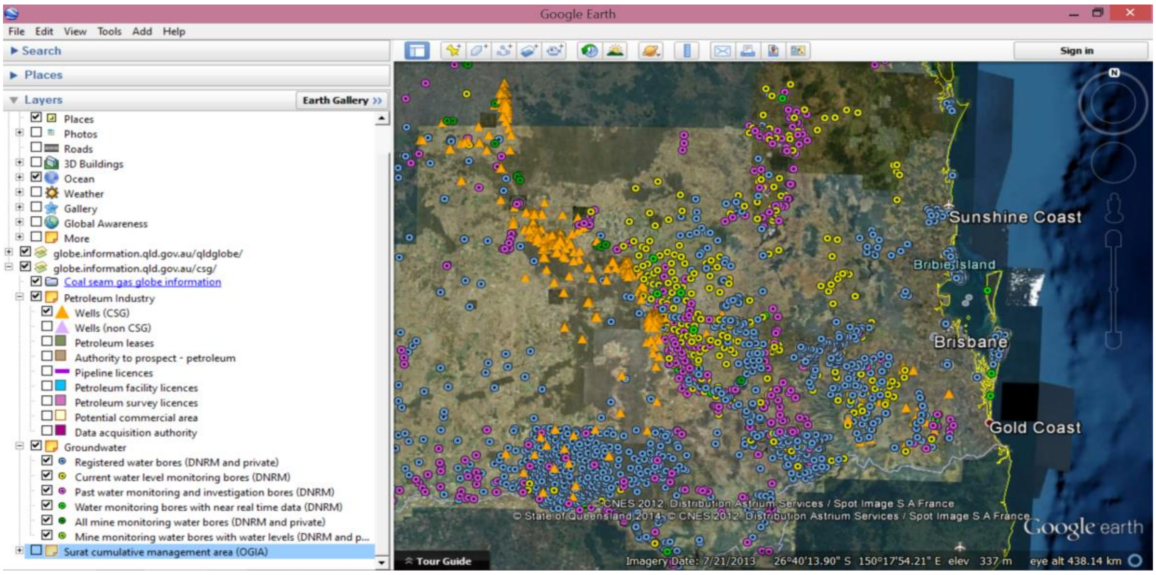
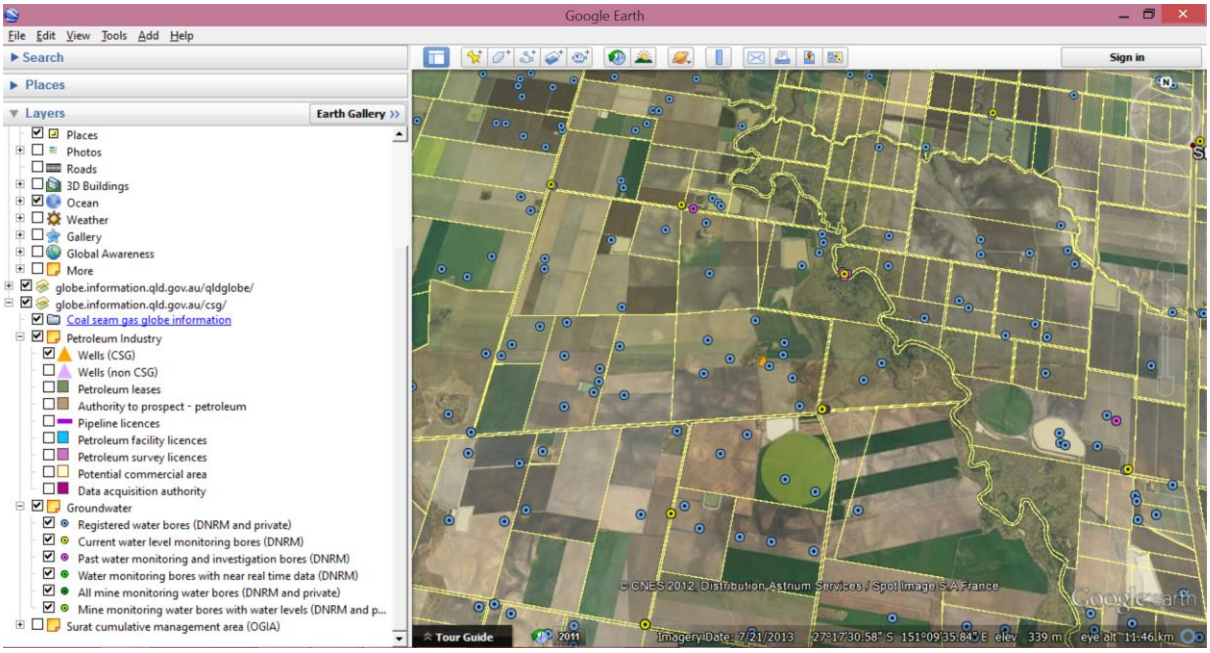


Fig. 3 – Queensland CSG Globe at a Property Level View



Landholders are also encouraged to monitor their own bores and to add information on a monthly basis into a central OGIA database known as *CSG Net*.[9] This community-based information source uses the data to bolster the knowledge of possible impacts predicted by the OGIA model.

The Surat Underground Water Impact Report is required to be updated every three years. The next report – due in 2015 – will incorporate the next level of modelling, using the monitoring points and company data to improve the knowledge of the possible impacts on existing groundwater users.

[8] CSG Globe; www.business.qld.gov.au/business/support-tools-grants/services/mapping-data-imagery/queensland-globe/coal-seam-gas

[9] CSG Net - https://www.dnrm.qld.gov.au/mining/coal-seam-gas/water/csg-net