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Well Design and Construction

Presented by Rohan Richardson,
to the Santos Community Committee – Upper Hunter,
Tuesday, February 28, 2012.

A history of high standards

November 1959

- Santos is an Australian company which has been a leader in the oil and gas industry for more than 50 years.
- Santos is a leader in onshore, offshore and CSG.

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A history of high standards

- Offshore operations are considered more complex with
  - higher pressures,
  - higher temperatures and
  - greater depths drilled.
- The same well design principles applied to offshore operations are used across the company, specific to the well type and properties.

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A history of high standards

- CSG operations are considered less complex with:
  - lower pressures,
  - lower temperatures and
  - shallower depths.
- The CSG conditions may be less complex, however our standards remain high.

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A history of high standards

- Our standards meet or exceed the Australian regulatory requirements, governed by each state
- Drilling designs are submitted to the state government regulators in the form of a drilling programme prior to commencing a well
- We comply with industry standards and best practices including the American Petroleum Institute (API) standards
    - Those standards include clear specifications for well design and construction

Well Definition

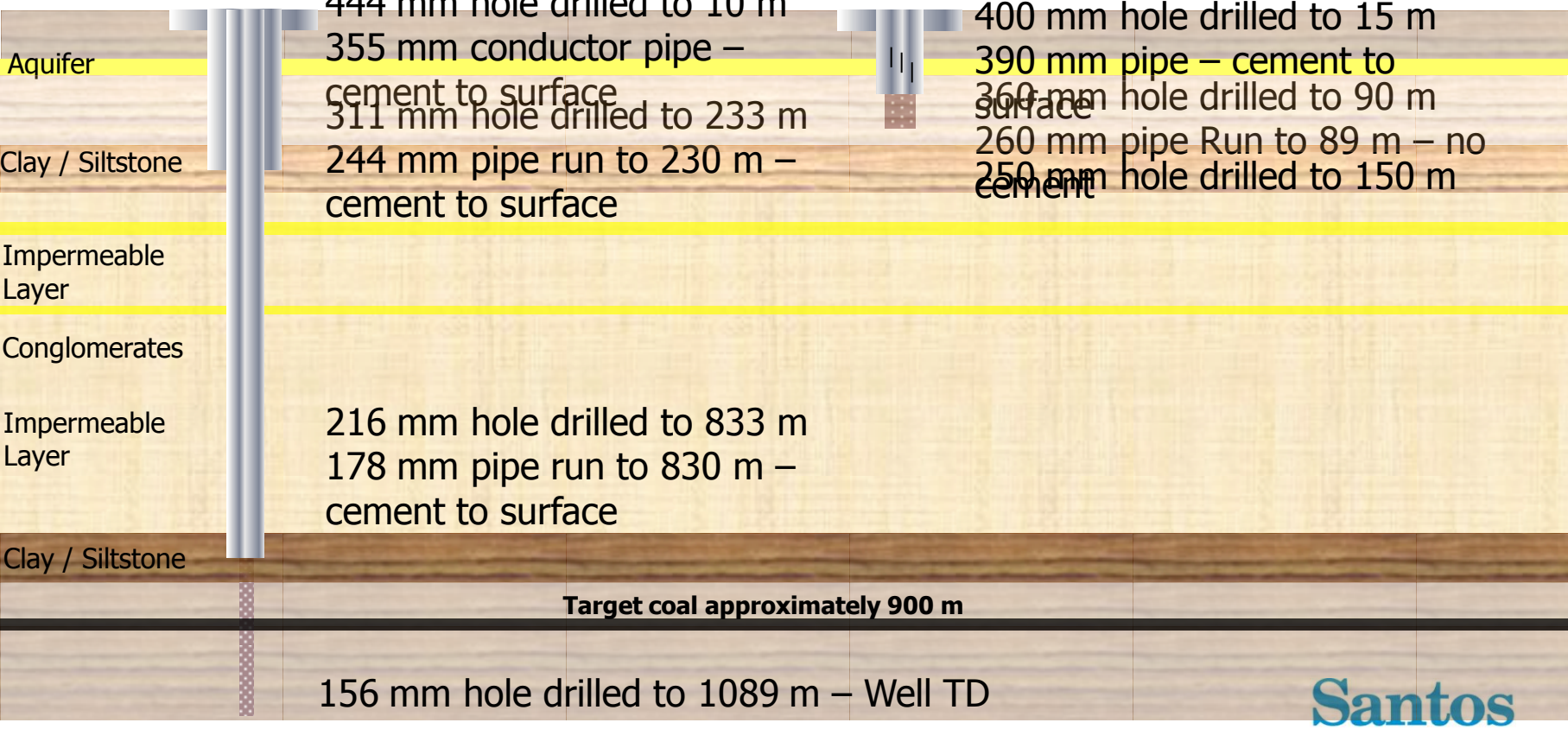
- **Core hole:** is drilled to evaluate the coal, usually by taking a sample of coal, known as a core sample, from a coal seam.
- **Pilot well:** is used to test the commercial viability of producing gas from a coal seam. It is a well that normally produces water then gas from the coal seam. If the tests are positive it may later be used as a production well.
- **Production well:** are usually of similar design as a pilot well, but are used to commercially produce gas, not to test viability. They are subject to a "production" licence.

Water Bore Gas Well Comparison

Local bores in the Bunnan area range from 7 m to approximately 150 m

Santos Core hole drilled near Bunnan

Local water bore drilled near Bunnan



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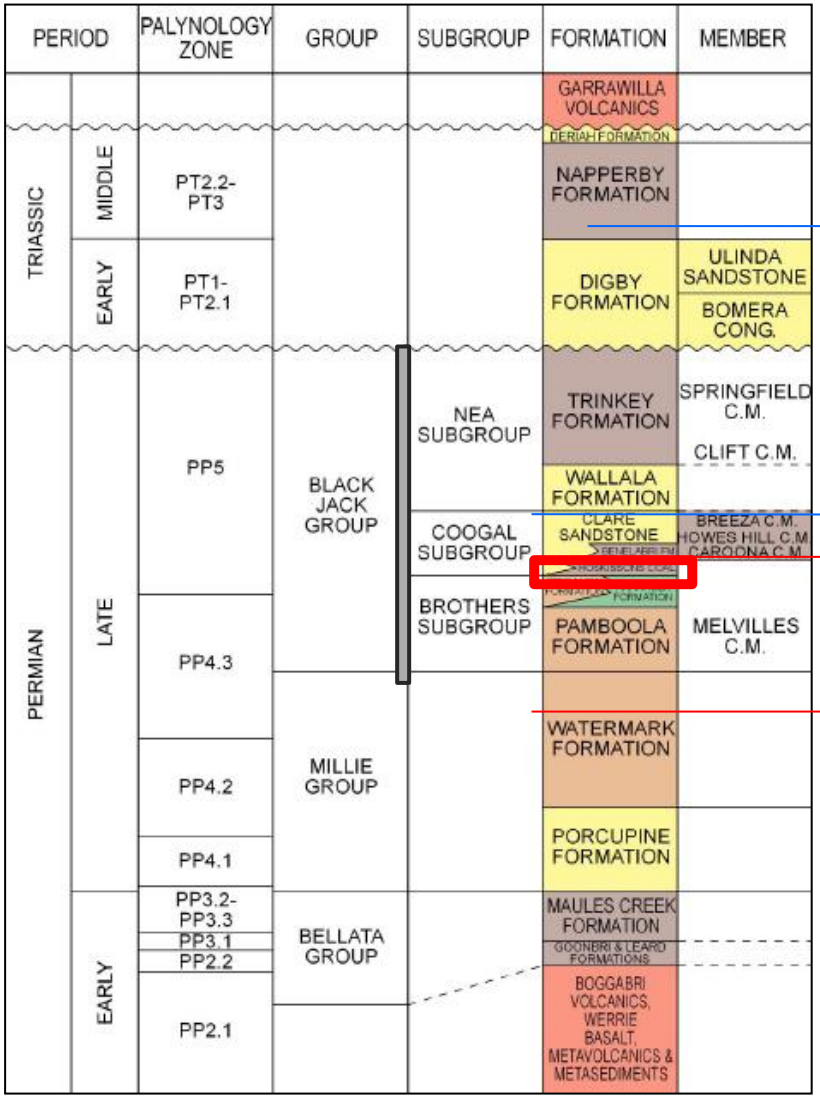
Geology – Expected geology at Bunnan



Surface Casing @ ~230 m.

Intermediate Casing @ ~830 m.

Target Coal @ ~870 m.

TD @ ~1089 m.

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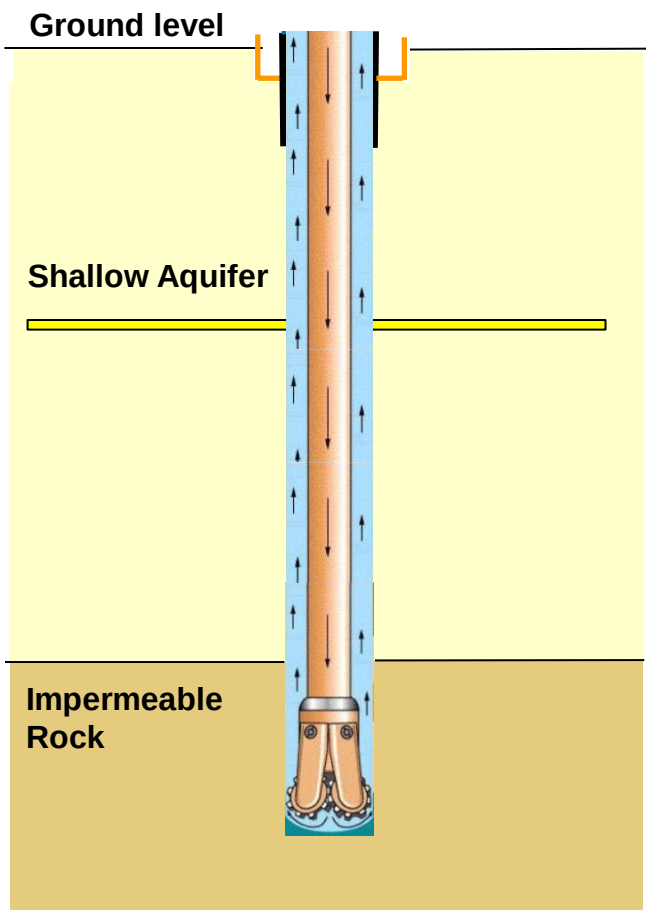
Pilot Well Design & Construction

Well Schematic



355 mm steel conductor is cemented into competent rock, 10 m below ground level

- isolates loose / unconsolidated rock near surface

311 mm hole drilled through sandstone aquifers, drilling fluid circulates down through drill bit and returns to surface, carrying rock chips out of the hole

-Water based drilling fluid used

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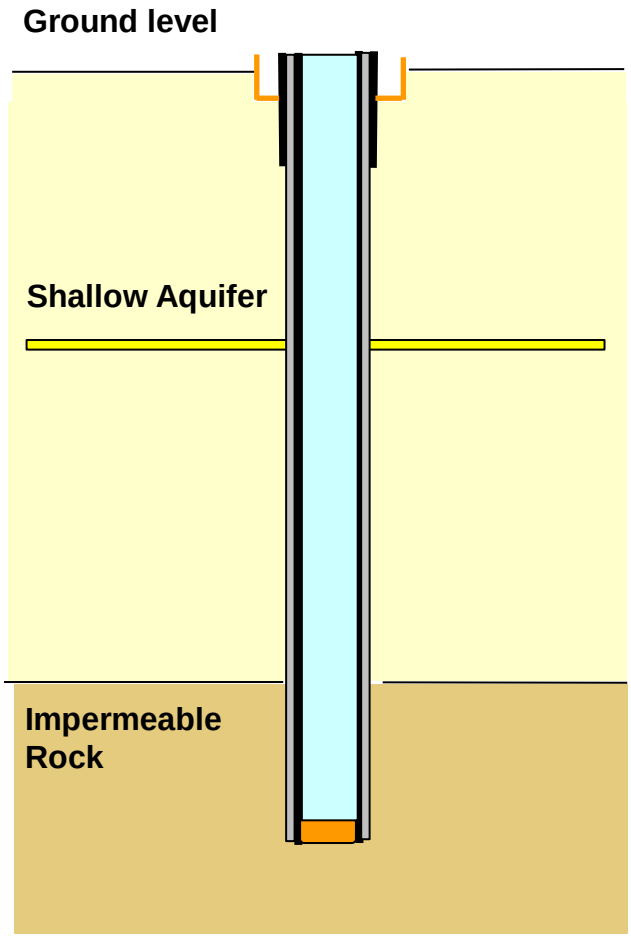
Well Schematic



244 mm steel casing is run into the hole

- This forms a barrier over shallow aquifers

Cement is pumped down the inside and then up around the outside of the casing

- Cement used is designed for the well conditions and once set, has a high compressive strength

Casing is built to API standards and designed for the expected pressures and well condition

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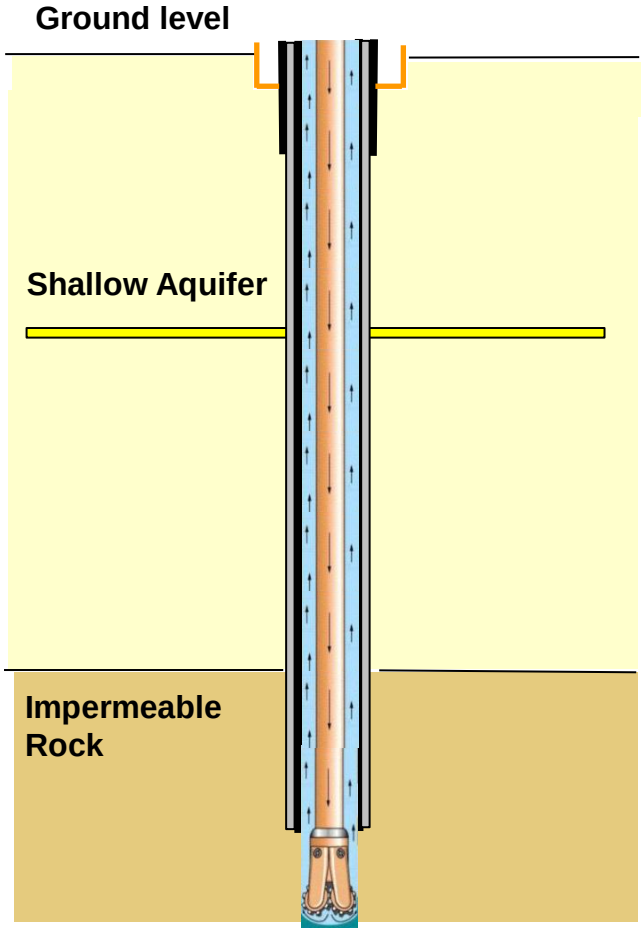
Pilot Well Design & Construction

Well Schematic



216 mm diameter hole is drilled through a series of impermeable rock layers before finishing above the targeted coal.

These layers exist at various depths and provide natural seals that stop water seeping down to deeper strata.

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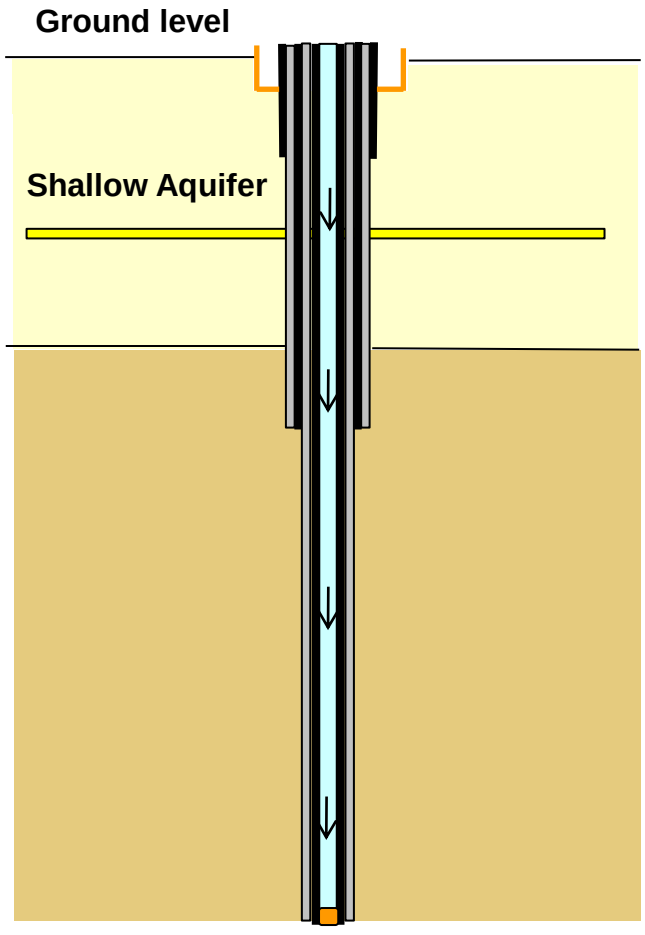
Well Design & Construction

Well Schematic



178 mm diameter steel casing is run into the hole
- This forms a second barrier to isolate the well bore from the shallow aquifers

Cement is pumped down inside and then up around the outside of the casing

156 mm hole is drilled through the targeted coals and to the well total depth

- This is known as the production hole and used to produce through

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Plugging and abandoning a well

- An abandonment includes filling the entire wellbore from bottom to surface with cement in cement 'plug' stages.
- All open hole 'plugs' are left to set and tagged to confirm placement before the next one is pumped.
- Once a cement 'plug' top is inside casing, it is left to set and tagged to confirm placement and pressure tested to confirm isolation.
- Cement 'plugs' are then pumped one by one to surface.

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Rehabilitating the Site

After this process has been completed the wellhead is cut off 1.5 m below ground level, an abandonment marker welded to the casing and the cellar pulled and site rehabilitated

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