

From: [David Paull](#)
To: [IPCN Enquiries Mailbox](#)
Subject: FW: Fw: "Our water is precious"
Date: Monday, 10 August 2020 11:24:40 AM
Attachments: [ADFE571FEA9C4A158507464C391A796A.png](#)
[Submission re Santos CSG Pilliga Groundwater solutions 9-13.docx](#)

Hello IPC

Please find attached submission from 'Groundwater Solutions International' with regard to the Narrabri Gas Project.

sincerely

David C. Paull (MResSc, Dip Hum., UNE)

ethical ecology

ABN: 5727012954

Mob. 0455634160

Sent from [Mail](#) for Windows 10

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Gomeroi elder Polly Cutmore is campaigning to defend the Pilliga forest against coal seam gas mining. The project threatens the Great Artesian Basin, the only fresh water supply for inland Australia. margot, sign the petition to stand with Gomeroi people to protect their sacred places.



Yanaay Santos Yanaay! Stop Santos's destructive coal seam gas project in Pilliga



5,142 have signed Polly Cutmore's petition. Let's get to 7,500!



[Sign now with a click](#)



I'm Polly Cutmore, a Gomeroi Traditional Owner and I'm fighting against Santos's unsustainable coal seam gas plan in Narrabri. As a Native Title applicant and representative of my people, I have

been opposed to this project for years. **Please sign my petition calling on NSW government to stop this destructive project from going ahead.**

The Narrabri Gas Project poses unacceptable risk to the Great Artesian Basin and the state's water supply. The extraction process can contaminate freshwater sources and reservoirs that our farmers rely upon during dry spells.

The Pilliga forest and water is an important place for the Gomeroi people. We believe in the healing power of these waters and have historically used it for medicinal purposes. Our water is precious to us. We cannot allow further destruction and alienation of our country and water.

The Environmental Impact Statement attracted more than 20,000 submissions, of which 98% were objections. Please join the Gomeroi people in opposing this coal seam gas project because of its significant environmental, heritage, social and economic impacts.

Please sign and share the petition to stand with the Gomeroi people as we fight for the protection of our sacred places, plants and animals.



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Groundwater Solutions International

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10 July 2013

Referral Business Entry Point, EIA Policy Section (EPBC Act)

Approvals and Wildlife Division

Department of the Environment, Water, Heritage and the Arts

GPO Box 787 Canberra ACT 2601

Email: epbc.referrals@environment.gov.au

Fax: +61 2 6274 1789

Dear Sir/Madam,

Reference Number: EPBC 2013/6918

Title: Santos NSW (Eastern) P/L/Exploration (mineral, oil & gas – non-marine)/PEL 238 & PAL 2, Narrabri Area, Gunnedah Basin/NSW/Energy NSW Coal Seam Gas (CSG) Exploration & Appraisal Program

I am an Independent Contract Hydrogeologist operating as a sole trader under the name Groundwater Solutions International, NZ. I worked for the formerly named Department of Water Resources, NSW, from 1992 until 1995 as a Project Hydrogeologist and was located in Gunnedah/Sydney. As a result of my work I obtained a good understanding of the hydrogeological processes that occur within, and between, the southern Surat Basin and Gunnedah Basin geological units, having undertaken an intense property-by-property three year study of all bores. Data collected and reviewed included bore and well hydrographic and water quality records; geological records from both the bores, wells and mining exploratory bores; hydrological data from creeks and rivers; and climatic data. I also participated in the mass installation of observation piezometers in the alluvial soils and shallow aquifers of the Liverpool Plains. I ran educational workshops for property owners and government employees working in the area. On occasions since then I have reviewed groundwater impacts of mining operations at the request of community groups. I remain an active interested party with respect to any hydrogeological investigations, and other relevant scientific studies, undertaken in the Namoi Valley Catchment.

I consider that this action will have a significant impact on Matters of National Environmental Significance (Water Resources).

1. Introduction

This review has been prepared in response to a document written by CH2M HILL (7 June 2013). This document, 'Referral of Proposed Action: Water Resources Assessment, Energy NSW Coal Seam Gas Exploration and Appraisal Program', was commissioned by Santos NSW (Eastern) Pty Ltd and serves as a supporting document for the Santos' Referral of Proposed Action which covers an area defined by Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2 located in the Pilliga State Forest, Narrabri region.

2. Background

The federal government announced in March 2013 that it proposes to amend the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) (EPBC Act) to include Water Resources as a Matter of National Environmental Significance (MNES), in relation to large coal mining and coal seam gas (CSG) developments. In anticipation of this amendment, Santos commissioned CH2M HILL to provide an assessment of the potential risks of the proposed pilot activities and associated works, on the water resources within the potential influencing distance of the proposed action.

Of great concern are the potential impacts of CSG exploration on the groundwater quality and quantity within the Great Artesian Basin (GAB) Pilliga Sandstone aquifer beds and the Quaternary (recent) unconsolidated alluvial aquifers beds. The GAB aquifer beds within PEL 238 and PAL 2 provide water for stock and domestic purposes. Of equal concern is that the CSG Program is located above the Pilliga Sandstone recharge beds to the GAB, which are unique to the region. Any activity which intercepts and potentially removes water from the recharge areas, or potentially allows cross contamination of GAB waters with the poor water quality from the coal seams should be scrutinised in light of these potential risks. Any degradation of the GAB beds may have significant consequences to this unique and highly valuable water supply.

3. Discussion

The purpose of this review is to highlight those parts of the CH2M HILL Water Resources Assessment that require further consideration.

The three most important conclusions stated in the report and my comments are as follows:

1. *Based on the modelling of cumulative pilot operational impacts to groundwater within the Bohena Creek Alluvium and Pilliga Sandstone groundwater sources, impacts are **not significant**, defined as long-term drawdown of less than 0.5m.*

If models are going to be used to make critically important decisions on whether a sensitive water resource receptor will be affected, then it is important to get appropriate data at the outset. There is no hydraulic data on the hydrostratigraphic units presented in this report.

Step drawdown and aquifer recharge tests, long term pump tests, and chemical analyses could have been carried out on bores located within the Pilliga Sandstone aquifer. Critical information could have been collected using observation bores located in the overlying alluvial aquifer system and the Keelindi Beds. This would help determine whether there is a leaky component to the Keelindi Beds. This would determine whether the Pilliga Sandstone is a confined, semi-confined or leaky confined aquifer.

The same could be done for the underlying Purlawaugh Formation to see if there is any leakage up from the lower quality Garrawilla Volcanic fracture rock aquifer system through the Purlawaugh Beds and into the Pilliga Sandstone aquifer.

The pump tests would help clarify the conceptual hydrogeology of the aquifer, aquitard and aquiclude units.

In addition, it is not shown how the hydrostratigraphic, aquitard and aquiclude units have been characterized in the Numerical Model. For example, have model runs been made for leaky Keelindi and Purlawaugh Aquicludes? Is the Pilliga Sandstone modelled as a confined aquifer, or have runs also been made for a leaky confined or semi-confined aquifer.

If this was done then we could see how sensitive this model is to its inputs. As it stands I have no confidence in the numerical model outcomes and long term drawdown predictions for the Pilliga Sandstone and Bohena Alluvial aquifers of less than 0.5m.

- 2. Risks of leakage of Produced Water to the water resource as a result of poor bore construction, improper site practices and operational procedures will be considered to be **low to insignificant** as they will be mitigated by adopting best practice site environmental processes and monitoring; appropriate site management procedures and appropriate design, construction, maintenance and monitoring.*

Even before drilling has reached the target seams and pulling out produced water I have concerns for well design in the initial stages of drilling. I have reservations about drilling an open hole, with water-based mud, right through to the Purlawaugh Beds before placing steel casing, back sealing with cement and then drilling through to the lower target formations. There would be considerable difference in water quality between the Bohena Alluvial aquifer and the Pilliga Sandstone aquifer. I am concerned that if the Keelindi Beds do serve as a protective semi-confining layer then driving through without sealing off the alluvial aquifer first could induce unwanted leakage between the Bohena alluvial and Pilliga sandstone aquifers. The high water quality of the Pilliga Sandstone aquifer may be degraded due to a decrease in groundwater residence time (effectively allowing bacteria to enter into the bacteria-free Pilliga Sandstone aquifer).

Figure 4-4 Schematic conceptualisation of hydrostratigraphy of the Bohena Trough suggests the Pilliga Sandstone aquifer's potentiometric surface is well below the alluvial aquifer water table. This would set up the likelihood of groundwater leakage down from the alluvial aquifer to the Pilliga sandstone aquifer if the drilling fluid fails and/or the Keelindi Beds are leaky.

Table 5-3: Water Resources Impacts and Mitigation Measures outlines Santos' management/mitigation approach for stopping passage of water between transmissive units. I am not confident that the well design is appropriate for the section including the Bohena Alluvial and Pilliga Sandstone semi-confined aquifers, and the Keelindi Beds.

- 3. 'A detailed baseline and on-going monitoring program is to be implemented to provide baseline water level and quality data to validate results of modeling and provide early warning of any potential impact to water resources within and surrounding the Program area.'*

It may be more useful for this monitoring and model ground truthing to be undertaken **before** the start of the Program in the upper Gunnedah Basin and Surat Basin aquifer, aquitard and aquiclude units. Pump testing and groundwater analysis before and after this pump testing would take some of the uncertainty out of the hydraulic parameters assigned to these model layers (including introducing model layers representing the aquitards and aquicludes).

I do not think there is sufficient real data input into the numerical model. I do not think the conclusion stating 'impact to the Bohena Creek Alluvium and Pilliga Sandstone groundwater sources are considered **not significant**', is appropriate at this referral stage. Bore monitoring should be carried out and the numerical model run again before approving this Referral of Proposed Action.

4. Discussion on Specific Concerns

1) Table 4-4: Summary of Groundwater Receptors.

Table 4-4 is based on Table 2-3: Significance of Impact. The construction of Table 2-3: relies heavily on the defining of Sensitivity of Water Resource Receptor (Table 2-1) and the Magnitude of Potential Impact (Table 2-2).

According to Table 4-4 the Pilliga Sandstone is considered to be of Medium sensitivity. I disagree. The Pilliga Sandstone is part of the very limited GAB Recharge Beds. The recharge beds only exist in northern NSW and the eastern GAB area of Queensland. According to Table 2-1 they are considered to be of medium sensitivity as they are locally unique but have few regional equivalents. Just because they exist in Queensland does not mean they should be classified as medium. All the recharge beds should be classified as highly sensitive given the important job they have in keeping the GAB replenished and of good quality.

Pump tests on the bores located in the Pilliga sandstone aquifer in the project area will show how responsive the potentiometric surface is due to changes in water levels. I am not convinced the numerical model represents the true drawdown of the Pilliga sandstone aquifer at a radius of 2km of less than 0.5m over 500 years. What will it be in 3, 5, 10, 50 and 100 years? As this is what will directly affect the property owners and their livelihoods in the near future; and ecosystems which will struggle to recover if at all.

I am not convinced that drawdown effects occur for only a 2km radius and that, at worst, it will be less than 0.5m. I do not have confidence that the model is valid due to the ambiguous conceptual model (see comments on Figure 4-4 below) and lack of ground truthed parameter inputs.

2) Figure 4-4: Schematic Conceptualisation of Hydrostratigraphy of the Bohena Trough.

What part of the Program area is this really representing? This figure is inconsistent with topographic information shown on Figure 4-2 and Figure 4-3 Surface Geology. Without seeing any geological logs for the pilot bores, the surface geological map suggests the bores should have encountered Keelindi Beds before the Pilliga Sandstone. The Pilliga Sandstone recharge beds outcrop at the surface further to the east of the Program area and they dip to the northwest. The report stated the Pilliga sandstone was considered to be confined at the Program area, but some of the pilot bores suggest that this can't be the case in Figure 4-4. They suggest the pilot bores are located directly in the Pilliga Sandstone recharge beds. The cross section indicates the Keelindi Beds outcrop all the way up to the top of the Bohena Creek Catchment. It does not show the Pilliga sandstone exposed in the upper tributaries of the Bohena Creek catchment as Figure 4-3

does. Which is correct the Schematic Cross section or Figure 4-3 Surface Geology. This is important as it affects the Conceptual Model on which the Numerical Model is based.

Hence I do not have confidence the numerical model is correctly set up leading to questionable model outcomes.

3) Section 5: Potential Impacts and Management/Mitigation Measures

I have concerns with the validity of the model set up. Section 5 is vague and there are no tables summarizing the parameters assigned to the hydrostratigraphic units and the boundary conditions used. It is hard to know if the model is sound. Given how important the numerical model setup is to the model outcome and conclusions drawn on significant impacts My concerns are discussed section by section as outlined in the Water Resources Assessment as follows:

5.2.1 Model Development

Model Code and Layering

1. The Keelindi Beds have not been modeled at all or not as a separate unit.
2. I don't agree that the Garawilla Volcanics and the Purlawaugh Beds should be modeled as the same layer. The Garawilla Volcanics is a fractured rock aquifer and the thinly bedded silts and clays of the Purlawaugh Beds probably act as an aquitard. Both have very different hydraulic characteristics and different roles to play in the numerical model.
3. The Triassic Digby, Napperby and Deriah Formations should be modeled separately. I would think they would all behave differently if the depressurized Permian target beds compacted over time. Some of these Formations may preferentially fracture along existing weakened planes and should be modeled for this scenario to see how they affect groundwater drawdown in the overlying Jurassic Garrawilla Volcanics, Purlawaugh Formation and Pilliga Sandstone beds.

I have no confidence the numerical model scenarios have been set up realistically.

Configuration of Pilot Program

I do not consider the results of the cumulative groundwater impact assessment should be considered to be conservative just because they included the five pilot sites within the proposed action. I do not think the setup of the numerical model has been done meaningfully. I do not think the conceptual model is clear and a model sensitivity analysis has not been reported to show how the drawdowns would change for various aquifer interaction scenarios.

Historical Abstraction

My concerns here are the vagueness of the comments. The historical abstraction values are used to form part of the steady-state model which in turn is used as the baseline for the predictive model. The predictive model outcomes contribute to the determination of aquifer drawdown in all the hydrostratigraphic units.

Which three pilot sites were used between March 2009 and February 2012? What formation were the bores screened over? What was the magnitude of these historical abstractions and was it for a continuous period (where the aquifers would be stressed so that good information could be obtained on aquifer characteristics)? Or were the abstractions for short time periods? The comments are vague as to whether the impacts on heads in the respective target seams were actually measured at the time of abstraction? What is the 'respective target'?

Initial Conditions and Transient Simulation Protocols

Initial heads (IH) for any of the hydrostratigraphic units are not available for the Program area.

A precursor 'steady-state model' was set up using limited data from the 'shallow Namoi Alluvial aquifers' and 'sparse head data for deeper layers obtained during exploratory drilling'.

Which 'deeper layers' are they referring to? Was this exploratory drilling the ten exploration bores they refer to further on? The groundwater regime and aquifer interactions in the Namoi alluvial aquifer will differ greatly from the Bohena Alluvial aquifer. Despite this, were the measurements from the Namoi alluvial aquifer carried out during the same time as the deep exploratory drilling? That is, were the measurements taken during the same climatic cycle?

The IH have then been used as 'seed heads' for the 'historical model'. As have historical abstractions from the pilot bores between March 2009 and February 2012. The historical model yields 'historical heads' (HH) which are supposed to represent the groundwater condition at the time of the start of the 'predictive model'.

The HH and the planned pilot site water extractions are used in the predictive model to yield 'pilot heads' (PH) representing the groundwater conditions at the end of the extraction phase of the last ten pilot sites.

There have been three steady-state models used, each relying heavily on the head conditions of the previous model, to produce the drawdown conditions in the Bohena Alluvial unconfined and Pilliga Sandstone semi-confined to confined aquifers. The dispute the validity of the initial heads and do not think in my professional opinion they represent the initial head conditions in the relevant aquifers. I also feel with each subsequent model being built the cumulative effect of these uncertain heads only increase my concern that they are not using a valid enough model to make statements that Bohena Alluvial unconfined and Pilliga Sandstone semi-confined to confined aquifers will not be significantly impacted.

A fourth model, the 'recovery model' was developed to simulate the recovery of groundwater heads over a 500 year period. They note they had to use three transient models to maintain model stability. I would like to know what part of the model was unstable, that is, which part of the model was sensitive to inputs and boundary condition changes? I believe the model was not robust enough and not valid for this water resource assessment. Ground truthing and some real head conditions needed to be input into the model earlier on before producing the predictive model.

5.2.2 Model Outcomes

Based on the numerical model inputs I do not have confidence the cumulative impact assessment indicates the depressurization of the target coal seam, as a result of pilot activities, would result in a negligible decline in water levels (less than 0.5m) within the Bohena Alluvium and the Pilliga Sandstone groundwater sources (the document actually says the Namoi Alluvium which I suspect is incorrect and should read Bohena Alluvium). They state that this would take at least 500 years to occur which I have no confidence in as there is no real data to suggest this.

Table 5-3: Water Resources Impacts and Mitigation Measures.

Page 39 'Evidence to date indicates non-artesian conditions within the vicinity of the pilot activities; this will be confirmed through further geological and hydrogeological investigations.'

Where is the evidence for this and in what formation? If they are referring to the Pilliga Sandstone they have modelled the hydrostratigraphic unit as being confined with artesian conditions. I do not have confidence in

what is being modelled in this report and that the model outcomes suggest the Pilliga Sandstone aquifer will have less than 0.5m drawdown over the long term period (>500 years).

Page 40 In Table 5-3 it is stated that the cumulative groundwater impact assessment undertaken for PEL238 suggests that coal seam depressurization will result in negligible decline in water levels within the Bohena Creek Alluvium and Pilliga Sandstone groundwater sources. I do not have confidence in the parameters set for the aquifer, aquitard and aquiclude model units and that the aquifer relationships are not modelled realistically. The do not think the numerical model is valid for this water resources assessment.

Page 41 In Table 5-3 with reference to the decline in groundwater quality as a result of coal seam depressurization it is stated that 'groundwater flow induced by CSG activities will be from generally 'good quality' aquifers and hence to 'low quality' coal seam aquifers and hence the risk to groundwater dependent ecosystems is low'. This suggests they are taking good quality groundwater away from groundwater dependent ecosystems.

4) Leewood Produced Water Storage Facility

I have concerns about the impact the Leewood Produced Water Storage pond will have on shallow groundwater flow. Bores completed in the shallow Bohena Alluvial aquifer located down gradient of the storage facility may experience a decrease in yield due to altered flow patterns by the impeding nature of the storage pond. There is no information on the dimensions of the pond to check this and it has not been mentioned as a potential impact on a receptor in Table 5-3 or in Appendix A.

5. Summary

1. The Conceptual diagram of the Hydrogeology of the area is at odds with their geological and topographic maps.
2. Their conceptual ideas of how some of the hydrostratigraphic beds interact with each other, including the aquitards and aquicludes, are a cause for concern. Especially given this information forms the basis of the numerical model. Therefore, I have no confidence in the model outcomes.
3. I do not agree with the designation of the Pilliga Sandstone aquifer as a Medium sensitivity receptor as 'they are locally unique but have few regional equivalents'. This statement is ambiguous. The Pilliga Sandstone aquifer Recharge Beds are very limited regionally too and should be given a High sensitivity status anyway.
4. Drawdown of the Pilliga Sandstone leaky confined to confined aquifer potentiometric surface is significant when pumping commences. When the potentiometric surface is lower than the Bohena Alluvial unconfined aquifer water table then leakage from the alluvial aquifer down to the Pilliga via the Keelindi Beds would have an effect on the water quality of the Pilliga sandstone aquifer and the lowering of water levels in the Bohena alluvial aquifers. This means domestic bores could start to produce lower quality water and sensitive ecosystems would be adversely affected due to lack of water in the alluvial aquifer.
5. The absence of any ground truthing of the numerical models hydraulic parameters and the process by which the numerical model was developed does not give me any confidence in the model outputs which forms the basis of their arguments that the Bohena Alluvium and the Pilliga Sandstone aquifers will experience drawdowns of less than 0.5m (which they say only manifests over 500 years or more).

Yours faithfully

Andrea Broughton

Independent Hydrogeologist

This submission has been prepared solely for the purpose of commenting on the supporting document 'Referral of Proposed Action: Water Resources Assessment' (CH2M Hill Australia Pty Ltd, 7 June 2013) which forms part of Referral of Proposed Action, Santos NSW (Eastern) Pty Ltd, Energy NSW Coal Seam Gas Exploration and Appraisal Program Gunnedah Basin. Neither this report nor its contents may be referred to or quoted in any statement, study, report, application, prospectus, loan, other agreement or document, without the express approval of Andrea Broughton, Groundwater Solutions International.

Disclaimer

The information contained in this desktop review is based on the contents of the Referral of Proposed Action: Water Resource Assessment (CH2M Hill Australia Pty Ltd, 7 June 2013), and my own professional experience. I accept no responsibility for the results of actions taken as a result of information contained herein and any damage or loss, howsoever caused, suffered by any individual or corporation.

The findings and opinions in this report are based on a desk top review undertaken by myself, Andrea Broughton, independent consultant (Contract Hydrogeologist, BSc (Hons), MAppSci Hydrogeology and Groundwater Management) of Groundwater Solutions International.

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