SENATE STANDING COMMITTEE ON RURAL AFFAIRS AND TRANSPORT INQUIRY INTO THE MANAGEMENT OF THE MURRAY-DARLING BASIN

SUBMISSION CONCERNING OFFSETTING THE IMPACTS OF EXTRACTING ASSOCIATED WATER BY COAL SEAM GAS EXTRACTION

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1. BACKGROUND

The author of this submission, Max Winders, is an engineer who operates an environmental consultancy, as well as being personally involved in the lot feeding of cattle in the Surat Basin.

He and his company, MWA Environmental, are experienced in assessing a wide range of water issues concerning the yield and environmental flow requirements of surface and groundwater resources and the need for resource industries to be concerned about their management.

Major water resource projects with which he has made major contributions professionally and relevant to this submission include:

- Preparing a submission for the Council of Mary River Mayors against the proposed Traveston River Crossing Dam, based upon the results of modelling the impact of reduced environmental flows upon the estuarine water quality of the Great Sandy Region and using pre-and post-barrage construction changes in estuarine salinities and nutrients to validate the model.

- Investigating the impact of the Paradise River Dam on the Burnett River to assess the changes in environmental flow patterns upstream and downstream of the dam which affect the migration of lungfish and to so assess the inadequacies of the upstream and downstream fish transfer devices which have been the subject of an appeal to the Federal Court.

- Development of a conceptual model of the recharge and other hydrogeological processes which produce perennial spring flows from the Coolibah Springs in Cape York and preparing arguments for the retention of the absorptive bauxite surface of the recharge areas to maintain the Wild Rivers status of this Special Feature of the Wenlock Wild Rivers catchment area.

- Development and validation of a hydrogeological model to demonstrate how substantial groundwater flows below layers of aquitards in the Cooloola Sand Mass of the Great Sandy Region could be extracted for urban uses without impacting upon the ecological values of the locality nor of the surface water expressions of groundwater emanating from the Sand Mass.

- Providing in-depth assessments of how to best set up and manage extensive (7000 ha) centre -pivot irrigation systems in Saudi Arabia in view of the limitations on aquifer yield and the extensive seasonal variations in crop water requirements.

Projects in which his rural enterprises have utilised his professional experience in water resource management include:

- Construction of a 1500 ML surface water storage, 300 ha of irrigation and a water supply pipeline from a regulated source, for a mixed farming operation in the Brisbane Valley.

- Construction of a 600 ML surface water storage as the first stage of the water supply for a 24,000 head feedlot in the Condamine-Balonne catchment.

- Construction of a 1100 metre deep bore into the Precipice Sandstones of the Great Artesian Basin to further augment the feedlot water supply.

- Negotiation with a coal seam gas company and obtaining an agreed supply of up to 500 ML/yr of untreated associated water for mixing with the feedlot surface water supply and providing stock water for the feedlot during dry seasons.

- Extensive investigations into the practicality and cost-effectiveness of treating coal seam gas water for intensive animal husbandry and irrigation.

The author has presented papers upon the potential treatment and use of associated water in the Surat Basin to three conferences, has chaired another conference and has been invited to make further presentations on the same topic.

This submission has arisen as a consequence of the author's professional capacity and his primary interest in ensuring that his company's feedlot can continue to avail itself of the associated water resource.

The submission is also aimed at providing information to the Inquiry such that Darling Downs farmers supplying the feedlot with grain, hay, silage and other commodities, can maintain their irrigation water supplies in the face of proposed cuts to water allocations from the Condamine River and from the Condamine Alluvials as suggested by the *Guideline to the Murray Darling Basin Plan* **(Reference 1**).

The author wishes to acknowledge the sources of the information and figures used in this submission, without which it would have been quite impossible to collate and to present the content of this submission with the clarity of those resources.

2. TERMS OF REFERENCE OF INQUIRY CONCERNING THIS SUBMISSION

This submission concerns the following Terms of Reference for the Inquiry:

(a) the implications for agriculture and food production and the environment:

(d) the opportunities for a national reconfiguration of rural and regional Australia and its agricultural resources against the background of the Basin Plan and the science of the future;

(e) the extent to which options for more efficient water use can be found and the implications of more efficient water use, mining and gas extraction on the aquifer and its contribution to runoff and water flow.

More specifically, this submission has been prepared to respond to the proposed reductions of the *Guideline* in the current diversion limits of the Condamine Alluvials groundwater resource (34 percent) and from the Condamine- Balonne's watercourse diversions (29 – 39 percent) by:

- illustrating how the former are currently threatened by the effects of coal seam gas extraction; and
- showing how the sustainable yield from both water resources might be taken into account by the MBDA by requiring the gas industry in the Surat Basin to offset the potential losses by the provision of systems to return treated coal seam gas water (associated water) into the Condamine Alluvials and/or into storages constructed for water course diversions from the Condamine - Balonne.

A schematic plan, representative of how the values of the above water resources may be assessed, is provided as **Figure 1** from **Reference 2**.

The potential for such impacts and offsets has previously been recognized in the *Healthy Headwaters* sponsored study by Queensland's Department of Environment & Resource Management, *CSG Water Feasibility Study* (**Reference 3**) – the design of this study being shown in **Figure 2**.

It is considered that this discussion might also be of assistance in the MDBA's understanding of the potential impacts of the gas industry expanding in the NSW catchments of the Murray Darling Basin and that similar consideration might be given to protecting the water resources of that state.

Consideration might also be given to extending the overall life of the CSG water treatment plants and infrastructure by using it to treat and distribute treated brackish and saline groundwaters from other than the coal-bearing aquifers of the Great Artesian Basin.

3. POTENTIAL IMPACTS OF CSG EXTRACTION IN THE SURAT BASIN

The CSG industry has expanded in the Surat Basin in two relatively distinct areas, with production in the Eastern Surat Basin being more likely to expand and at a greater rate because of proposals to liquefy and export gas through Gladstone. Thus the impact is more likely to be measured firstly upon the Condamine River's surface and groundwater resources.

The locations and ownership of the various gas field tenements in this area is indicated in **Figure 3** such that each may be placed in its spatial and temporal context. The dots represent existing gas wells.

The rate of extraction of gas to meet existing domestic energy needs will need to be ramped up quite considerably if the LNG export proposals from this part of the Surat Basin are to succeed.

The potential impact of these upon the water resources of the Condamine Balonne maybe gauged approximately from the 28 Mtpa LNG production curve of **Figure 4** which has been taken from **Reference 4**, a precursor to **Reference 3**.

Reference 4 reports on a preliminary risk assessment undertaken for DERM to initially assess the risks of CSG extraction dewatering the Walloon Coal Measures and adversely affecting other aquifers of the Great Artesian Basin. This risk assessment showed significant risks to the groundwater resources of at least the Condamine Alluvials and the Hutton Sandstones, as shown in **Figure 5**.

As these aquifers provide significant water resources for rural production and rural communities - particularly the Condamine Alluvials, further development of the gas tenures of the Eastern Surat Basin is now being constrained by political and rural community pressure to protect the threatened groundwater supplies and farming potential of the Central Darling Downs and the more widespread rural industries and communities which depend upon the water resources of the Great Artesian Basin.

This level of concern recently led the Central Downs Irrigators to commission a report into the potential groundwater connections between the Walloon Coal Measures, the alluvium of the Condamine River and other aquifers of the Great Artesian Basin **(Reference 5)**

From analysis of extensive borehole records and comparison with the results of hydrogeological modelling of the alluvials and other extensive research, the report identified the following important features of the local hydrogeology which support the UQ's preliminary risk assessment, viz.

- The alluvial sediments of the Condamine River are incised to a depth generally greater than 120 metres into the Walloon Coal Measures and intersect the current water level (potentiometric surface) of the Walloons, as shown in **Figure 6**.
- The potentiometric surface of the Walloons is currently higher than that in the Condamine Alluvials as a result of unsustainable rates of extraction for irrigation, causing brackish groundwater from the Walloons to infiltrate the Alluvials and increase the salinity of the groundwater in the more northern parts, as indicated on **Figure 7**.
- The potentiometric surface of the Walloons slopes to the NW and with it the inflows from the intake beds of the GAB, as indicated on **Figure 8**.

The above enabled Hillier to conclude that the water in the Alluvium could leak into the Walloons when CSG dewatering caused the potentiometric surface within the Walloons to be lower than within the Alluvials (i.e. when the gas extraction causes a further drop of more than 20 metres).

There are numerous references which can lead to the same conclusion.

It is generally expected that CSG extraction will lower the potentiometric surface in the Walloons by many times the current level differential.

The Queensland Government's proposal to establish a reliable array of monitoring bores and to develop hydrogeological models calibrated against the monitoring data does not recognise the irreversibility of the potential impacts, their lengthy time-scale nor the impracticality of imposing realistic performance bonds on CSG operators to mitigate the impacts and "make good" at the time these potentially widespread impacts become evident..

Hillier and others have shown that there is an existing capability within his profession to model the impacts of gas production on aquifers such as the Condamine Alluvials and the means by which such impacts can be mitigated.

The conditional response by Geoscience Australia to Hon. Tony Burke MP regarding the value of contemporary modelling to mitigate such impacts **(Reference 6),** indicates that the results of appropriately validated groundwater impact modelling may not be available in time to prevent the impacts from becoming both significant and irreversible.

In the Eastern Surat Basin such impacts would mostly be felt by the Condamine Basin irrigators and the rural communities which depend upon them.

It is advised that further information concerning these matters was provided to Hon. Tony Burke MP in December 2010 in an independent report (**Reference 7**), the Minister, in his media release of December 10, advising:

> *Maintaining groundwater pressure in the Condamine Alluvium, including re-injection where necessary, is important. The report states that this would alleviate potential loss of wter and may result in the return of higher groundwater levels to the Condamine Alluvium.*
>
> and
>
> *The results of this study will provide important information for the Great Artesian Basin Water Resource Assessment led by the CSIRO.*

There is substantial support for a moratorium to be placed immediately on the granting of further CSG leases for the LNG industry until comprehensive and validated groundwater impact modelling has been completed and the results reviewed by the community.

This would be consistent with the conditions placed by the Queensland Coordinator General and Hon. Tony Burke MP on recent LNG project applications and it is suggested that means of ensurance of compliance with these conditions should be a matter of interest to this Inquiry.

4. THE VALUE OF BENEFICIAL RE-USE OF TREATED CSG WATER TO AGRICULTURAL PRODUCTION & RURAL COMMUNITIES

The *Surat Basin Future Directions Statement* **(Reference 8)** shows the value which the Queensland Government places upon its agricultural production (**Figure 9**) and has introduced policies and guidelines to enable CSG water to be treated for beneficial re-use to enable these values to be at least maintained or enhanced (**Figures 10, 11 & 12**).

An extract from a presentation by MWA Environmental (**Figure 13**, from **Reference 9**) indicates the potential value of beneficial reuse of treated CSG water to various industries in the Surat Basin and the amounts of water required for each.

From this is should be obvious that, although rural and resource industries can achieve a higher value of production per megalitre of water, their demand volumes are relatively low when compared with that of irrigated agriculture and could not be increased to accept any significant proportion of the amount of CSG water that could be produced from the Surat Basin to support the proposed LNG industry, i.e. significantly more than 200 GL/yr (see **Figure x**).

Figure 14, from **Reference 9**, shows how and where approximimately 1500 GL of groundwater depletion has occurred in the Condamine Alluvials since 1966, i.e. an average of 37 GL/yr.

Figure 15, from **Reference 10**, shows how the rate of production of water from a gas field increases rapidly during the first few years of development, stabilises for more than 15 years and then declines.

The differential between the dynamics of untreated water production and potential treated water usage shows the need for storage of much of the initial production of treated CSG water until the agricultural and other sectors can accommodate the new treated water resource..

It is suggested that injection of treated CSG water into substantial, productive aquifers such as the Condamine Alluvials, with an existing 1500 GL deficit and 37 GL/yr continuing demand, is a sustainable solution for conservation of the Murray-Darling Basin's resources and environmental flows and one which should be of interest to the gas industry - if the cost of treating and delivering the water is to be not prohibitive - relative to the cost of production of LNG.

Another alternative that could be considered in addition to the above or re-injection into other alluvial aquifers, is to supply the water directly into farm off-stream storages, enhancing agricultural production and reducing the impact of water harvesting upon environmental flows.

5. PLANNING THE BENEFICIAL RE-USE OF TREATED CSG WATER IN THE SURAT BASIN

As indicated above, the impacts of CSG water extraction on the region's water resources are likely to be felt well after the industry is established and that the potential time-scale of any "making good" is such that the impacts on agricultural and rural production will be virtually irreversible.

That is why provision for treating CSG water from the outset for beneficial re-use in agricultural and rural production should be a mandatory condition of approval by government and why it should be considered as a significant factor in the further development of the Murray Darling Basin Plan.

Several factors are involved in planning for beneficial re-use, viz:

- the time-scale differentials between CSG water production and beneficial re-use by agriculture and rural industries;
- the widespread distribution of gas wells and gas tenures;
- the technical complexities of desalination and salt recovery;
- equitably distributing the costs of water treatment and treated water delivery;
- planning treated and untreated water trunk mains and sub-mains to and from a series of treatment plants to service the gas fields and deliver the treated water to beneficial uses.

The extent and complexity of the changes to past practices to what is now required in beneficial re-use may be gauged by comparing the two systems shown schematically on **Figures 16 & 17**.

6. FACTORS INVOLVED IN MAKING BENEFICIAL RE-USE OF TREATED CSG WATER A SUSTAINABLE SOLUTION IN THE SURAT BASIN.

6.1 *Incorporating The Water Grid Concept Into CSG Water Treatment and Its Beneficial Re-Use*

The water grid concept was introduced by the Queensland Government as a solution to meeting the water demand from SE Queensland**.**

The value of this concept to distributing the beneficial use of treated CSG water was recognised by SunWater (**Reference 11**), who proposed that several CSG water treatment plants would supply treated water into a trunk water main which would ultimately link a future Nathan Dam on the Dawson River to the Dalby region. Sub-mains from the trunk main would then transfer treated water to centres of beneficial re-use, as shown on **Figures 18 & 19**.

Implementation of the concept relies upon the staged development of CSG water treatment plants consistent with the expansion of those segments of the trunk main and sub-main network that are required to meet the demand for water from existing and proposed beneficial re-users.

Given the time-dependency of treated water supply rates and development of beneficial re-use systems and associated water main networks, it is obvious that planning of the water grid needs to start by designing the first stages of the grid to receive treated water from gas fields already developed to supply gas to domestic energy users.

In the Eastern Surat Basin, these are those of Arrow Energy and BG-QGC's southern region, where RO plants have already been installed and plans have been made for their further expansion if the Gladstone LNG proposals proceed.

Given that these fields are already producing moe than 40 GL/yr of CSG water and that very little is being treated and directed to beneficial re-use, it is obvious that a large proportion of this water should be returned to the Condamine River and the Condamine Alluvials where it can be stored for re-use by existing irrigators and urban communities and where the storage of such large amounts of water would offset the potential draining of the Condamine Alluvials by CSG extraction.

The groundwater flow in the Walloons in the Eastern Surat Basin is generally in a westerly direction and parallels the flows in the Condamine River and Alluvials down to the Chinchilla Weir. This suggests that the maximum benefit from re-injection of treated CSG water would be obtained by injecting the water principally in the Dalby Region, into those parts of the Condamine Alluvials where rectification of the current water deficit would show the most economic benefit to the Region – as has now apparently been recognized by Hon. Tony Burke MP in his December 2010 mdeia statement.

Otherwise, the trunk main could distribute treated water to existing and future users from Dalby to Chinchilla.

A suggested route for such a trunk main is shown in **Figure 20**.

6.2 Desalination, Brine Treatment, Salt Recovery Aspects

To date, the desalination of CSG water has been achieved by the use of reverse osmosis, with 70-75% water recovery and the balance going to evaporation ponds. The process is well known and appropriate pre-treatment technologies have been developed.

Given that no further evaporation ponds are to be allowed, current proposals are that the brine rejected from the RO plants would be directed to major brine storage ponds. It is understood that this is one of the major concerns addressed in the Coordinator General's conditions.

To reduce the volumes of brine produced, a further stage of RO can be added, giving 85% recovery and halving the volume of brine. Otherwise, thermal energy can be provided to evaporate the brine in a closed vessel and to crystallise out the salt(s) for disposal or further processing to commercial grades.

The Higgins Loop ion exchange process has been used in US gas fields and a pilot plant is about to be trialled in Queensland gas fields. This technology has the advantage that it can recover 98% of the water and produce a brine ready for crystallisation.

The choice of desalination technology depends upon many factors, most of which are site and scenario dependent.

Most proposals to date do not rely on recovering the salt from the brine, except that it was offered in the SunWater/Osmoflow/Penrice proposal referred to above.

Penrice is an experienced salt producer and has carried out pilot studies into recovering salt from CSG water. It is understood that its business case is assisted if the production of sodium carbonate can be optimised rather than that of sodium chloride.

Leighton/Severn Trent have considered the production of salt from the quite concentrated brine produced by the Higgins Loop process. One of the purposes of the proposed pilot plant is to examine the content of the concentrate and to determine how it should be further evaporated and crystallised to maximise the value of the recovered salts.

Cheetham Salt, Australia's largest salt producer, has expressed interest in participating in these trials and has had discussions with the CSG companies with a view to establishing the likely extent and location of salt production.

It is likely that a process of Pre-treatment / Reverse Osmosis / Thermal Evaporation / Crystallisation will prove optimal for the size of CSG water treatment plant that could treat CSG water from several gas fields, deliver treated water into a trunk main and recover the salt for processing and/or safe storage.

The feasibility of using a dedicated gas-fired co-generation plant to satisfy the power requirements of water pumping and reverse osmosis and the thermal energy requirements of evaporation, crystallisation and drying is seen to be a significant factor in locating a major CSG desalination facility.

6.3 The Potential Role Of A Third Party Water Service Provider

The legal basis for such a third party water service provider is included in the *Water Act 2000* **(Reference 12)** and specifically referred to in the Queensland Government's *Guideline for the beneficial re-use of coal seam gas water* **(**see **Figure 21**, from **Reference 13).**

References to the role of aggregated CSG water treatment plants in providing treated water for beneficial re-use have been presented to several forums over the past two years and it is believed that APPEA commissioned consultants to undertake a feasibility study into such a proposal. However, it would appear that the conclusions and recommendations of this study have not been released to persons outside the gas industry.

A preliminary investigation into the feasibility of a third party, Special Purpose Vehicle (SPV) operated CSG water treatment plant, servicing local gas fields and delivering treated water from Braemar, operated by a Special Purpose Vehicle was undertaken by Leighton Contractors and MWA Environmental in late 2008.

Figure 17 indicates the complex structure of the operations so-required of the SPV, the need for storage to be integrated at various levels in the flow of water from wells to benefical uses and the degree to which the management of each sector needed to be coordinated to obtain optimal performance, reducing the overall costs to gas companies while maintaining water prices at commercial levels.

Figure 22 shows how the earlier system has now been modified to commercially address the complex and un-regulated situation which has developed under legislation which allowed gas companies to operate independently of the *Condamine-Balonne Water Resource Plan* and the *Great Artesian Basin Water Resource Plan* (**References 14 & 15**).

Basically, the revised system provides for untreated and treated water trunk mains to be constructed along a selected route, with water treatment and salt removal plants being located at optimal intervals along the route. Submains from the gas fields to the untreated water trunk main can deliver either or both untreated water or concentrate from gas field storages to the treatment plants, while another submain can deliver treated CSG water from each gas field RO plant to the treated water main.

Each treatment plant manager would manage the inputs of untreated water from each gas field's storages such that a consistent quality and quality of untreated water can be processed through the pre-treatment, desalination, brine concentration, evaporation and salt production phases and delivered to the treated water trunk main. Flows from the trunk mains to beneficial uses or suitable storages would also be managed by the plant manager.

Participating gas companies would be billed on the basis of quantity and salts content of their untreated water supply, while beneficial users would be billed upon the quantity of water supplied and the priority assigned to that supply under a water supply agreement. Arrangements might also be made with government for the delivery of environmental flow releases.

6.4 Potential Viability of the Proposal

A report produced for the Queensland Government in 1999, *Queensland LNG Industry – Viability and Economic Impact Study* (**Reference 16**) provides some guidance upon the financial implications of two important aspects of CSG water treatment and beneficial re-use, viz. the cost of treatment per megalitre of water treated and the cost of water treatment per gigajoule of gas produced.

Figure 23 , from **Reference 16**, provides a useful summary of water management options that were under consideration in 1999, in which, for example, full treatment refers to achieving potable water standards, the quantity treated is 12,000 ML/yr, of which 700 ML/yr would be pumped 150 km for urban use (@ $154/ML), while 9,300 ML/yr would be blended and piped to local surface waters and the balance 2000 ML/yr of brine from the RO plant would be re-injected in twelve 1400m deep wells.

It may be seen from the above that the most expensive option would cost $ 2,819 per megalitre for full treatment and partial beneficial re-use 150 km away, reducing to $ 830 per megalitre for only partial treatment to river water quality and delivery back to the river 50 km from the treatment plant.

While the latter option might be considered as a typical cost of providing environmental flows and, at 5 cents per gigajoule, quite acceptable to gas companies, it is doubtful that it would be acceptable to those whose access to groundwater is likely to be denied by gas extraction.

The table included as **Figure 24**, also from **Reference 16**, puts the most costly treatment option in perspective as far as the cost of gas production is concerned.

7. CONCLUSIONS

1. There is an increasing amount of evidence becoming available that the large volumes of water to be extracted from the Walloon Coal Measures to supply coal seam gas for LNG production and domestic uses will lower the potentiometric surfaces within the Surat Basin and that this may adversely impact upon bores extracting from the Walloons and from aquifers above and below the Walloons.

2. The water produced by CSG extraction is brackish to saline and would, in general, require desalination before being used for irrigation or other beneficial re-uses or for release into waterways to supplement environmental flows or on-stream surface water allocations.

3. Queensland Government policies and guidelines, addressing landholders' concerns that expanded CSG extraction will adversely impact upon their groundwater resources, have led to gas companies developing plants and strategies to remove the salt and provide treated water for beneficial re-use or for making good depleted bore water supplies.

4. The value of such an *ad hoc* and non-regulated approach to sustaining the agricultural, rural and other production in the Surat Basin has been questioned.

5. This is particularly the case in the farming areas of the Darling Downs, where potential access to groundwater supplies from the Condamine Alluvials is threatened by further CSG production and where groundwater and surface water diversions are recommended for further reduction by the need to increase environmental flows down the Condamine River.

6. Monitoring bore water levels in this area over the past 40 years indicates that the net effect of low recharge and irrigation during drought periods has resulted in a loss of 1500 GL of groundwater, i.e. at an average of approximately 37 GL/yr.

7. The beneficial re-use of treated CSG water to replenish this loss and meet an on-going deficit that might be exacerbated by extracting water from the underlying and potentially hydraulically connected Walloons, is a matter which has been given serious thought by the Queensland Government, landholders and, more recently, by the Australian Government.

8. SunWater's original proposal to develop a water grid from a future dam on the Dawson River to Dalby and to supply this grid with treated water from gas field CSG treatment plants appears to have lost traction for unspecified reasons but the concept is valid.

9. Progression further in this regard requires the development of a business case which addresses the reasonable expectations of the gas companies concerning

costs of water treatment and salt recovery and disposal, while allowing for the equitable sharing of the treated water as beneficial re-use in the areas affected by gas field operations.

10. The author of this submission is the principal of a company which owns land at Braemar, in the Eastern Surat Basin, which spans two gas tenures. The company has an agreement with one gas company under which up to 500 ML/yr of untreated water is supplied to the cattle feedlot on the property for cattle watering after mixing and stabilising in the company's 600 ML surface water storage.

11. In view of the potential for treated CSG water to allow the feedlot to be developed to its 24,000 head approved capacity and for allied industries to be set up in association, the author has applied considerable resources towards determining how this might best be achieved.

12. The location of the feedlot property has also been a driving factor in that it is adjacent to three major gas-fuelled power stations and gas pipelines and that the feedlot receives most of its grain, hay, silage and cottonseed from farms on the Condamine Alluvials – all of which either are or could be users of treated CSG water.

13. In order to develop a business plan for a third-party operated treatment plant, untreated water collection system and treated water distribution system, a concept plan has been developed, by which two water treatment and salt removal plants might be located adjacent to power stations at Braemar and Kogan Creek, treat water from nearby gas fields and distribute treated water from south of Dalby to the Condamine River above the Chinchilla Weir. The route of the collection and treated water mains is shown on **Figure 20**, while the overall concept plan is shown on **Figure 22**.

14. The development of a business plan for such a concept was encouraged by the economic assessments of less complex but similar concepts reported upon a 2009 report to the Queensland Government, **Reference 16**, extracts from which are included as **Figures 23 & 24** of this submission.

15. Reference to **Figure 23** shows, for an example involving the full treatment of 12000 ML/yr of CSG water to provide 700 ML/yr of potable water to an urban use 150 km away, 9300 ML/yr piped to local surface waters and 2000 ML/yr of concentrate pumped back into quite deep aquifers, the overall cost of treatment would be $ 2,819/ML, whereas the value of the water for urban use was credited at only $ 154/ML and that delivered to local surface waters was considerably less.

16. While this overall treatment cost per megalitre of CSG water might be seen to be an impediment to developing a beneficial use of all of the treated water, gas

companies need to consider the cost of waste treatment and disposal as just one more component of their overall cost of gas production, principally as the Queensland Government regards CSG water as a regulated waste.

17. Consideration of **Figure 23** indicates how the relative costs of waste treatment per gigajoule of gas have escalated from only 2 cents/GJ for the now unacceptable evaporation pond option to 18 cents/GJ for an equivalent to what appears to have been recently offered to government as a solution.

18. Why this high relative escalation in cost has been found acceptable to potential LNG producers is evident by comparison of the cost per gigajoule of gas of the above most expensive option (18 cents) against the total and other production costs and by comparison with the probable value of the gas to the gas producers of $3.50 to $ 8.00 per gigajoule.

19. Other assessments of the fee which might be charged to a gas company supplying untreated CSG water to an Eastenr Surat Basin water service provider suggest that this fee might be in the range 30 – 40 cents/GJ or double the **Reference 10** assessment to allow for the costs of salt removal and disposal – a provision now required if the proposal to construct extensive long term brine storage ponds is disallowed.

20. The business plan is being developed on the basis of two water treatment plants (Braemar & Kogan Creek) each being developed as 40 ML/day stages and having a combined treatment capacity of 160 ML/day. It is envisaged that at least 40 ML/day could be pumped eastwards to the Condamine Alluvials, 80 ML/day could be pumped into the Condamine River system from Macallister to above the Condamine Weir and the balance to power stations, coal mines and rural industry users in the area from Daandine to Kogan Creek.

21. The water supply to the Condamine Alluvials could be by direct injection into the shallower aquifers to replenish the overall aquifer or could be pumped into on-farm storages for direct application on to crops.

22. The water supplied to the Condamine River could be used to augment the allocations to irrigators and other licensees or to provide a basis for increasing the environmental flows in the river.

23. The author recommends to the Inquiry that the MDBA should investigate the water allocation and pricing aspects of the above and communicate with the proponents of the scheme.

24. If the business model shows that investment in the plants and pipelines is justified and that the MBDA is supportive, it is proposed that an application be made to the Queensland Government for it to be recognised as an *Infrastructure Project of State Significance* to enable the necessary licences, planning

approvals and pipeline easements to be obtained and for the project to be financed.

25. The author recommends to the Inquiry that the MBDA should investigate the potential for similar projects to be developed in other potential gas fields in the Murray Darling Basin, particularly those in New South Wales.

26. Consideration might also be given to extending the overall life of the CSG water treatment plants and infrastructure by using it to treat and distribute treated brackish and saline groundwaters from other than the coal-bearing aquifers of the Great Artesian Basin.

REFERENCES FOR MDBA SUBMISSION

1. MDBA, *Guideline to the Murray Darling Basin Plan*, 2010
2. CSIRO, *Water Resources of the Condamine-Balonne*
3. DERM, *CSG Water Feasibility Study*
4. Centre for Water in the Mining Industry, *Scoping Study: Groundwater Impacts of Coal Seam Gas Development – Assessment and Monitoring*, U of Q Report to Queensland Department of Infrastructure & Planning, December 2008
5. Hillier, J.R., *Groundwater connections between the Walloon Coal Measures and the Alluvium of the Condamine River*, Report to the Central Downs Irrigators Limited, August 2010.
6. Geoscience Australia, *Advice to Hon. Tony Burke MP re the QCLNG Project,* 2010.
7. Moran, C, *Assessment of impacts of the proposed coal seam gas operations on surface and groundwater systems in the Murray Darling Basin*, Report to Hon. Tony Burke MP, December 2010.
8. Queensland Government, *Surat Basin Future Directions Statement*, February 2010
9. MWA Environmental, *Presentation to Surat Basin Coal & Energy Conference*, Brisbane, May 2010.
10. QGC, *QCLNG Project EIS*, 2010.
11. Boettcher, P., *The Role of CSM Water as a Valuable Water Resource*, *pers.comm.* 2009.
12. Queensland Government, *Water Act 2000*.
13. Queensland Government, *Guideline for the Beneficial Use of CSG Water*
14. Queensland Government, *Condamine-Balonne Water Resource Plan*
15. Queensland Government, *Great Artesian Basin Water Resource Plan.*
16. MMA, *Queensland LNG Industry – Viability and Economic Impact Study*, Report to the Queensland Government, 2009.

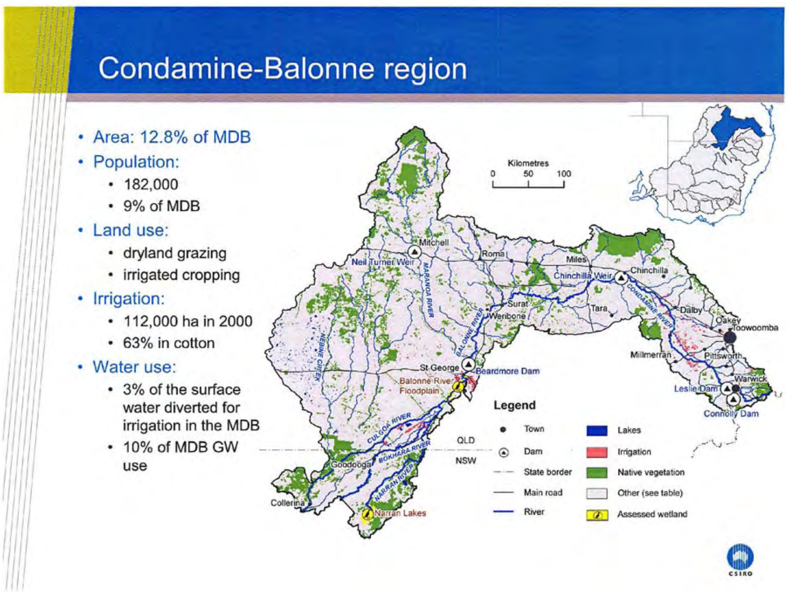

FIGURE 1

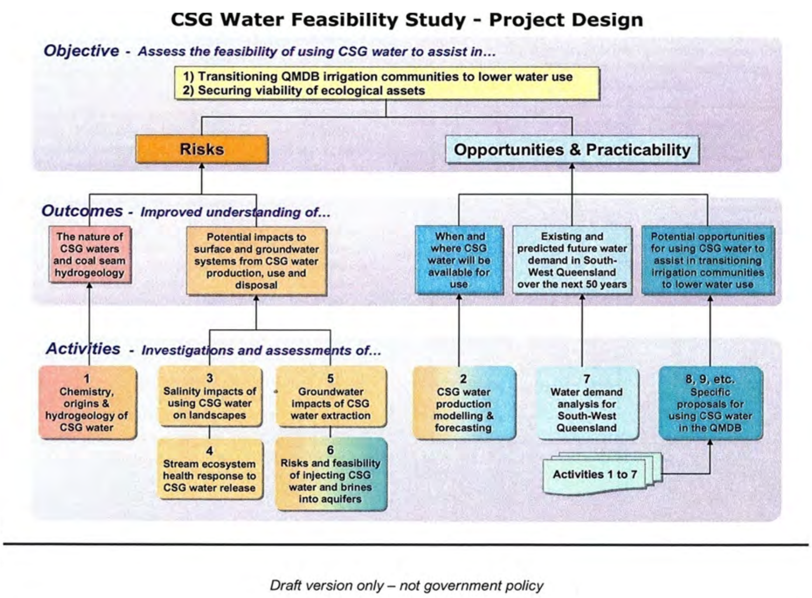

FIGURE 2

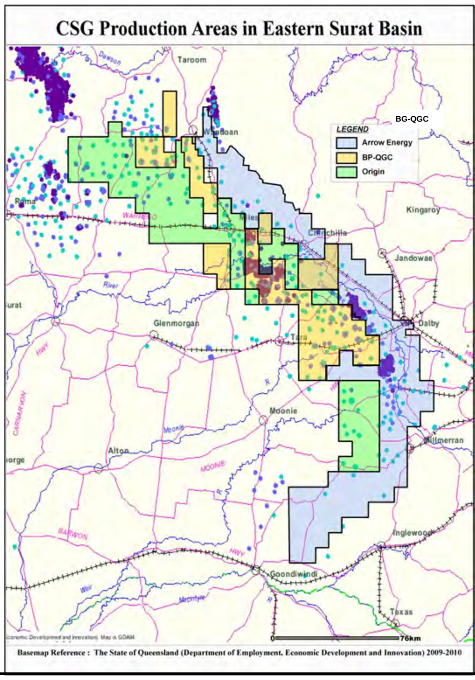

FIGURE 3

UQ PRELIMINARY RISK ASSESSMENT

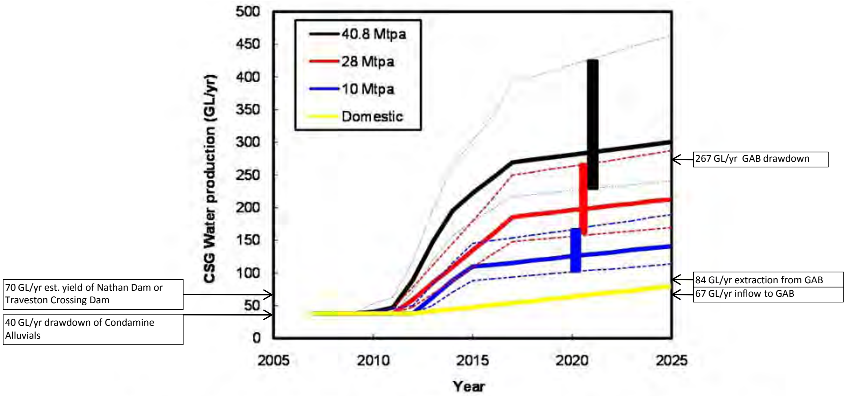

Figure 13. Trajectories of model output for coal seam gas water production (ML/year). The plot depicts three gas production target scenarios and the domestic production target for the Bowen and Surat basins (solid lines). Dotted black, red and blue lines show sensitivity of water production based on +/-25% uncertainty in average gas production rates per well. Vertical bars indicate the range in sensitivity of water production estimates for 2020.

CWiMI

FIGURE 4

UQ PRELIMINARY RISK ASSESSMENT

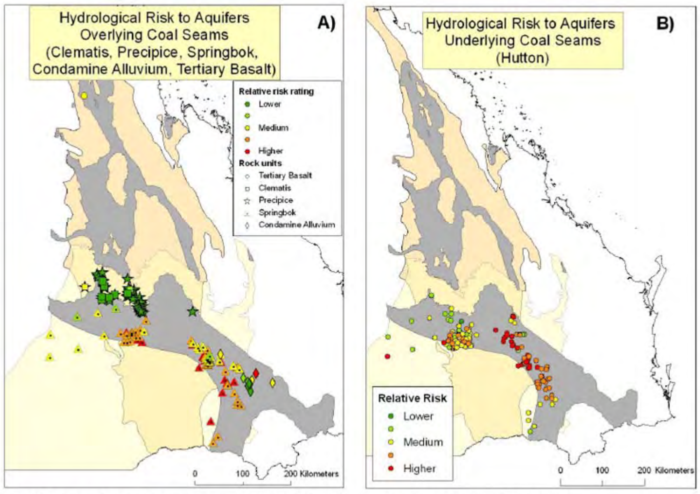

Figure 22. Relative risk to aquifers a) overlying coal seams and b) underlying coal seam in the Bowen and Surat Basins.

FIGURE 5

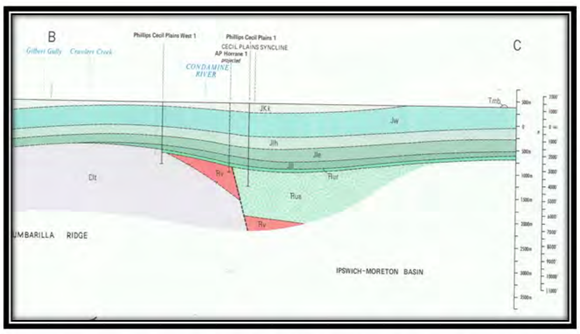

Figure 3 – Geological Section Through Cecil Plains to Mt Maria. (From Exon et al, 1972). The Kumbarilla Ridge at "B" separates the Surat Basin to the west from the Clarence Moreton Basin. The Walloon Coal Measures (Jw) overlies the Hutton Sandstone (Jlh) and other GAB sediments. The Condamine River alluvium has eroded a channel into the Kumbarilla Beds (JKk) and the Walloon Coal Measures and filled the eroded channel with clay, sand and gravel.

FIGURE 6

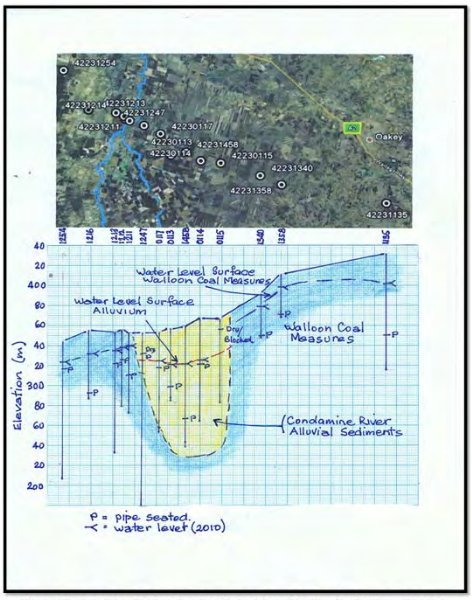

Figure 12 – East West Section showing the incision of the Condamine River into the Walloon Coal Measures and the groundwater level in each, with bore locations. The bores in the section have been projected from the plan above.

FIGURE 7

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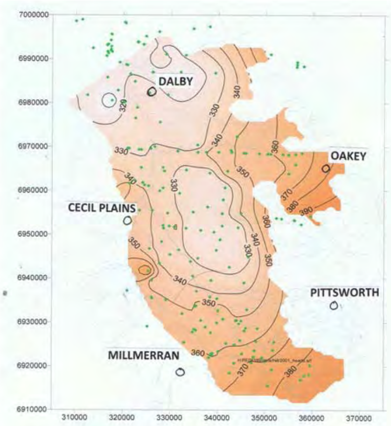

Figure 10 – The piezometric surface in the Condamine alluvium in 2001. (From SKM, 2002)

The contours of the groundwater piezometric surface in the Walloon Coal Measures is difficult to derive as there are few dedicated monitoring bores from which accurate information can be obtained. Hence data from private bores that tap these sediments have been used, but the water levels are spread over several years, thus affecting the contour accuracy. However they do give a very good indication of the direction of flow of the groundwater and are shown in Figure 11. Flow is to the west, with evidence that there is vertical discharge into the overlying alluvium of Oakey Creek (near the centre of this figure) and into the Condamine River alluvium (in the north west of the figure), where the streams have cut into the Walloon strata.

FIGURE 8

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Value of Agriculture, Food Processing & Associated Businesses – a Key Sector of the Surat Basin (from *Future Directions Statement)*

- Total value agricultural production 2005-06 was $ 1.58 billion, 18.2% of the total value of agricultural production in Queensland.
- Livestock slaughtering accounted for $ 985.3 million and livestock products were valued at $ 118.9 million.
- Field crops accounted for $ 478.3 million.
- The region produced 11.5% of the total value of field crops in Queensland and 23.9% and 28.6% of the total value of Queensland livestock slaughtering and livestock products respectively.

CURRENT QLD GOVERNMENT ACTIVITIES REGARDING SURAT BASIN

- Investigation of proposed Nathan Dam, including scoping of a potential Nathan Dam agricultural precinct.
- Development of policy for CSG Water, to facilitate its beneficial use.
- Water demand study.
- Implementation of water resource plans.
- Development of State Water Grid Concept Plan.

FIGURE 10

NEW ARRANGEMENTS TO PROTECT GROUNDWATER RESOURCES IN COAL SEAM GAS EXTRACTION AREAS

A statutory framework is being developed by the Queensland Government to manage the groundwater resources by:

- Managing impacts of CSG water production on water supply bores, including setting triggers, requiring investigations and "making good".
- Managing impacts of CSG water extraction on springs.
- Requiring periodic underground water impact reports to be submitted to the government for approval and to be available to the public.
- Managing cumulative impacts where the water level impacts of CSG producers overlap will be the responsibility of the Queensland Water Commission – allowing bore owners to deal directly with the QWC rather than any individual CSG producer;

and

- CSG producers will meet the costs incurred by the QWC through an industry charge.
- The unit within QWC would be supported by a technical advisory panel to review the data collected quarterly and an industry advisory panel, comprising members from the CSG industry, agriculture, environment and community sectors.

FIGURE 11

Elements of the policy relevant to the approval of coal seam gas water for beneficial use are as follows:

- CSG producers are responsible for the treatment and disposal of the CSG water they create.
- CSG producers must treat CSG water to a standard defined by the Department of Environment and Resource Management before disposal or supply to other users.
- At the approval stage, CSG producers will need to advise how they intend to manage water on their operations through the preparation of a CSG Water Management plan.
- Water which is excess to that which can be directly injected or beneficially used is to be aggregated for disposal.

The Government wishes to see CSG water beneficially used where that is feasible, practical and sustainable.

FIGURE 12

WATER SUPPLY & DEMAND ISSUES
(extracts from ACIL Tasman 2007)

VALUE OF PRODUCTION PER MEGALITRE

Electricity & Gas	$ 52,000 /ML
Coal Mining	$ 86,000 /ML
Cotton	$ 500 / ML
Sugar	$ 380 /ML
Rice	$ 160 / ML
Pasture & Grains	$ 260 / ML
Grapes	$ 1,800 / ML
Vegetables	$ 3,800 / ML
Irrigated horticulture	< $ 15,000 / ML
Feedlots	$ 54,000 / ML
Abattoirs	> $100,000 / ML

TYPICAL WATER CONSUMPTION

Electricity & Gas	1.5 % Australian consumption
Coal mining	0.6 % Australian consumption
Agriculture	65 % Australian consumption
Coal Fired Power Station	2.1 ML/Gwh
CFPS with cooling pond	1.55 ML/Gwh
Combined Cycle Gas PS	0.95 ML/Gwh
Open Cycle Gas PS	0.1 ML/Gwh
Darling Downs Irrigated Farm	9 ML/yr/ha
Feedlots	200 ML/yr/ 10,000 head
Abattoirs	1.5 ML / 1,000 head

FIGURE 13

CONDAMINE ALLUVIALS AQUIFER STORAGE

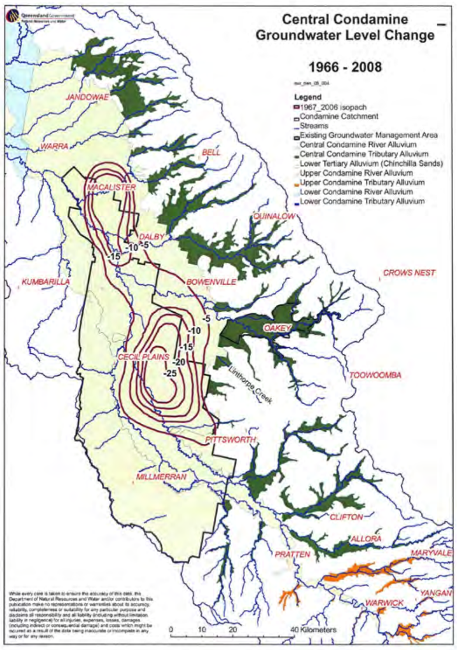
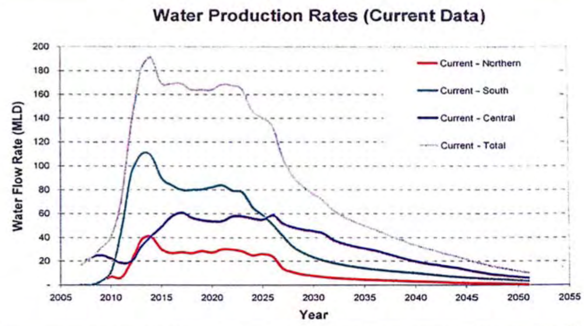


FIGURE 14

QUEENSLAND CURTIS LNG VOLUME 3: CHAPTER 11

Figure 3.11.5 Water Production by Area and in Total (ML/d)



At peak production the current conservative estimates are that the:

- CDA (Central) will produce approximately 61ML/per day
- NWDA (Northern) will produce approximately 40 ML/per day
- SEDA (Southern) will produce approximately 110 ML/per day.

The peak production periods for each area do not coincide.

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FIGURE 15

Current CSG Water Disposal

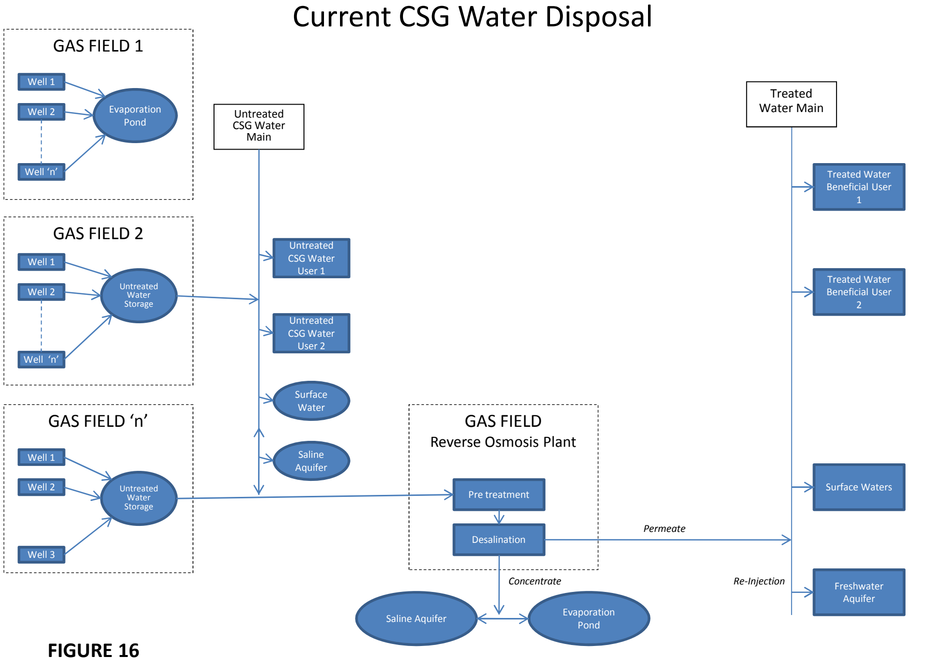


FIGURE 16

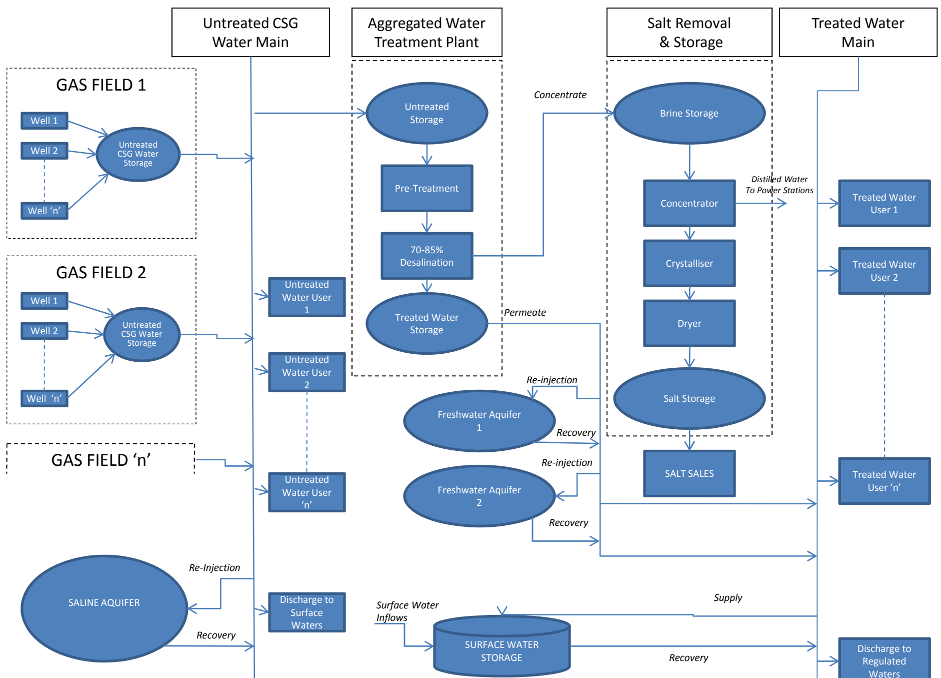
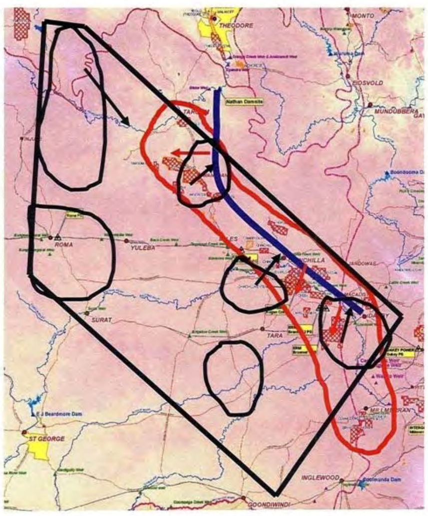


FIGURE 17



SunWater
Making Water Work

FIGURE 18

mwa
ENVIRONMENTAL

The Concept

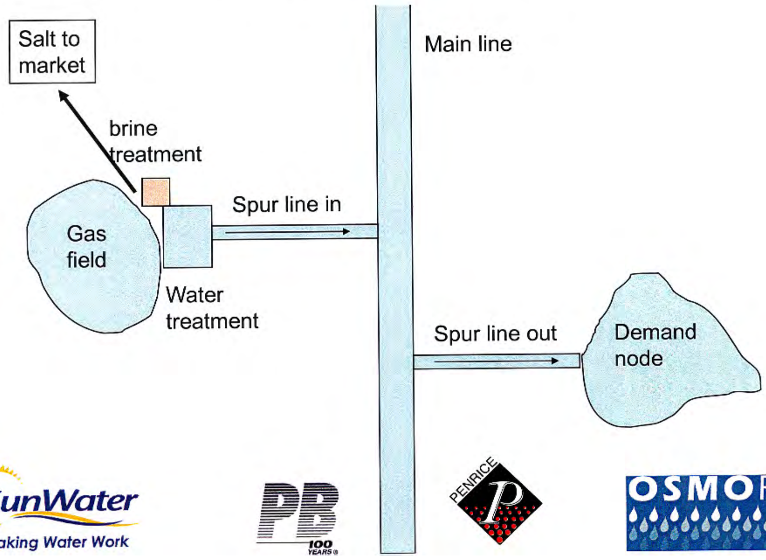


FIGURE 19

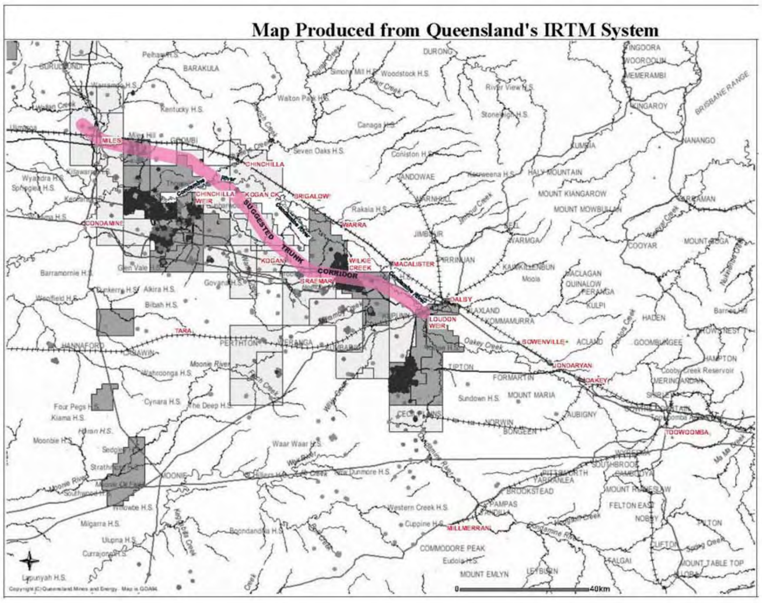


FIGURE 20

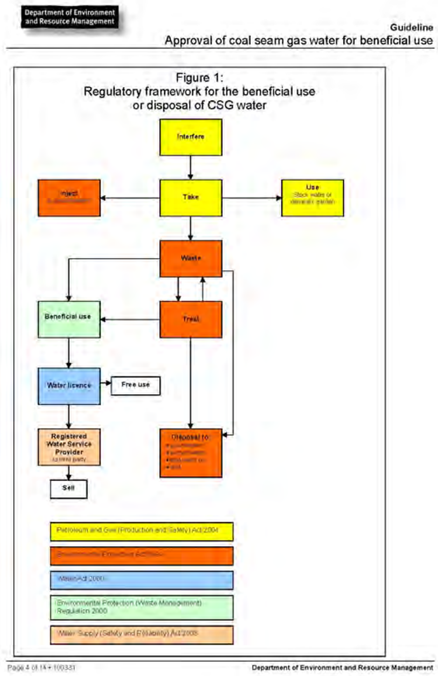


FIGURE 21

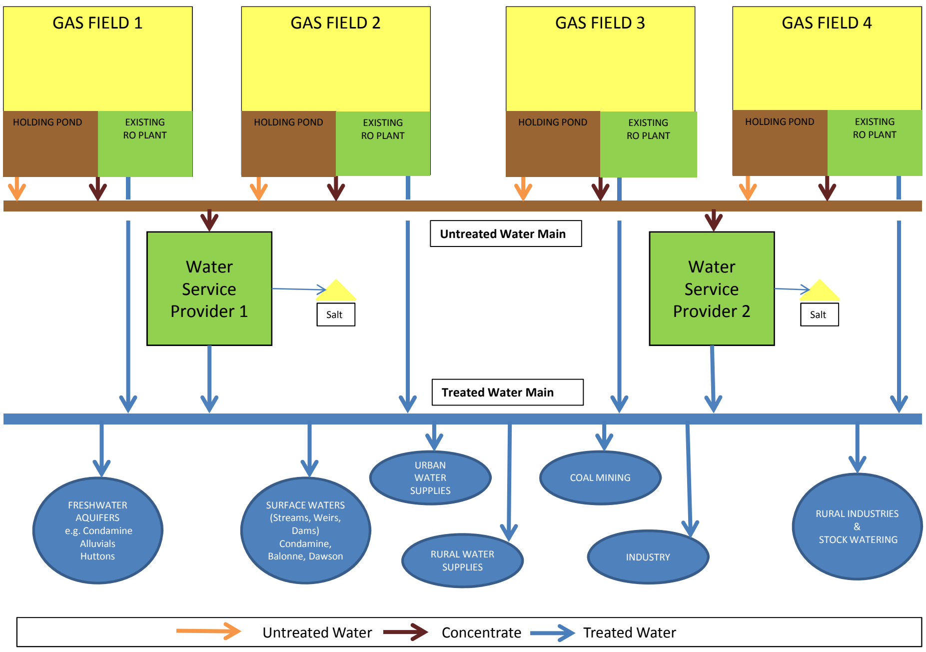


FIGURE 22

Table 3-22 Summary of Water Management Options

Option	Description of Option	Water Quality Assumption	Capital Cost	Cost		Revenue		Net	
			$	$/ML	$/GJ	$/ML	$/GJ	$/ML	$/GJ
1	Evaporation Pond		($30,000,000)	($335)	($0.0211)	$0	$0.0000	($335)	($0.0211)
2	Partial treatment + 50km irrigation quality pipeline to a local river	Good	($54,217,500)	($830)	($0.0524)	$92	$0.0058	($738)	($0.0467)
3	Full treatment + 50km irrigation quality pipeline to a local river	Inferior	($93,415,000)	($1,442)	($0.0911)	$83	$0.0053	($1,359)	($0.0858)
4	Partial treatment + 50km DICL quality pipeline for town water supply	Good	($77,885,000)	($1,097)	($0.0693)	$162	$0.0102	($935)	($0.0591)
5	Full treatment + 50km DICL quality pipeline for town water supply	Inferior	($115,110,000)	($1,542)	($0.0974)	$153	$0.0097	($1,389)	($0.0877)
6	Partial treatment + 150km DICL quality pipeline for town water supply	Good	($189,987,500)	($2,378)	($0.1502)	$162	$0.0102	($2,216)	($0.1400)
7	Full treatment + 150km DICL quality pipeline for town water supply	Inferior	($211,987,500)	($2,819)	($0.1780)	$153	$0.0097	($2,666)	($0.1683)

FIGURE 23

Table 3-13 CSG Cost of production ($/GJ, real $2008)

	2008	2010	2030
Capital	$1.19	$1.19	$1.19
Operating	$1.10	$1.10	$1.10
Water Disposal*	$0.17	$0.17	$0.17
Royalties	$0.18	$0.18	$0.25
CPRS	N/a	$0.07	$0.18
Total	$2.64	$2.71	$2.89

* Worst case scenario

FIGURE 24