# WIDE BAY – BURNETT AGRICULTURAL INDUSTRIES.

## Report on the potential impacts of Unconventional Gas development on the Agricultural Industries in the Coastal Wide Bay Burnett Region.

## A Report on the impacts on Surface water & Groundwater resources.

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**7/30/2018**

# Executive Summary:

**Stellar Advisory Services** was engaged by the **Wide Bay - Burnett Water Agricultural Industries** to undertake a desk top analysis and prepare a report on the potential impacts of the establishment of an unconventional gas industry by Blue Energy on the Coastal Wide Bay Burnett Region's surface and groundwater resources within the Maryborough Geological Basin. A synopsis of the findings of this analysis is presented in this Executive Summary.

- Blue Energy holds 3 X Authorities to Prospect for petroleum resources over a large part of the Coastal Wide Bay Burnett Region. Two of these Authorities are due to expire on 31st December, 2018 and the third is due to expire and not be renewed on 31st March, 2019. The Queensland Petroleum & Gas legislation does not allow for the cancellation of these expired Authorities – only a partial relinquishment of exploration blocks or sub-blocks. Unless Blue Energy agrees to fully relinquish the two Authorities expiring in December 2108, they are likely to be renewed.

- A Report prepared by Geosciences Australia on the Maryborough Basin outlines the prospective coal and gas resources of the Maryborough Basin as:

    - The middle section of the Burrum Coal Measures contains what are considered to be economically viable seams of black coal.
    - The most viable conventional (gas) hydrocarbon reservoir in the Maryborough Basin is the 'Gregory Sandstone member' of the Maryborough Formation.
    - MBA Petroleum Consultants (2010) identified the 'Cherwell Mudstone Member' (within the Maryborough Formation) as a shale gas target.
    - Kunskraa, Stevens et al (2011) identified the Maryborough Basin as one of four (4) Basins in Australia with major shale gas potential.
    - **The prospective shale gas resource in the Cherwell and Goodwood Mudstone Members of the Maryborough Formation are potentially the focus of Blue Energy's interest.**

- Queensland's legislative frameworks provide statutory "underground water rights" to the Resources Industry (Mining and Petroleum & Gas lease holders) to take unlimited volumes of "associated groundwater" during their development and production operations. These rights are secured through an Environmental Authority for a petroleum & gas lease which overrides any existing groundwater planning instruments or plans. Any impairment to existing water bores is to be addressed through "Make Good" obligations by the Petroleum & Gas lease holder.

- While Queensland has a **Regional Planning Interests Act** which ostensibly offers protection to "priority agriculture areas" and "strategic cropping areas" through State Government prepared Regional Plans – this legislation is not sufficiently robust. There are exemptions in this legislation which allow petroleum & gas projects to still be approved in these "priority and strategic areas". Furthermore - the Wide Bay Burnett Regional Plan is outdated and

does not contain sufficient or robust protective measures for high quality agricultural lands. Both the Regional Planning Interests Act and the Wide Bay Burnett Regional Plan need amending to provide robust protection of high quality agricultural areas.

- An expansion of the Unconventional Gas Industry into the Coastal Wide Bay Burnett Region is likely to involve the hydraulic fracking of gas wells. Any hydraulic fracking operations will require a substantial water supply. Hydraulic fracking could require up to 26,700ML of water for a single fracking of 100 shale gas well pads. The likely source of this water is currently unknown. If a Coastal Wide Bay Burnett shale gas industry was to access its projected water use of 26,700ML/yr from aquifers utilized for agriculture, it could have serious implications on the "announced take" of groundwater by agriculture in the region.

- The hydraulic fracking of gas wells presents some significant risks to underground water quality, surface water quality and human health. The safe disposal of toxic fracking "flow back" fluids, the potential for well failure and the associated leakage of fracking fluids as well as the failure or overflow of ponds and tanks holding toxic fracking fluids, all present significant risks for soil and water contamination. The Coastal Wide Bay Burnett community needs to inform government that it finds these risks unacceptable and it will not tolerate an Unconventional gas industry in the Region. .

- Evidence in the United States of America indicates that reinjection of fracking wastewater will increase the risk of seismic activity in earthquake susceptible areas. Given that the Wide Bay Burnett Region is one of the most susceptible areas to earthquakes in Queensland, this evidence from the United States of America is highly relevant to the Region.

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# 1.0 Introduction:

**Blue Energy Pty Ltd** (a listed company) has three (3) Authorities to Prospect (ATP's) for Petroleum Exploration in the area from the north of Gympie through to the north of Bundaberg. These ATPs are:

- ATP 733 for petroleum - expires 31/12/2018
- ATP 613 for petroleum - expires 31/03/2019
- ATP 674 for petroleum - expires 31/12/2018

Blue Energy's interest in these Authorities is Unconventional Gas – either Coal Seam Gas (CSG) or Shale Gas projects. Unconventional Gas is formed in more complex geological formations which limit the ability of gas to migrate, and therefore, different methods are required to extract the gas.

There are several types of unconventional gas, including shale gas and tight gas, which occur in reservoirs with very low permeability, compared to conventional reservoirs. In these geological formations, horizontal drilling and hydraulic fracturing (see Diagram 1 below) are often necessary for economic gas extraction. Unlike CSG production - there is no need to lower the pressure by removing water to produce shale gas, however like CSG production - there is a need to use water for hydraulic fracking to stimulate the wells for shale gas production.

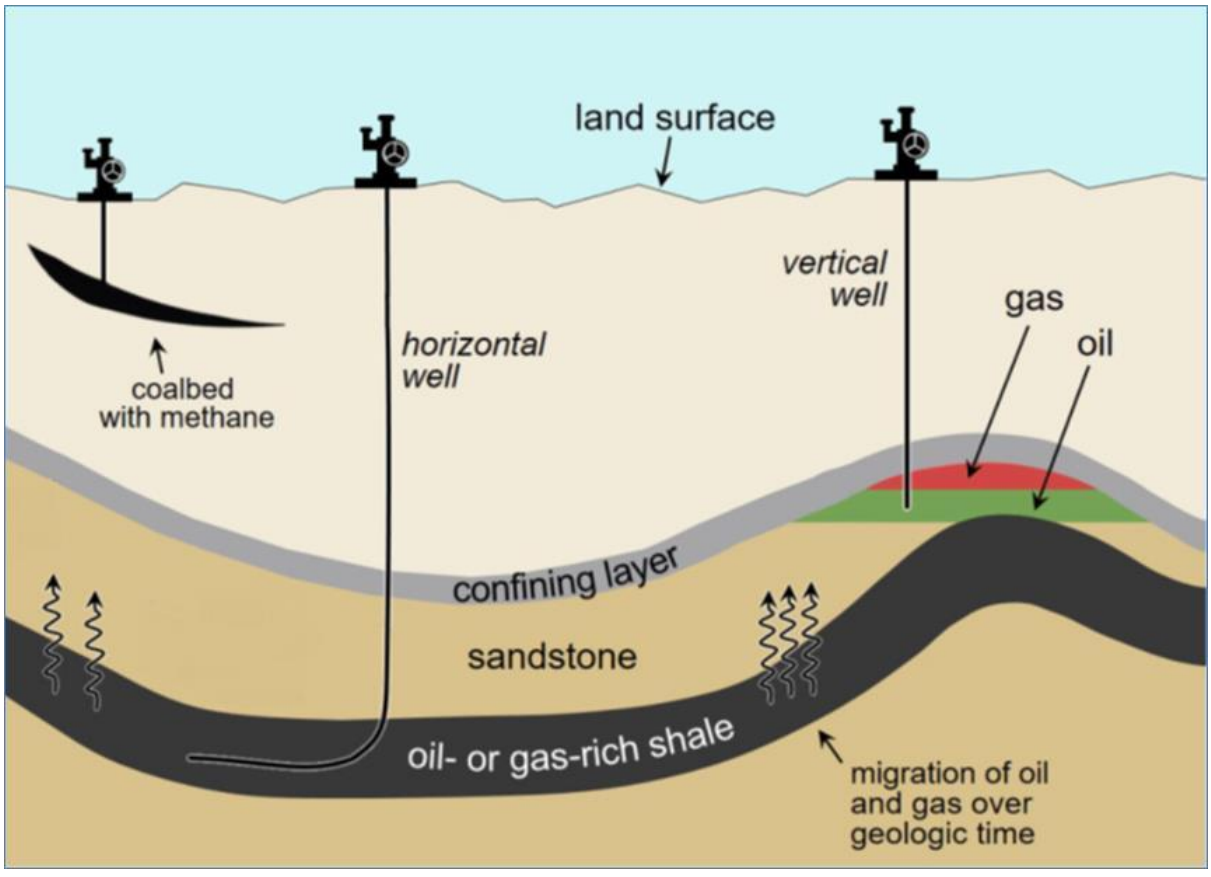



Diagram 1: Methods of gas extraction (***Source:-*** https://frackinginquiry.nt.gov.au/about-shale-gas)

Coal seam gas (CSG) occurs where methane gas is trapped within the coal seam under pressure by overlying formations. To extract the gas, a steel-encased well is drilled vertically into the coal seam at which point the well may also be hydraulically fractured or stimulated, or drilled horizontally along the coal seam, to increase access to the gas reserves. When the coal seam is de-watered, the pressure is released, allowing the methane to escape the coal formation by flowing through the cleats and fractures in the coal seam and back to the gas well.

Further details of Blue Energy's Authorities are provided in Section 4.0 of this Report, however, it is worth noting that **Blue Energy are most likely to focus on Shale Gas production in the Coastal Wide Bay region**.

**Stellar Advisory Services** was engaged by the **Wide Bay - Burnett Water Agricultural Industries** to undertake a desk top analysis and prepare a report on the potential impacts of the establishment of an unconventional gas industry by Blue Energy on the Coastal Wide Bay Burnett Region's surface and groundwater resources within the Maryborough Geological Basin.

**Scope of the Project Area for this Report:** The area of this investigative report extends from the Kolan River in the north to the Burrum River in the south and west to the extent of the cropping lands within the Bundaberg and the Fraser Coast Regional Councils.

This report has been prepared on the basis of an analysis of publicly available reports and documents on a range of websites, as well as unpublished DNRM&E Reports.

# 2.0 The legislative framework for the Petroleum & Gas and Mining Industry's access to groundwater and the rights of landholders:

The Petroleum & Gas Sector interfaces with the following Queensland statutes for its take of, or interference with, or management of surface and groundwater resources.

**The *Water Act (2000)*** provides for the sustainable management of water and other resources, the establishment and operation of water authorities, and for other purposes. The Act's purpose is achieved by, amongst other legal/policy frameworks, the development of Statutory Water Plans and associated instruments (Water Plans, Water Management Protocols, Water Entitlement Notices and Operations Manuals) which outline the allocation and management of water for consumptive and environmental purposes in a river catchment.

**Chapter 3 of the Act** also contains provisions for the management of impacts on underground water caused by the exercise of "underground water rights" by resource tenure holders (Petroleum & Gas and Mining tenement holders). The Act provides the process for petroleum & gas tenement holders to secure their "underground water rights" and for the grant of an "Associated Water Licence" for mining tenement holders to exercise their "underground water rights".

In 2008, the Queensland Government started to encourage the development of an Unconventional Gas (CSG) Industry in the Surat & Bowen Basins. To deal with the management of this expanding industry, in 2010, the Queensland Government introduced the Chapter 3 (Underground Water Management) amendments to the *Water Act 2000* which granted petroleum & gas tenement holders "underground water rights".

The government's preferred approach to the absence of a rigorous legislative framework to manage the rapid expansion of the Unconventional Gas Industry, was to adopt an "adaptive management framework", where issues were dealt with as they arose. This resulted in Chapter 3 of the *Water Act 2000* being amended in 2010 to include the Cumulative Management Area provisions and the Office of Groundwater Impact Assessment (OGIA) provisions. The *Water Act 2000* was further amended in 2012, to clarify the functions and operations of the OGIA. At this point - the OGIA is only authorised to operate in the Surat Cumulative Management Area.

In response to growing disquiet from landholders, regional communities and environmentalists at the CSG Companies practice of storing CSG waste water in evaporation dams in the Surat Basin, particularly in the middle of the Federation drought, the Queensland Government introduced the 2010 CSG Water Management Policy. This Policy was introduced to manage salt produced by CSG operations and to encourage the beneficial use of treated CSG water. In doing so – it discontinued the use of evaporation dams as a primary method for dealing with CSG water disposal and introduced a 3 year timeline for all existing evaporation dams to be remediated.

The amendments to the *Water Act 2000* also introduced a framework which obligated petroleum & gas tenure holders, when they impaired a landholder's water bore through the exercising their "underground water rights", to meet "make good obligations". Petroleum & gas lease holders are now required to meet "Make Good" provisions if their extraction of water impairs an adjoining landholder's bore/s. "Make Good" provisions may include:

a) the deepening of an existing bore to another aquifer,
b) providing for a replacement bore,
c) providing for an alternative source of water, or d) paying the bore owner compensation for the loss of access to water.

On 18th March 2011, the Queensland Government gazetted the Surat Cumulative Management Area (SCMA) which introduced a new and different level of management of the underground water resources within the "Declared Area". This action precipitated the establishment of the Office of Groundwater Impact Assessment (OGIA) to monitor and provide advice to the government on the management of the groundwater resources in the Surat CMA. Every 4 years the OGIA is required to issue an Underground Water Impact Report (UWIR) which details the outcomes of OGIA's monitoring of the CSG Industry's impacts (aquifer levels, GAB pressures and ecological impacts) on the Surat CMA's groundwater resources.

**AUTHOR'S RECOMMENDATION:**

If the Queensland Government grants petroleum & gas leases to Blue Energy, the agricultural and associated support industries dependent on underground water in the Coastal Wide Bay Burnett Region, should consider requesting the Queensland Government to declare a Coastal Wide Bay Burnett Cumulative Management Area (CMA) which would require the OGIA to monitor and develop a cumulative impacts groundwater hydrogeological model to manage the groundwater resources in the declared CMA.

OGIA would provide advice to the Government on the actual and potential impacts of the use and extraction of groundwater by the Resources Industry on the Region's aquifers.

It should be noted that the OGIA has no legislative powers and cannot compel a gas or mining company to 'make good' – it only monitors and provides advice to government.

In 2014, the Queensland Government introduced the ***Water Reform and Other Legislation Amendment Act 2014*** (the WROLA Act). This Act introduced some major changes to the management of Queensland's underground water resources, including the grant of "underground water rights" to miners to take and/or interfere with unlimited volumes of underground water.

However, this Act failed to address major short comings with the "make good provisions" of Chapter 3 of the *Water Act 2000* or the "identification of impairment" to landholder's water bores impacted by either petroleum & gas operators or miners exercising their "underground water rights".

**AUTHOR'S NOTE:**

Landholder's water bores that became gassy as a result of CSG gas wells in close proximity, were <u>not</u> considered to be "impaired" or subject to the "make good provisions" of the *Water Act 2000*.

Furthermore – Landholders, in undertaking their negotiations with a CSG or Mining Company, were only permitted to have their legal representative and a valuer present.

They were <u>not</u> permitted to engage the services of an agronomist or a hydrogeologist to assess the impacts of gas or mining operations on their enterprise or to be present to assist in arguing their case during 'Make Good' negotiations.

On the election of the Palaszczuk Labour Government in January 2015, one of their first actions was to defer the proclamation of a number of the *WROLA Act 2014* provisions which had not come into effect.

The policy objectives of the *WROLA Act 2014* were:

- to establish a new purpose for the whole Water Act that will encompass the broad nature of the Water Act's provisions to ensure it provides for the responsible and productive management, allocation and use of Queensland's water and riverine quarry resources
- to establish a watercourse identification map to identify what is and is not a watercourse
- to provide a new framework for management and allocation of water to deliver a significantly more efficient, flexible and responsive framework for water resource planning by:
    - providing for the development of statutory water plans as the primary catchment-based water management instrument
    - providing for the development of water entitlement notices to grant, amend, refuse, repeal or cancel entitlements (under certain situations) to implement a water plan
    - establishing a streamlined assessment and approval framework to facilitate major water infrastructure projects (including large-scale agricultural projects)
    - streamlining the framework for regulating the take and interference with water to reduce the regulatory burden
    - reforming the framework for water licensing
    - enabling the surrender of water allocations, and making other changes to Chapter 2 such as minor amendments to align the streamlined frameworks
- to establish a consistent framework for underground water rights for the resources sector and for the management of impacts on underground water due to resources sector activities through changes to:
    - the *Mineral Resources Act 1989* and *Petroleum and Gas (Production and Safety) Act 2004*
    - expand the application of Chapter 3 of the Water Act 2000 to the mineral resources sector
- to enact safety and health legislative provisions for the new overlapping tenure framework for Queensland's coal and coal seam gas industries
- to broaden the categories of mandatory qualification for eligibility for appointment as the Commissioner for Mine Safety and Health
- to support the transition of category 2 water authorities to other institutional forms and simplify the administrative requirements for both category 2 water authorities and river improvement trusts
- to provide a pathway for water rights held under special agreement legislation to be transitioned into the Water Act framework to ensure consistency with the Water Act and provide clarity of access to water for all water users
- to remove the reversal of the onus of proof under section 812A and 812B of the Water Act, and to make other amendments to:
    - remove provisions of the Water Act relating to drainage and embankment areas
    - provide flexible 'fit for purpose' public notice requirements
    - provide for online fees and payment, and
    - remove spent transitional provisions from the Water Act.

In response to the deferment of the proclamation of parts of the *WROLA Act 2014*, in November 2015, the Queensland Government introduced the ***Water Legislation Amendment Bill (2015)*** to deal with some of the policy objective excesses of the *WROLA Act 2014*. This Bill was passed on 10th November, 2016 and was assented to on 22nd November, 2016.

However - the Water Legislation Amendment Act (2015) still did not address the serious flaws within the Chapter 3 – *Water Act 2000* provisions on "make good" for landholder bores impaired by CSG Companies exercising their "underground water rights". Subsequent representations to the Palaszczuk Government, the Cross Benchers and the Speaker's Office were the catalyst for the introduction of the Environmental Protection (Underground Water Management) and Other Legislation Amendment Bill 2016 in September 2016 and its passage by the Parliament in November 2016.

**To summarise, the current provisions of the *Water Act 2000* for managing the impacts of the Resource activities on groundwater include:**

**Chapter 3 – Section 370** - requires Petroleum & Gas lease holders to prepare an **Underground Water Impact Report** for the lease area – except where the impact of the resource activity is considered to be low risk. Chapter 3 provisions of the Water Act are administered by the Department of Environment & Science (DES) – not the DNRM&E.

**Chapter 3 – Section 376** - outlines that an Underground Water Impact Report must include information on:

- The quantity of water to be taken in exercising underground water rights.
- A description of each aquifer affected or likely to be affected.
- An analysis of water movement in each aquifer – including connectivity to other aquifers.
- An analysis of aquifer water level changes from the exercising of underground water rights.
- Maps showing the areas of aquifers impacted by the exercising of underground water rights.
- Information about all water bores in the areas shown on the maps.
- A description of likely impacts on environmental values.
- A water monitoring strategy. and
- A spring impact management strategy.

**Chapter 3 – Section 382** - outlines that the Resource lease holder must **publish a notice** about the Underground Water Impact Report (UWIR) and give a copy of this notice to each owner of a water bore, within the Report's area. The notice must outline where copies of the UWIR can be obtained, as well as where submissions on the UWIR can be lodged. The legislation states that a minimum period of 20 business days must be allowed for submissions to be lodged. Submissions are to be made to the UWIR lease holder with copies to the Chief Executive of the Department of Environment & Science. The lease holder must

give the Chief Executive a report on how all properly made submissions were considered and dealt with.

**Chapter 3 – Section 394** – outlines the process for a **baseline assessment of existing water bores** within the lease area. This assessment is required to obtain information for determining if an existing bore has been impaired by a resource activity (petroleum & gas well). The baseline assessment of bores must be approved by the Chief Executive.

**AUTHOR'S NOTE:**

While this baseline assessment of existing bores should be undertaken before gas extraction starts – this doesn't always happen. The baseline assessment of an existing bore is based on water levels, **not** the sustainable pumping rate of a bore.

**This has caused considerable consternation with the owners of water bores whose access to water and pumping rates have been affected by produced water from gas extraction.**

The "Associated Water" of a Petroleum & Gas operation is described as "**that underground water taken or interfered with, from a petroleum well, either necessarily or unavoidably taken during the drilling of a petroleum well or water observation bore, or underground water necessarily or unavoidably taken during the testing of a well for petroleum production**". **It is often referred to "produced water" once a gas well is in production.**

Petroleum & Gas producers are automatically granted an "underground water right" to take unlimited volumes of groundwater when they secure an Environmental Authority and a petroleum & gas lease. If an existing water user's water bores is impacted by a petroleum & gas producer exercising their "underground water right", the Queensland Government's policy position is that there are "Make Good" provisions to remedy these impacts.

**The *Environmental Protection Act (1994)*** provides for the protection of Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The Resources Sector (Petroleum & Gas and Mining) interfaces with this Act for its take of, or interference with, or management of surface and groundwater resources.

The Environmental Protection Act has an underlying principle of promoting **Ecologically Sustainable Development**. It details the requirements and specifies the processes for the development and assessment of **Environmental Impact Statements** and the setting of development approval conditions which are reflected in an Environmental Authority.

The Act (Section 34) outlines that an Environmental Impact Statement (EIS) is a requirement for a mining activity or a resource activity, other than mining; and other than a Coordinated Project under the *State Development & Public Works Organisation Act 1971.*

Affected parties of an EIS include landholders, local government and proponents for mining and petroleum & gas projects (Section 38). The Act also outlines processes for the development of "draft" Terms of Reference for an EIS (Section 41), the Public Notification and Submissions on the "draft" Terms of Reference (Section 42), the decision on whether an EIS may proceed (Section 49) and the Public Notification and Submissions on the final EIS (Sections 51 & 52).

There is also a process where the EIS proponent may request the Minister to review the Chief Executive's decisions on the "draft" and "final" EIS. **There is no such review provision available for third parties (such as concerned Landholders) who may have made submissions on an EIS and had their legitimate concerns ignored.**

The EIS process is an essential step in a mining or petroleum & gas proponent securing an Environmental Authority for their project. **Blue Energy is required to have an Environmental Authority for each of its Authorities to Prospect in the Coastal Wide Bay Region and will be required to have an Environmental Authority to secure a petroleum lease.**

The ***Environmental Protection (Underground Water Management) & Other Legislation Amendment Bill 2016*** (EPOLA 2016) was passed on 10th November, 2016 and assented to on 22nd November, 2016. **This legislation contained some substantive measures to address a number of deficiencies in the *Water Act 2000* (Chapter 3 provisions) for underground water management and "make good" obligations across Queensland. The impact of gassy bores from unconventional gas operations was added as a reason for a bore's impairment by a resource activity.**

As a consequence of amendments to the *WROLA Act 2014,* which were affected through the *Water Legislation Amendment Act 2016,* and the *Environmental Protection (Underground Water Management) & Other Legislation Amendment Act 2016,* all outstanding Parts of the *WROLA Act 2014* became law on 6th December, 2016.

With the EPOLA Act's passage by the Parliament in late 2016 - the "underground water right" for a petroleum & gas tenure holders' take of "Associated Water" for a petroleum & gas well was an integral part of the assessment and grant of an Environmental Authority. For the Petroleum & Gas Industry - "Associated Water" is described as that underground water taken or interfered with, from a petroleum well, either necessarily or unavoidably taken during the drilling of a petroleum well or water observation bore, or underground water necessarily or unavoidably taken during the testing of a well for petroleum production.

**To put this in perspective, in the Surat Basin, the Unconventional Gas Industry extracts in excess of 55,000ML of "Associated Water" from the GAB aquifers each year and pays no water charges to the Queensland Government for this right (Source – DNRM&E GABORA Draft Water Plan consultation meetings).**

**The *Petroleum and Gas (Production and Safety) Act (2004)*** (**and the *Petroleum Act 1923*),** provides for the exploration for recovery and transporting by pipeline, petroleum and fuel gas, and ensuring the safe and efficient carrying out of those activities, and for other purposes. The Act states that it manages the States petroleum resources "in a way that has regard to the need for ecologically sustainable development".

In 2010, the Queensland Government amended both the *Petroleum & Gas (Production & Safety) Act 2004* and the *Water Act 2000,* through the introduction of provisions which dealt with Underground Water Management. **In particular, the amendments granted "Underground Water Rights" to petroleum and gas lease holders to take and/or interfere with unlimited volumes of underground water.**

Section 185 (1) of the Act (outlines the "Underground Water Rights" for petroleum & gas leases, which allow for the interference and unlimited take of "Associated Water" when drilling petroleum wells or observation bores, or the testing for petroleum production, or the production of petroleum (including gas), as well as the overriding of a groundwater planning instrument.

**The Act (Section 185 (3)) clearly outlines that there is no limit to the volume of water that may be taken and it also (Section 185 (5)) allows for a petroleum lessee to use "Associated Water" for any purpose, within or outside of the lease area.**

**AUTHOR'S NOTE:**

In dealing with impacts of the "Unconventional Gas Industry" on Queensland's groundwater resources, the Queensland Government is currently using an "adaptive management" approach where changes to the State's regulatory frameworks are made, as risks are identified, or impacts occur.

Through all of the legislative changes outlined above, Queensland's groundwater users now experience a situation where:

- Petroleum & Gas Lease holders are able to exercise their "underground water rights" and extract unlimited volumes of groundwater as part of their day to day operations.

- As a consequence of these "Underground Water Rights" provisions - in the Surat Basin - the CSG industry is currently allowed to extract in excess of 55,000 ML/annum (projected to exceed 65,000 ML/annum). This has already resulted in a depressurisation of the two Great Artisan Basin (GAB) aquifers – to the extent that the new GABORA Water Plan **does not permit the agricultural sector to drill any new bores into these two aquifers for intensive animal production or irrigation uses** (Source – GABORA Water Plan and personal knowledge of Surat Basin).

- The water extracted by Petroleum & Gas Lease holders can be used for gas well development (for example fracking operations and well testing), dust suppression around gas well pads or on gas lease roads.

- If a Petroleum & Gas lease holder requires water for a worker's camp, or their Office operations – they are required to obtain a "non-associated water licence" from the Department of Natural Resources, Mines & Energy (DNRM&E). This water licence is processed through the same *Water Act 2000* requirements as a water licence for a landholder.

- The monitoring and management of the groundwater resources in a Declared Cumulative Management Area (such as the Surat CMA) is notionally under the auspices of the Office of Groundwater Impact Assessment (OGIA) within the DNRM&E. The OGIA provides advice to government on the impacts of the CSG Industry on the Surat CMA's groundwater resources and recommendations on its management.

- However – as the Surat CMA does not cover the entire Surat Basin, water users face the situation where OGIA manages some of the Surat Basin and the DNRM&E manages the remainder. This dual management is not an ideal situation.

- Successive Queensland Governments have made public claims that Queensland's groundwater resources are being managed sustainably and there is nothing to worry about from allowing Petroleum & Gas operators to exercise "Underground Water Rights" and Miners to have "Associated Water Rights".

- While Petroleum & Gas operators have been required to measure and report on their "associated water use" since the commencement of Queensland's CSG Industry, it wasn't until December 2016, (less than two years ago) that all Miners were required to measure or estimate their "associated water use" and report it to the Queensland Government. Hence - claims by the Queensland Government that it is "sustainably managing Queensland's groundwater resources" is not backed by factual water use data. The volume of water being extracted by the Mining industry, demonstrate its total lack of credibility on this matter.

**A summary of the legislative changes to the Queensland's legislation to manage the impacts of the Unconventional Gas Industry on water resources is:**

- 2008 – Chapter 3 on Groundwater Management introduced to the *Water Act 2000*

- 2010 – Cumulative Management Area provisions added to Chapter 3 of *Water Act 2000*

- 2010 – Coal Seam Gas Water Policy introduced for Queensland

- 2010 - *Petroleum & Gas (Production & Safety) Act 2004* and the *Water Act 2000* amended to introduce provisions for Underground Water Management
- 2010 – Amendments to *Water Act 2000* granted "Underground Water Rights" to petroleum and gas lease holders to take and/or interfere with unlimited volumes of underground water
- 2010 - Amendments to *Water Act 2000* obligated petroleum tenure holders, when they impaired a landholder's water bore through the exercising their "underground water rights", to meet "make good obligations"
- 2011 – Surat Cumulative Management Area gazetted
- 2012 – *Water Act 2000* amended to clarify functions & operations of Office of Groundwater Impact Assessment
- 2014 - Water Reform and Other Legislation Amendment Act passed
- 2015 - Water Legislation Amendment Bill introduced and passed
- 2016 - Environmental Protection (Underground Water Management) & Other Legislation Amendment Bill passed

# 3.0 Legislative framework for the possible protection of "agricultural lands":

Historically Queensland has applied a State Planning Policy (SPP) 1/92 for the protection of good quality agricultural lands. ***SPP 1/92: Development and the Conservation of Agricultural Land***, required decision makers in both Local and State Governments to be aware of the location and extent of good quality agricultural land. This information allowed provisions for the protection of this land to be included in Local Authority strategic plans (SPs), development control plans (DCPs) and other elements of Council's planning schemes. Local Authorities were required to ensure that development proposals did not compromise or alienate land that was classed as "good quality agricultural land".

However, in 2014 the Queensland Government replaced SPP 1/92 with the ***Regional Planning Interests Act (2014).*** This legislation ostensibly introduced a new approach to the protection of high quality agricultural lands – including grazing lands.

The *Regional Planning Interests (RPI) Act 2014* identifies and protects areas of Queensland that are of regional interest. To do this, **the Act seeks to manage the impacts, and supports the coexistence of the Resource sector activities and other regulated activities, in areas of regional interest**. The RPI Act is supported by an RPI Regulation.

The RPI Act and Regulation aim to deliver an appropriate balance between protecting priority land uses and delivering opportunities for a diversified and economic future for the State's regions. To achieve this, the RPI Act protects:

- living areas in regional communities
- high-quality agricultural areas from dislocation
- strategic cropping lands
- regionally important environmental areas

While the RPI Act includes definitions of **Priority Agricultural Areas** and **Strategic Cropping Areas** as well as protective measures for these areas – Section 22 of the Act outlines a number of exemptions for "resource activities" in "Priority Agricultural Area" and/or "Strategic Cropping Area" when:

- A Conduct & Compensation Agreement* (CCA) applies
- There is a voluntary agreement with the landholder, or
- The activity is not likely to have a significant impact on an area of regional interest**

**A Conduct and Compensation Agreement means a legal agreement made between a landholder and a resource company that relates to the activities or conduct proposed to be undertaken and, where there is impact on the landholder, compensation arrangements for those activities.*

***To secure an exemption on an area of regional interest – an applicant may seek approval from the Chief Executive of the Department of State Development, Manufacturing, Infrastructure and Planning. The allocation must be accompanied by a report assessing the impact of the resource activity on the area of regional interest. The applicant must give the owner of the land a copy of the assessment application. The decision on this matter by the Chief Executive can be appealed.*

Furthermore, the RTI Act (Section 24) provides exemptions for pre-existing resource activities (an exploration well or a petroleum & gas well) from the provisions of a "Priority Agricultural Area" and/or a "Strategic Cropping Area".

**The application of the RTI Act's protection provisions is delivered through the Regional Plans and a Regional Planning framework.**

There is a Restricted Land Provision (RLP) applying in Queensland which offer some protection to landholder's residences and structural improvements.

For rural properties - a Resource Company must comply with Restricted Land Provision and MUST not undertake any activities within 200 metres of a:

- Permanent building used for residential or business purposes

- Restricted land is also the area within 50 metres of a bore, a well, a dam, a water storage facility or a stockyard

These restrictions apply to any activities authorized by an Authority to Prospect or a Mine Lease or a Petroleum & Gas Lease. A Resource Company cannot enter restricted land without the written consent of the landholder. There are some limited exemptions to preventing access to restricted land – however they are mainly to allow access across the land or the maintenance of infrastructure that may already exist.

**AUTHOR'S NOTE:**

It is worth noting that the Regional Plan for the Wide Bay Burnett Region was finalised in September 2011 (prior to the RTI Act's introduction) and has not been updated since.

**Hence, there are no RTI Act measures in respect to the protection of Priority Agricultural Areas and Strategic Cropping Areas in the Wide Bay Burnett Regional Plan – only the old SPP 1/92 requirements which are now superseded.**

To remedy this situation, the Wide Bay Burnett Regional Organisation of Councils (WBBROC) should be applying pressure on the Queensland Government to update the Wide Bay Burnett Regional Plan as a matter of high priority.

**AUTHOR'S RECOMMENDATIONS:**

To provide a strong and positive direction to the Queensland Government for the protection of the high-quality agricultural areas in the Coastal Wide Bay Burnett Region - the **Wide Bay Burnett Regional Organisation of Councils (WBBROC)** should give serious consideration to the following:

- Lobbying the Queensland Government to update the Wide Bay Burnett Regional Plan to include provisions for the protection of Priority Agricultural Areas and Strategic Cropping Areas across the region. As the Coastal Wide Bay Burnett Region is the salad and fruit bowl for much of the East Coast of Australia it should be afforded maximum protection from the impacts of totally inappropriate uses such as the Resources Industry.

- Lobbying the Queensland Government to make legislative changes to the *Regional Planning Interests Act 2014* to remove the preferential provisions for the Resources Industry. **It is an unacceptable policy setting where a region with high quality soils, an abundant water supply and an equitable climate, suitable for producing large volumes of food, fibre, fruit & vegetable crops for the domestic and export markets, can be impacted through exemptions granted to the Resources Industry.**

- Within the Coastal Wide Bay Burnett Region – the Fraser Coast Council has adopted a policy

position that it **does not support unconventional gas extraction within its boundaries and the Council supports the rights of landholders to do the same.** While the Fraser Coast Council has no legally binding powers to prevent the expansion of the unconventional gas industry into the Council area – it is a symbolic position which has been communicated to the community as well as the Australian and Queensland Governments. (***Source:*** Fraser Coast Chronicle report – 7th September, 2016)

- The Wide Bay Burnett agricultural industries and the Local Governments of the region (WBBROC) should give strong consideration to working collaboratively to achieve these outcomes.

# 4.0 Prospective petroleum & coal resources in the Maryborough Basin:

The most recent and authoritative information available on groundwater hydrology and the mineral and petroleum resources for the Maryborough Basin in the Wide Bay Burnett Region, is the Report titled:
***Regional Hydrogeological Characterisation of the Maryborough Basin, Queensland. Technical report for the National Collaboration Framework Regional Hydrogeology Project,*** authored by - Marshall, S. K., Fontaine, K., Kilgour, P. L. and Lewis, S. J.

**Hereafter in this Report - this published report is referred to as Marshall et al's Report.**

Marshall et al's Report outlines that the prospective petroleum and coal resources are primarily located in the "Tiaro Coal Measures" the "Burrum Coal Measures" and the "Maryborough Formation", which is an aquitard between the "Burrum Coal Measures" and the "Duckinwilla Formation". An aquitard is described as a natural geological barrier that restricts the flow of groundwater between aquifers.

The Tiaro Coal Measures are 1,200 metres thick and contain coal seams with a maximum thickness of up to 3.0 m. Due to their mixed and complex geological structure they are not considered to be highly prospective for coal or CSG.

The Burrum Coal Measures are considerably shallower that the Tiaro Coal Measures and have a thickness of up to 1,700 metres. The middle section of the Burrum Coal Measures contains what are considered to be economically viable seams of black coal.

Two wells were drilled by Magellan Petroleum in 2007 to investigate the petroleum and coal potential of the Burrum Coal Measures (Burrum No. 1 to a depth of 438.09 m and Burrum No. 2 to a depth of 535 m). A total thickness of approximately 9.0 m of coal was encountered with seams ranging from 0.2 m to 1.5 m. Although these two wells demonstrated that the Burrum Coal Measures have gas producing potential, neither well produced sufficient quantities of methane, and

hence a viable resource was unable to be identified (page 53 – Marshall et al's Report). It is not known if fracking was undertaken as a part of this investigation – however advances in fracking technology may encourage Blue Energy to revisit this potential resource.

Marshall et al's Report (page 63) outlines that the most viable conventional (gas) hydrocarbon reservoir in the Maryborough Basin is the "Gregory Sandstone member" of the Maryborough Formation. Drilling in 2001 found gas at a reported rate of up to 200 million cubic feet/day.
However, the Report notes that the matrix permeability is low and hence it might be difficult to extract this gas.

**AUTHOR'S NOTE:**

**Of significant note - Marshall et al's Report (page 63) outlines that MBA Petroleum Consultants (2010) identified the 'Cherwell Mudstone Member' (within the Maryborough Formation) as a shale gas target. Kunskraa, Stevens et al (2011) identified the Maryborough Basin as one of four (4) Basins in Australia with major shale gas potential.**

Marshall et al's Report - also outlines that the Cherwell & Goodwood Mudstone Members of the Maryborough Formation have been identified as prospective shale gas targets (page 63). Approximately 4,000 $Kms^2$ has been identified as potentially prospective for shale gas, with the remainder of the Basin being either too deep, or, there is insufficient data available to determine its availability. **The Report mentions a prospective resource of 2.687 trillion cubic feet of gas.**

It is acknowledged that this is a "desk top analysis and estimate of the gas potential" and it would take a lot more exploratory drilling to prove it up. It should also be noted that while the Maryborough Formation underlies the Bundaberg Irrigation Area – the Cherwell & Goodwood Mudstone Members are not at the top of the Maryborough Formation and they are at least 1000 metres below the Elliott Formation. Due to this depth - the potential risk of connectivity and drainage from the Elliott Formation and the Fairymead Beds, through the Burrum Formation and into the Maryborough Formation, is unknown.

Furthermore, if Blue Energy (or another petroleum lease holder) was to attempt to extract gas from the Cherwell & Goodwood Formations located under the Bundaberg Irrigation Area, they may seek approval to drill directional (horizontal) wells along roads and in reserve lands to avoid as much as possible, the drilling on farming lands (based on the exploration operations of Arrow Energy in the rich farming lands around Dalby). While this directional drilling would assist in avoiding disruption to farming operations, it is anticipated that some "on farm" drilling would still be undertaken. Directional drilling doesn't remove the potential impact of gas wells on the groundwater resources under these farm lands.

While Blue Energy has not publicly declared its "specific interest", it is speculated in the Marshall et al Report that the prospective shale gas resource in the Cherwell and Goodwood Mudstone Members of the Maryborough Formation are potentially the focus of Blue Energy's interest.

# 5.0 Current Petroleum Authorities in the Maryborough Basin and the Legislative Provisions for their Renewal or Extinguishment:

The specific details of Blue Energy Pty Ltd's Petroleum Authorities (ATPs) are as follows:

**ATP 613.**

- Issued to QGAS, Roma Petroleum & Magellan Petroleum (Eastern) Pty Ltd in November 1994, transferred to Magellan Petroleum in July 2003 and transferred to Blue Energy in January 2015.
- Expires on 31 March, 2019.
- Initially issued for 875 sub-blocks but this has subsequently been reduced to 67 sub-blocks and 67 sub-blocks are to be relinquished on 31st March, 2019**. As all sub-blocks will be relinquished at the expiry date – Section 71 of the P&G Act clearly indicates that this ATP should end (not be renewed) when it expires in March 2019.**
- **The Queensland Government could initiate a public process to offer this land for a new ATP to either Blue Energy or another petroleum & gas explorer.**
- Annual rental of 125 units @ $2.80/unit – total of $350/year.

**ATP 674.**

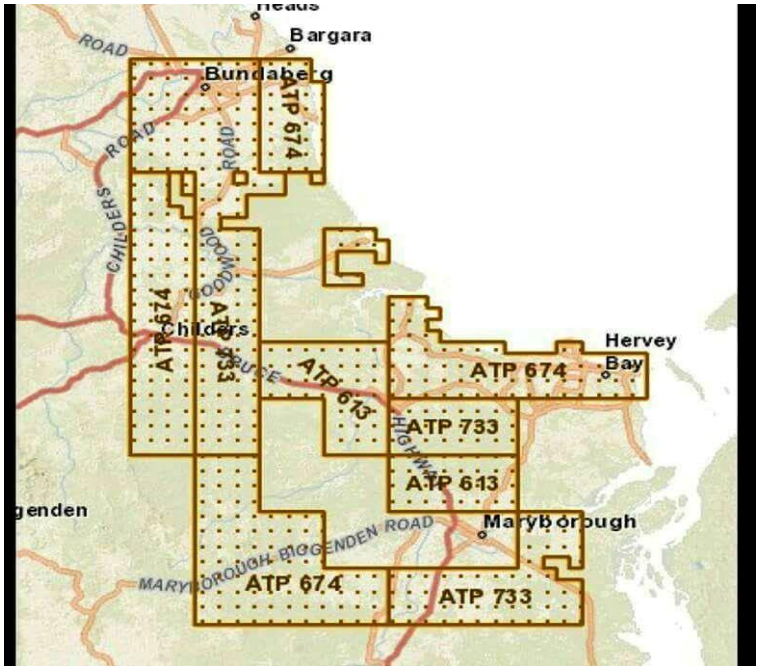
- Issued to Magellan Petroleum (Eastern) Pty Ltd in December 2012, transferred to Australian Unconventional Gas Pty Ltd in September 2013 and then transferred to Blue Energy in July 2014.
- Expires on 31st December, 2018.
- Initially issued for 18 blocks and 423 sub-blocks - 212 sub-blocks are to be relinquished on 31st December, 2018. This infers if the ATP is renewed, it may be renewed for 211 sub-blocks.
- Annual rental of 423 units @ $2.80/unit – total of $1,184.40/year.

**ATP 733.**

- Issued to Magellan Petroleum (Eastern) Pty Ltd in December 2012.
- Expires on 31st December, 2018.
- Initially issued to Magellan Petroleum/Novus Australia Energy in February 2003, transferred to Australian Unconventional Gas Pty Ltd in September 2013 and then transferred to Blue Energy in July 2014.
- Initially issued for 17 blocks and 385 sub-blocks with 193 sub-blocks to be relinquished on 31st December, 2018. This infers if the ATP is renewed, it may be renewed for 192 sub-blocks.
- Annual rental of 385 units @ $2.80/unit – total of $1,078.00/year.

Figure 1 below shows a map of the Blue Energy's ATPs. A map of the remaining active sub-blocks within these ATP's, has not been secured.

## Figure 1 – Map of Blue Energy Pty Ltd's ATP's.




***Source:*** Lock the gate.

The *Petroleum & Gas (Production & Safety) Act 2004* (Section 63D) outlines that the holder of an ATP may make an application for a 2-year extension to an ATP to carry out a current work program. **Importantly – Section 71 of the Act clearly outlines that if all the area of an ATP is relinquished – the authority ends. This indicates that on expiry at 31st March, 2019 – ATP 613 ends and it should not be renewed. However, the Queensland Government could initiate a public process to offer this land for a new ATP to either Blue Energy or another petroleum & gas explorer. Furthermore - if Blue Energy renews ATP's 674 & 733 – they can be sold & transferred to another gas explorer**

Section 65A of the Act outlines that if an ATP holder does not comply with a relinquishment condition, and is given a notice to comply, and still does not comply, the ATP is automatically cancelled.

Section 80 of the Act outlines if an ATP holder does not comply with the lodging of a later work program (for exploration) – under Section 79 (5) (a) the ATP holder must be given a notice to lodge a later work program. If the ATP holder does not comply with this notice – the ATP is cancelled. While Sections 65A and 80 do outline narrow provisions for the cancellation of an ATP – these provisions are specifically for a lack of compliance by the ATP holder with the ATP conditions.

The Act (Section 81) outlines that an ATP holder may apply to renew an ATP – subject to conditions such as annual rent and security arrangements being in order. The application cannot be made more than 60 business days before the expiry date – nor after the expiry date. **This means that Blue Energy is likely to make an application for a renewal of ATPs 674 & 733 sometime between 1 October and 31 December, 2018.**

**The Act (Section 84) provides details on the issues the Minister (or his/her delegate) must consider before granting or refusing an ATP renewal**. A renewal cannot be granted by the Minister unless:

- The proposed program of exploration work has been approved.
- The applicant satisfies the capability criteria (these are specific to financial and technical resources and ability to manage petroleum exploration and production).
- The Minister is satisfied that the applicant a) continues to satisfy any special criteria referred to in Sections 35 (2) & 43 b) has substantially complied with the ATP being renewed, and
- A relevant Environmental Authority for the renewed ATP has been issued.

**AUTHOR'S NOTE:**

**Landholders will notice that the conditions in the Act for renewal of an ATP make no mention of the current land use of the ATP, the unique land or water resources of the ATP which may be impacted, or the potential impact on sensitive areas such as the Great Barrier Reef. Hence, the Minister has very little scope to refuse the renewal of an ATP based on the potential threat of Unconventional Gas Mining to existing agricultural industries.**

**The Petroleum & Gas (Production & Safety) Act (Section 99) allows the Minister to exclude land from an ATP – however this land must be within the original sub-blocks of the Authority, and it cannot be a whole block. This limits the powers of the Minister to only extinguishing a part of an ATP and not the entire ATP and means that the Minister is no able to fully extinguish Blue Energy's ATPs on renewal, unless the company fails to meet the renewal criteria outlined in the Act.**

**These review and appeal rights only apply to the applicant for a renewal of an ATP** and there are no third-party review or appeal rights. The application of community pressure on the Minister for a part forfeiture of the sub-blocks of Blue Energy's ATPs, is the only avenue for stakeholders to progress the removal of a "priority agricultural area" or a "strategic cropping area" from an ATP's renewal. It must be noted that such action by the Minister or the Chief Executive, may the subject of an appeal by the applicant.

**AUTHOR'S NOTE:**

**What does this mean for landholders in the Coastal Burnett/Wide Bay Region?**

- The provisions of the Petroleum & Gas Act prevent the Minister from a wholesale cancelling of Blue Energy's ATPs – he or she can consider a non-renewal of these ATPs if Blue Energy has not met or cannot meet all of the requirements set out in Section 84 of the Act – see Appendix A.

- The Minister can reduce the number of blocks and sub-blocks in a renewed ATP – however he or she can only extinguish a part of an ATP.

- The Minister's decision on changes to the blocks and sub-blocks of an ATP renewal are appealable by the holder of the ATP to the District Court AND the Court of Appeal.

- **Landholders or third parties impacted by an ATP or the community have no such appeal rights.**

- The conditions in the Act for renewal of an ATP do not consider the current land use of the ATP, the unique land or water resources of the ATP which may be impacted, or the potential impact on sensitive areas such as the Great Barrier Reef. Thus, the Minister has very little scope to refuse the renewal of an ATP based on the potential threat of Unconventional Gas Mining on existing agricultural industries

- **The only way to balance these statutory powers, and provide affected Landholders with a right to be considered in these decisions, is to apply public and industry pressure on the Queensland government for a change to the P&G legislation.**

- **Another way to achieve an extinguishment of Blue Energy's ATPs is to apply community and industry pressure on Blue Energy not to make an application for their renewal, AND to apply community and industry pressure to the Queensland Government not to offer new ATPs for exploration for the Coastal Burnett Wide Bay Region**.

# 6.0 Potential hydrological impacts of Unconventional Gas development on the Coastal Wide Bay Burnett Region's aquifers:

As outlined in Section 4.0 - the most recent and authoritative information available on groundwater hydrology and the mineral and petroleum resources for the Maryborough Basin in the Wide Bay Burnett Region, is the Report titled: ***Regional Hydrogeological Characterisation of the Maryborough Basin, Queensland.*** ***Technical report for the National Collaboration Framework Regional Hydrogeology Project*** , authored by - Marshall, S. K., Fontaine, K., Kilgour, P. L. and Lewis, S. J. (Hereafter in this Report - this published report is referred to as the Marshall et al Report.)

**This Report was prepared in 2015 by Geoscience Australia (from existing data sets) to support the Australian Government's Independent Expert Scientific Committee's (IESC's) future assessments of the impacts of CSG and Large Coal Mining developments on the Maryborough Basin's surface and groundwater resources.**

The IESC is a requirement of the Commonwealth's Environmental Protection & Biodiversity Conservation (EPBC) Act. This Act enables the Australian Government to join with the states and territories in providing a national scheme of environment and heritage protection and biodiversity conservation. The EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance.

One of the key objectives of the EPBC Act is to provide for the protection of the environment, especially matters of national environmental significance (such as the Great Barrier Reef). Water resources, in relation to coal seam gas development and large coal mining development, are also a matter of 'national environmental significance' under the EPBC Act.

The "water trigger" provisions of the Commonwealth's EPBC Act requires the IESC to provide scientific advice to decision makers on the impacts that CSG projects and Large Coal Mining Projects may have on Australia's water resources.

**AUTHOR'S NOTE:**

**Regrettably – at this stage the EPBC Act's provisions <u>do not apply</u> to the impacts of shale gas or tight gas so, until there is a change to the legislation to include these forms of unconventional gas, we are unable to rely on this Act to apply any controls on Blue Energy's potential operations.**

**Furthermore- to date there has not been a CSG or Large Coal Mining project refused by the "water trigger" provisions of the EPBC Act. All projects have been given conditional EPBC Act environmental approvals and so the full teeth of the EPBC Act have never been used or tested.**

In 2018, the Queensland Department of Natural Resources, Mines & Energy (DNRM&E) also engaged the Geo-Eng Group to undertake some further work on the groundwater aquifers in the Bundaberg Irrigation Area (BIA). This work builds on the investigatory work undertaken by the Geo-Eng Group and Dr Peter Baker between 1996 & 1999. DNRM&E has allowed Stellar Advisory Services access to the "draft" Bundaberg Groundwater Investigation Project Report – May 2018 which has been prepared for the Department by the Geo-Eng Group. This Report provides significant detail on the Elliott and Fairymead Bed aquifers to allow the DNRM&E to better manage these resources. It builds on the information in the Marshall et al Report.

The Marshall et al Report identifies the major Aquifers of the Maryborough Basin as being.

- Quarternary Coastal Aquifer.
- Quarternary Alluvial Aquifer.
- Quarternary Basalt Aquifer.
- Elliott Aquifer.
- Burrum Aquifer.
- Graham's Creek Aquifer.
- Duckinwilla Aquifer.

- There are also 2 aquitards – Quarternary Coastal Aquitard and the Maryborough Aquitard.

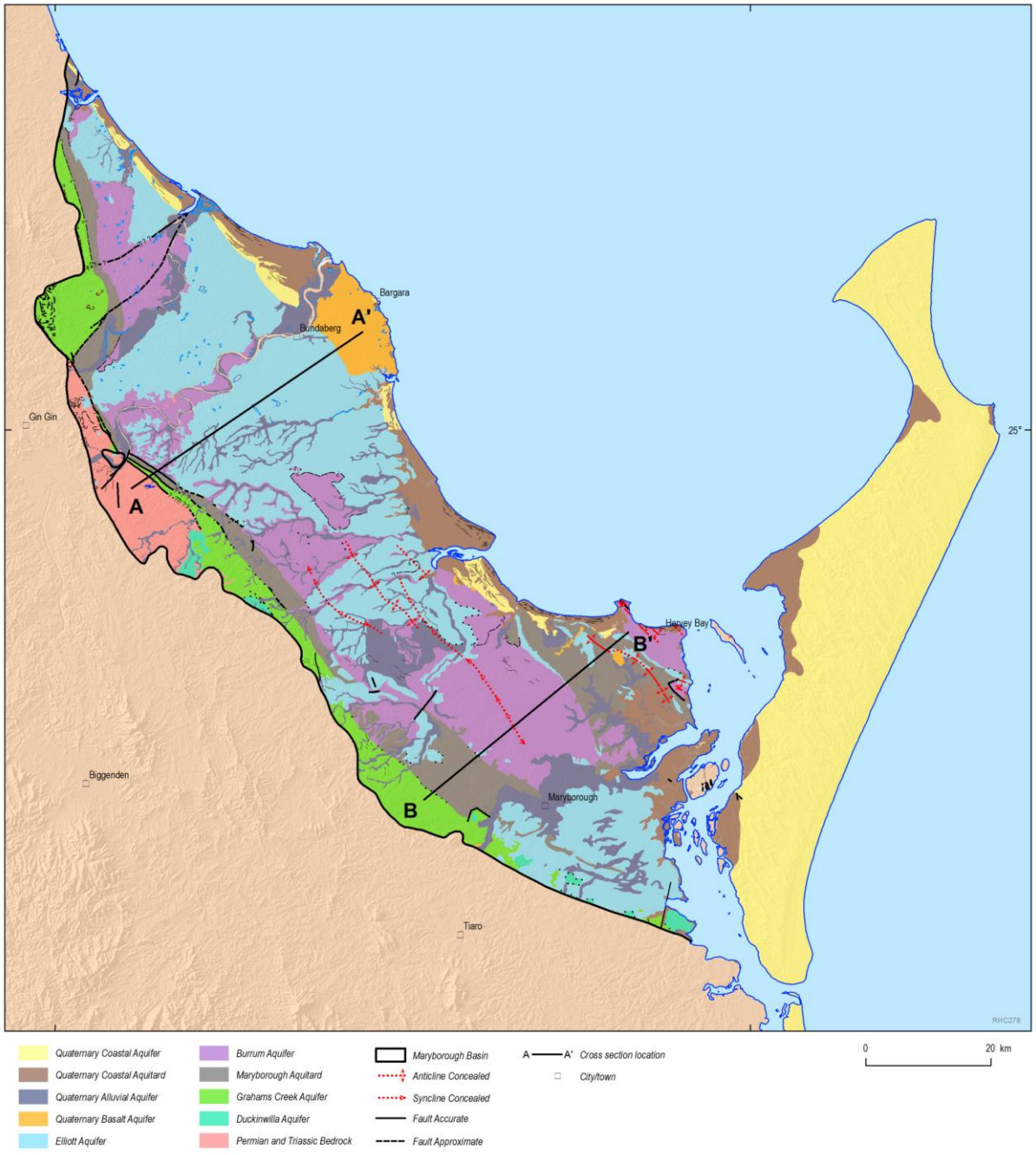



**Figure 2: Map of Aquifers in the Maryborough Basin.** ***Source:*** – page 73 Marshall et al Report.

The Quarternary aquifers are described as spatially small and shallow aquifers that provide useful sources of groundwater. The Quarternary Coastal Aquifer has a limited and discrete occurrence along the coastline and comprises of a series of small dunal sequences. The Quarternary Alluvial Aquifer is comprised of unconsolidated sedimentary sediments associated with the Kolan, Burnett, Elliott and Mary Rivers. They predominately consist of unconsolidated sands and silts deposited in channels which are not continuous – but are lenses incised into older rock formations.

The Quarternary Basalt aquifer occurs in numerous locations across the Basin and can provide productive sources of groundwater at a local scale. The groundwater occurs in fractures and vesicular basaltic rock formations.

**The Elliott Formation is the major aquifer for groundwater used for town water supplies and agriculture purposes in the Coastal Wide Bay Burnett Region**. The aquifer is defined by Marshall et al as an unconfined aquifer with semi-consolidated to consolidated sediments with discrete beds of gravel into the underlying Burrum Coal measures. The aquifer has a thickness of 0 – 100 metres (see Figure 4.4 - Stratigraphic chart on page 40). Unconsolidated sediments are loose materials, ranging from clay to sand to gravel. Groundwater flows through spaces between these sediments. Geologic processes like minor earthquakes can likewise erode and metamorphose unconsolidated sediments.

**A major aquifer underlies the Elliott Aquifer in the Bundaberg Region – known as the Fairymead Beds Aquifer** - it comprises of unconsolidated sands, gravels and clays. It is separated from the Elliott Aquifer by a layer referred to as the Gooburrum Clay Aquitard. There is considered to be limited connectivity between the Elliott aquifer and the Fairymead Beds.

In the southern part of the Maryborough Basin, there are water bearing beds (called the Takura Beds) which are colluvial layers formed from coarse-grained sediments, which contain local aquifers. These aquifers have been included within the Elliott Aquifer.

There are also significant volumes of groundwater extracted from the sandier sequences of the Burrum aquifer in the southern part of the Maryborough Basin. The Burrum aquifer underlies the Elliott aquifer and contains coal measures that are the focus of coal & unconventional gas (CSG) exploration. The Burrum aquifer has a thickness of up to 1,000 metres. Marshall et al indicate the extent of connectivity between the Elliott & Burrum aquifers is unknown.

**While Marshall et al outline that the extent of connectivity between the Elliott and Burrum formations is largely unknown – they postulated that the Elliott & Burrum aquifers are most likely to be effected by coal and unconventional gas (CSG) extraction. They suggest that increased water extraction by coal mining or CSG extraction from the Burrum Coal Measurers could impact on the hydraulic process for the Elliott and Burrum aquifers which could pose a risk to groundwater resources currently being utilised by Bundaberg Irrigation Area (BIA) irrigators, the local Council and other water users.**

**Studies undertaken by Sinclair Knight & Mertz (SKM) into the connectivity and interaction between surface flows and groundwater aquifers, indicate there is a "high degree of connectivity" between groundwater aquifers and surface water base flows in the Kolan, Burnett & Burrum Rivers and any impacts of extraction of groundwater by coal mining and CSG operations on the Burrum aquifer - could result in some impacts on surface water flows in these rivers.**

Marshall et al outline that the Maryborough Aquitard is a thick siltstone unit that separates the Burrum aquifer from the underlying Grahams Creek aquifer. Due to a paucity of data - the exact distribution and hydraulic properties of this aquitard are poorly understood.

The Graham's Creek and Duckinwilla aquifers underlie the Burrum aquifer. The Graham's Creek aquifer is described as having a sporadic distribution and variable thickness and is a minor source of groundwater along the western margins of the Basin. The Duckinwilla aquifer lies beneath the Grahams Creek aquifer. It has two sub-units – the Tiaro Coal Measures and the Maryborough Formation. Marshall et al outline there is very little data available on the groundwater potential in these Duckinwilla aquifers.

**A major issue highlighted on a number of occasions in the Marshall et al Report - is the lack of detailed and relevant data to inform their hydrogeological assessment. The best available data is concentrated in the Bundaberg Groundwater Management Unit and the Canozoic Elliott aquifer. There is no understanding of the deeper aquifers which could in Marshall et al's view, yield useful water.**

# 7.0 Water requirements for an Unconventional Gas Industry in the Coastal Wide Bay Burnett:

The Queensland Government is still actively promoting the expansion of unconventional gas exploration (coal seam gas, tight gas and shale gas) in Queensland – in particular in the Eromanga and Cooper Basins (Cooper Basin Industry Development Strategy) in South Western Queensland, and the Galilee and Bowen Basins in Central Queensland. Accordingly, much of the available 'data' on water use by unconventional gas in Queensland is drawn from these regions. However, as the United States has been involved in unconventional gas development for many years, in many different climates and geological formations, information will also be drawn from data from the United States.

As a reminder, Unconventional Gas refers to "coal seam gas", "tight gas" and "shale gas". At present, there is no shale gas being extracted in Queensland, so the data used below is based on coal seam gas production. Data from the United States on shale gas production will also be used as it gives a better picture of the likely impact of shale gas activity.

In CSG production there is a significant extraction of water from the coal seams. In the Surat Basin this is averaging 11 ML/well per year and in the order of 55,000 ML/annum is being extracted from the regional aquifers.

A literature review indicates that the volume of "produced water" extracted from a shale gas well is likely to be very low and a lot less than a CSG well - somewhere in the order of 0.10 & 1.6ML/gas well per year. If 100 shale gas well pads (with 2,000 gas wells) are drilled iby Blue Energy nto the Maryborough Formation – it could equate to an additional water use of 200 – 3,200ML of "produced water" being extracted from these wells each year.

The major impact on water resources by the shale gas industry is, the volume of water required for hydraulic fracking of gas wells and this issue will now be addressed.

While it is acknowledged that the fracking process for an unconventional gas well may use large volumes of water, there are considerable differences of opinion as to how much water is required.

| Information Source | Water Use/Gas Well |
|---|---|
| Cooper Basin Strategy | Up to 5 ML (Vertical Well)<br>Up to 20 ML (Horizontal Well) for initial frack<br>Approx 13 ML per additional hydraulic fracking (assuming 'flowback water' is reused* |
| Environment America's Research & Policy Centre<br>(Fracking by the Numbers) | 11.35 ML of water on average (data sourced from 114,438 unconventional gas wells between 2005 & 2015) |
| "The intensification of the water footprint of hydraulic fracking";<br>Andrew J Kendash, Nancy E Lauer & Avner Vengosh – Nicholas School of the Environment, Duke University, Durham. North Carolina. USA. August 2018 | Looked at six years of data on water use from more than 12,000 wells across the U.S. and found the amount of water used per well in fracking jumped by as much as 770 percent, or nearly 9-fold, between 2011 and 2016. Even more dramatically, wastewater production in each well's first year increased up to 15-fold over the same years |
| New York State Department of Environmental Conservation estimates<br>(Source: https://www.dec.ny.gov/energy/75370.html) | 7.0 – 29.5 ML/frack<br><br>Each well pad can consist of up to 20 wells – so each **well pad** could require between 180 – 590 ML for each frack (this assumes no reuse of "flowback" water) |

**Shale Gas Technology May Increase Water Use**

Since the early 2000's the unconventional gas industry has been exploring new technology for increasing the gas extraction from tightly held gas reserves such as coal seam gas and shale gas. One of the key new technologies, which have allowed previously uneconomic gas reserves to become more viable, is Directional Drilling (also known as Horizontal Drilling), which involves deliberately shifting a well's pathway from the vertical.

According to Dr Tony Ingraffea, an Engineer from Cornell University who helped develop the unconventional gas industry, directional drilling is relatively new technology in the unconventional gas industry, having been commercialised in the early 2000s, and the long-term impacts of this methodology are still yet to be fully understood. Dr Ingraffea has studied shale gas activities in the United States and has noted sharp increases in water use for fracking shale gas, as compared to coal seam gas (***Source:*** https://www.ecowatch.com/meet-anthony-ingraffea-from-industry-insider-to-implacable-fracking-op-1881680606.html)

Reasons for directional drilling include:

- To avoid a surface site that is operationally difficult (for example - Landholder has refused access) or environmentally sensitive
- Drilling an offshore well from an onshore site
- Reducing costs or surface impact by drilling several wells in different directions from the one surface location
- Enhancing oil and gas production by drilling in a way that exposes more of the reservoir to the wellbore.

To steer the well path, rotary steerable equipment is mounted on the drill pipe just behind the drill bit. These systems can be remotely steered from the surface to redirect the drill bit to deviate the well on any desired path.

See illustration of directional drilling in Figure 3 below.

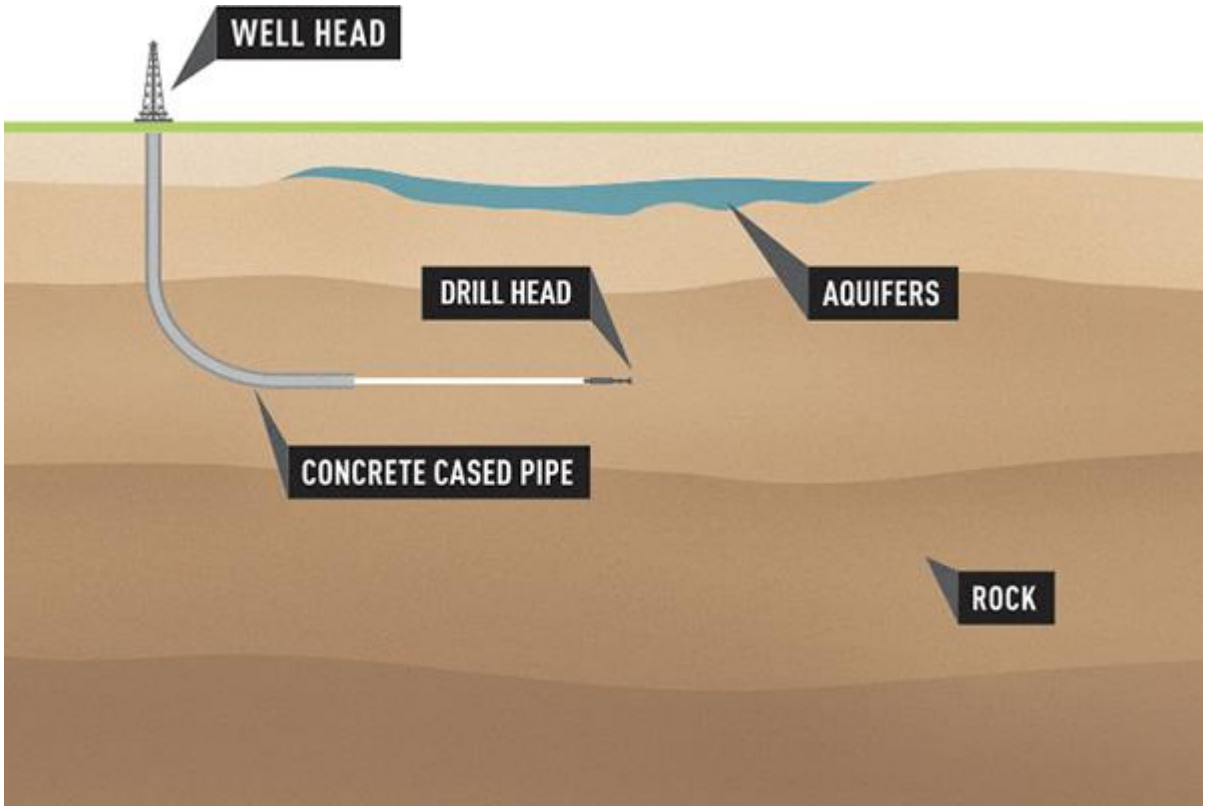



**Figure 3: Outline of Directional Drilling of a Gas Well** (***Source:*** APPEA Fact Sheet.)

Arrow Energy is currently using directional drilling for the installation of CSG wells in the Dalby District. However - irrespective of whether vertical drilling or horizontal drilling is used to drill shale gas wells in the Coastal Wide Bay Burnett Region – all shale gas wells will be required to drill through the Elliott and Burrum water bearing Formations.

A US investigation into the water footprint of fracking by Kendash, Lauer & Vengosh suggests that as the fracking boom matures, the US drilling industry's use of water and other fluids to produce oil and natural gas has grown dramatically in the past several years, outstripping the growth of the fossil

fuels it produces. (***Source:*** The intensification of the water footprint of hydraulic fracking. Andrew J Kendash, Nancy E Lauer & Avner Vengosh – Nicholas School of the Environment, Duke University, Durham. North Carolina. USA. August 2018).

Their recently published study in the peer-reviewed journal Science Advances, says the results from recent changes in drilling practices as drillers compete to make new wells more productive, is resulting in greater environmental impacts than previously described.

For example, well operators have increased the length of the horizontal portion of wells drilled through shale rock. They also have significantly increased the amount of water, sand and other materials they pump into the wells to hydraulically fracture the rock and thus release more hydrocarbons trapped within the shale. The study looked at six years of data on water use, as well as oil, gas and wastewater production, from more than 12,000 wells across the U.S. It found the amount of water used per well in fracking jumped by as much as 770 percent, or nearly 9-fold, between 2011 and 2016. Even more dramatically, wastewater production in each well's first year increased up to 15-fold over the same years.

The Environment America's Research & Policy Centre reports that the average gas well consumes 11.35 ML of water for hydraulic fracking operations. This was an average water use for the fracking of 114, 438 unconventional gas wells between 2005 & 2015. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling. E. Ridlington, K Norman & R Richardson (April 2016).

The New York State Department of Environmental Conservation estimates that each unconventional gas well will require 9.0 – 29.5 ML/frack. Furthermore, each well pad can consist of up to 20 wells – so each well pad could require between 180 – 590 ML for each hydraulic fracking. This assumes that there is no reuse of "flowback" water (Source – GasLand Website) 2016.

**Likely Water Use for Fracking in the Maryborough Basin?**

The volume of water required for fracking of shale gas wells in the Maryborough Basin will depend on:-

- the nature of the rock
- the size of the hydraulic frack
- the number of wells drilled
- the number of stages in each well

Based on the following:-

- a projected water use of 20 ML/fracking/well
- the reuse of the "flowback" water (30% retrieval)
- assuming each well pad consists of 20 shale gas wells

**AUTHOR'S NOTE:**

Shale gas water use in the Maryborough Basin could potentially be a 267 ML/pad (1 X 20 ML & 19 X 13 ML) volume, which is likely to be sourced from either the Elliott, Burrum or Maryborough Formations – whichever is the most accessible and least expensive water source.

If 100 well pads with 20 wells/pad (2,000 gas wells) were developed and hydraulically fracked once – it could equate to **26,700 ML of water use for <u>each</u> hydraulic fracking** in the Maryborough Basin. Typically unconventional gas wells are fracked multiple times in their lifespan – so their water use could be much higher than these projections.

**Marshall et al have postulated that the Elliott & Burrum aquifers are the aquifers most likely to be affected by coal and unconventional gas (CSG) extraction. They suggest that increased water extraction by CSG extraction from the Burrum Coal Measurers could impact on the hydraulic process for the Elliott and Burrum aquifers – the major aquifers utilised by irrigators and other water users in the Coastal Wide Bay Burnett Region.**

**Furthermore - the potential of producing 26,700 ML of contaminated fracking water each year also highlights that the safe disposal of fracking water is a significant issue – this issue is covered in Sections 10 & 11 of this Report.**

# 8.0 The potential for increased seawater intrusion from Unconventional Gas water extraction:

As outlined in Section 6.0 above – Geo -Eng undertook extensive investigations into the groundwater aquifers and seawater intrusion in the Bundaberg Irrigation Area in 1998 & 1999 and the Geo-Eng Group Australia Pty Ltd have undertaken some further investigations in 2018.

The Bundaberg Irrigation Area (BIA) covers approximately 55,600 ha of land between Childers, Gin Gin and Bundaberg. Overuse of groundwater in the 1960's resulted in seawater encroachment into the BIA's aquifers systems. While the total Nominal Volume of allocation is 88,296 ML - the long-term sustainable yield for that part of the BIA south of the Elliott River has been estimated at 6,900 ML, the area between the Elliott and Burnett Rivers at 30,500 ML and the area between the Burnett and Kolan Rivers at 25,000 ML - a total of 62,400 ML/year. (Source – Geo-Eng Report (unpublished) provided to Stellar Advisory Services by DNRM&E).

For the last 24 years, extraction of groundwater in the BIA has been managed by an annual "announced allocation" system which is administered by the DNRM&E in consultation with a Groundwater Advisory Committee. This system aims to restrict water extraction to a sustainable level that is not detrimental to the groundwater aquifers, in particular those that are at risk to saline intrusion from seawater sources. Advice from the DNRM&E is that the annual take of groundwater

could range from 48,600 ML to 89,300 ML, with an average use of 68,900 ML/year based on aquifer water levels for each water year. (***Source*:** – Brian Latcham – DNRM&E – personal communication).

If a Coastal Wide Bay Burnett shale gas industry was to access its projected water use of 26,700 ML/yr from the Elliott aquifer, or the Fairymead Beds, or the Burrum aquifer, it could have serious implications on the "announced take" of groundwater by agriculture in the BIA. As Councils are allowed a 100% announced allocation for their Town Water Supplies - they will be immune to this potential impact.

Although there have been some instances of temporarily increased seawater intrusion due to local effects, the announced allocation system being applied by the DNRM&E has largely been effective in controlling seawater intrusion. The variation in the location of the 2,500 µS/cm conductivity boundary line indicates that the seawater interface is relatively stable under the current "announced allocation" groundwater management system. (***Source:*** Bajracharya, K, Moser, A, and Heidke, K (DNRM&W Report)).

The DNRM&W's **Burnett Basin WRP Amendment – Coastal Burnett Groundwater Project - Instructional Seawater Intrusion Model Report**, June 2006, presents a detailed interpretation of seawater-intrusion data for those areas which interface with the coast. A summary of this data is outlined Appendix B.

As the ATPs in the Maryborough Basin cover the Seawater Intrusion Area, if fracking activities were to affect water levels in this Area, the risk of seawater intrusion would be a major concern for irrigators, and other water users, especially as many of the irrigators in this Area have no alternative sources of water supply.

In respect to the potential risk that Blue Energy's ATP's pose to seawater intrusion of the major aquifers of the BIA (Elliot Formation and Fairymead Beds) – this will be dependent on the location and volume of water sourced for the hydraulic fracking of gas wells. If fracking water is sourced from those aquifers that are already susceptible to seawater intrusion – an additional risk of seawater intrusion will be created. The only way to offset this risk for irrigation and other water users in the BIA, is for Blue Energy to be required to source their fracking water from alternative sources or for irrigation users to have a lower "announced allocation" to compensate for Blue Energy's potential take of water. This would have a major impact on those agricultural enterprises in the BIA who have no other alternative sources of water.

# 9.0 Potential risks of geological activity on the integrity of Unconventional Gas wells:

A report by the Central Queensland Seismology Research Group (CQSRG) details 137 earthquakes and lists three (3) **hotspots** in Queensland for seismic activity – these being the **Mt Perry area**, **Rainbow Beach to Lady Elliott Island along the Fraser Coast** and the Whitsunday Passage.

The report indicates these three hotspots have experienced the largest number of earthquakes in Queensland of greater than 3.5 magnitude on the Richter Scale. **The largest recorded earthquake was a magnitude 6.2 near Lady Elliott Island in 2018.**

The CQSRG Report indicates the average return period for a 6.0 magnitude earthquake is around 100 – 120 years. Lead seismologist Michael Turnbull cited strong seismic events north of Rainbow Beach in 2015 followed by more than a dozen aftershocks into 2016 as an indication of an unusually active 2 years. Aftershocks of a magnitude of 5.7, 5.2 and a 5.0 were experienced.
A review of USA literature shows there is a growing body of evidence of a link between hydraulic fracking and the disposal of fracking wastewater into deep geological strata, to increased earthquake activity. (***Source:*** Concerned Health Professionals of New York & Physicians for Social Responsibility. Compendium of Scientific, Medical and Media Findings Demonstrating Risks & Harms of Fracking (Unconventional Gas & Oil Extraction). Fifth Edition. March, 2018.) The US Geological Survey agency acknowledges that fracking wastewater injection can cause earthquakes by unclamping stressed faults. According to the New York State Department of Environmental Conservation Public Health Review of High Volume Hydraulic Fracturing (HVHF) for Shale Gas Development - recent evidence from studies in Ohio and Oklahoma suggest that HVHF can contribute to the induction of earthquakes during fracturing (Holland, 2014; Maxwell, 2013).

The injection of water into Queensland aquifers by the CSG Industry is currently limited to the "trial" injection of treated CSG "produced water" in the Surat Basin. While this injected water has resulted in aquifer levels raising in close proximity to the injection sites – there are some emerging issues with water quality impacts associated with this injected water.

**Studies in Texas, New Mexico, Oklahoma and Colorado have identified <u>wastewater injection wells as a cause of earthquakes</u>.** There are numerous documented studies in the Compendium of Scientific, Medical & Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas & Oil Extraction) – Fifth Edition - March 2018, linking hydraulic fracking and fracking wastewater to increased seismic activity. A number of US States are applying measures to either reduce or stop the disposal of fracking wastewater into deep geological strata.

**AUTHOR'S NOTE:**

This evidence indicates that either hydraulic fracking of shale gas resources in the Coastal Wide Bay, or the disposal of hydraulic fracking wastewater into the Duckinwilla Formation in the Maryborough Basin, could increase the occurrence of seismic activity in an area that has been clearly identified as a seismic hotspot in Queensland.

Furthermore – the occurrence of increased seismic activity may impact on the integrity of shale gas wells and allow for the leakage of fluids and associated contamination of groundwater aquifers used for agriculture and domestic water supplies.

# 10.0 Groundwater Contamination Risks due to Well Bore Failure:

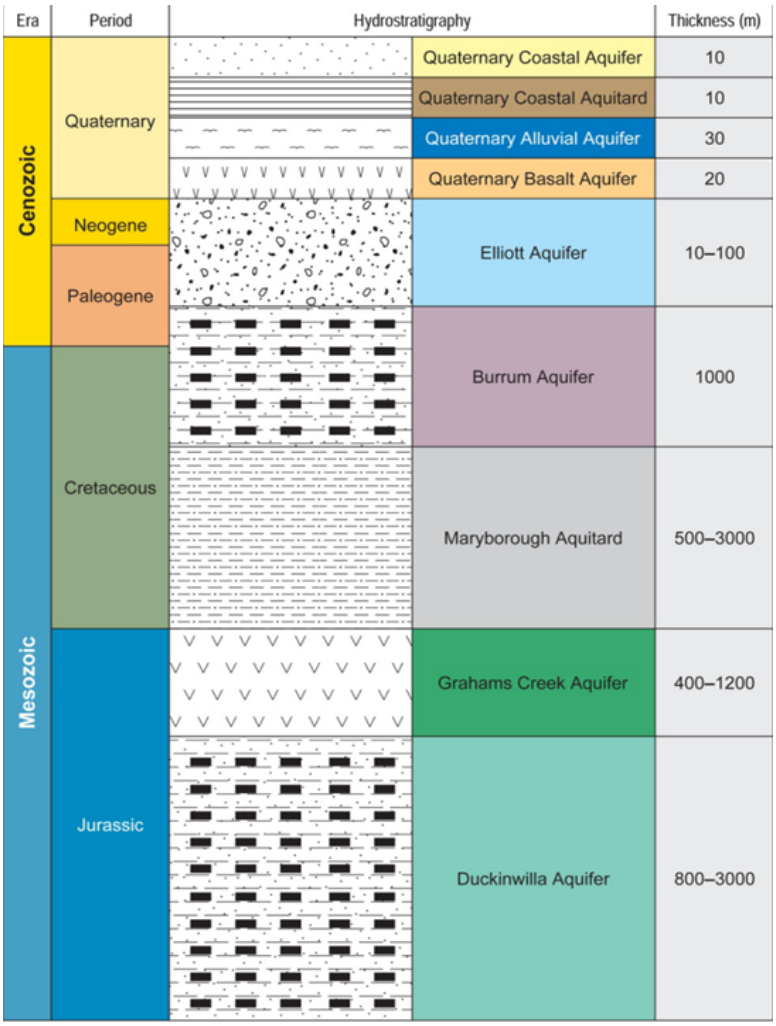
The Maryborough Basin is described as a hydrogeological basin comprising of complex geological sequences.

The main aquifers within the Maryborough Basin include:

- Quarternary Coastal Aquifer.
- Quarternary Alluvial Aquifer.
- Quarternary Basalt Aquifer.
- Elliott Aquifer.
- Burrum Aquifer.
- Graham's Creek Aquifer.
- Duckinwilla Aquifer.and
- Two (2) aquitards – the Quarternary Coastal Aquitard and the Maryborough Aquitard.

As already outlined in Section 6.0 of this Report - the Elliott aquifer is the major source for agriculture and town water groundwater supplies and significant volumes are also extracted from the sandier sequences of the Burrum aquifer in the southern part of the Maryborough Basin. Marshall et al's Report has highlighted that the Elliott and Burrum aquifers are most likely to be effected by future coal and gas extraction.

**Figure 4: Hydrostratigraphy and Strata Thickness – Maryborough Basin. (*Source:* – Page 66 – Marshall et al Report.)**




The Hydrostratigraphy and Strata thickness for the Maryborough Basin is outlined in Figure 4 above. This information was sourced from the Marshall et al Report (page 66) and is based on research and interpretation undertaken in the preparation of their Report.

**The information presented in Figure 4 clearly shows that the Elliott and Burrum water-bearing formations will be intersected by a drill stem when an unconventional shale gas well is drilled into the Cherwell and Goodwood Mudstone Formations in the Maryborough Formation (Aquitard). It is this intersection of the Elliott and Burrum water-bearing formations that presents a significant risk of groundwater contamination, should the construction of a gas well fail.**

**Current Data on Groundwater Contamination though Well Failure**

A review of the websites for both the Departments of Natural Resources, Mines & Energy (DNRM&E) and Environment & Science (DES) has not uncovered any data on the rate of failure of petroleum & gas wells in Queensland. A GasFields Commission of Queensland Report indicates that the P&G

Inspectorate of the DNRM&E does compile data on petroleum & gas well failures, however this data is not publicly available.

In July 2015, the GasFields Commission of Queensland released a publication titled Onshore Gas Well Integrity, on the integrity of onshore gas wells in Queensland. The Report states that more than 1,800 conventional gas wells have been drilled in the Cooper Basin and there have been no reports found of a failure of subsurface well integrity. ***Please note:*** this report relates to CONVENTIONAL gas wells, which are managed differently to Unconventional gas wells. It should also be noted that Marshall et al's report indicates that a gas industry in the Coastal Wide Bay will most likely be focused on Shale Gas, but there are currently NO shale gas wells in Queensland, and thus, no data is available on the likelihood of shale gas well failures in Queensland.

Furthermore – on page 10 of the GasFields Commission report - it states there have been 21 statutory notifications (0.3%) under the well construction code concerning suspect downhole cement quality during well construction. All of these notifications were remediated.

The Gasfields report also cites a 2013 review by King & King of 253,090 wells in Texas State (USA) which found only 4 in every 100,000 wells (0.004%) constructed to modern standards, experienced a loss of well integrity.

However, a review of data in the US indicates that Pennsylvania regulators have confirmed **at least 260 instances of private well (water bore) contamination from fracking operations in the decade between 2005 & 2015**. While the data also indicates that the level of well failure in Pennsylvania State was 6 – 7% of wells drilled, data on the contamination risks due to well failure was not presented. However, anecdotal evidence certainly indicates that there is a significant risk of inter-aquifer leakage and potential contamination from fracking fluids or poor quality water interfacing between aquifers, from well failure. (***Source:*** Environment America – Research & Policy Centre - Fracking by the Numbers – The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – E. Ridlington, K Norman & R Richardson (April 2016) - page 10). The Physicians, Scientists, and Engineers (PSE) for Healthy Energy also cites numerous documented cases in the US of groundwater contamination from gas industry activities (https://www.psehealthyenergy.org/our-work/publications/). The risk of this happening to the groundwater resources of the Coastal Wide Bay Burnett region is not acceptable.

The recent National Chemical Notification & Assessment Scheme (NICNAS) national assessment of chemicals associated with coal seam gas extraction in Australia (Technical Report 4) made the following statements in relation to well integrity: "A number of large-scale studies indicate that there is not full integrity in a significant percentage of all wells. In the Gulf of Mexico, US (United States), approximately 10 per cent of wells experienced sustained casing pressure (SCP) within one year of being completed, and this figure rose to 50 per cent after 15 years of production.

This sustained casing pressure state indicates that there is a leakage path to pressurised reservoir fluids through one or more of the cement sheaths or cased intervals. According to the National Petroleum Safety Authority, in areas offshore of Norway, 18 per cent of the wells surveyed in a pilot

study (more than 400 wells) had integrity failure issues or uncertainties, and seven per cent of these were shut down because of well integrity issues.

In Canada, 4.6 per cent of 316,439 wells in the database collected by the Energy Resources Conservation Board (ERCB) had leakage issues with gas migration outside casing or surface casing vent flow (SCVF) from well/bore annulus cement failure.

Within the Barnett Shale Formation in Texas State, there are increasing levels of 10 different metals and 19 different chemicals which are associated with fracking – including benzene, toluene, ethylbenzene and xylene. Increasing concentrations of arsenic, selenium & strontium have been recorded as a result of the disturbance that fracking causes underground. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling - page 11).

Water-quality Impacts Studies in the US have found evidence for underground migration of methane associated with faulty well construction (***Source:*** Darrah, 2014; US EPA, 2011). A recent study identified groundwater contamination clusters that the authors determined were due to gas leakage from intermediate-depth strata through failures of annulus cement, faulty production casings, and underground gas well failure (Darrah, 2014). In addition, shallow methane migration has the potential to impact private drinking water wells, creating safety concerns due to explosions (***Source:*** New York State Department of Environmental Conservation A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development).

Other studies suggest additional sources of potential water contamination, including surface spills and inadequate treatment and disposal of radioactive wastes (Warner, 2013). A recent review paper presented published data revealing evidence for stray gas contamination, surface water impacts, and the accumulation of radium isotopes in some disposal and spill sites (Vengosh, 2014). Another study suggests that chemical signals of brine from deep shale formations can potentially be detected in overlying groundwater aquifers (Warner, 2012). These contaminants have the potential to affect drinking water quality (***Source:*** New York State Department of Environmental Conservation A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development).

**AUTHOR'S NOTE:**

It is surmised that given the "hands off" approach adopted by the Queensland Government to the regulation of the Unconventional Gas Industry, that there would be few if any restrictions to the chemical cocktail used for fracking operations in Queensland and similar contamination issues as have been reported in US studies may occur with Queensland unconventional gas wells.

**Risks Associated with Groundwater Contamination**

The **National Toxics Network (NTN)** is a community-based network of health professionals and others working to ensure a toxic-free future for all. The NTN was formed in 1993 and has grown as a national network with direct linkages into organisations such as the Hazardous Waste Reference Group, the Stockholm Stakeholders Reference Group, the National Industrial Chemicals Notification Assessment Scheme (NICNAS) Community Engagement Forum and the Australian Pesticides and Veterinary Medicines Authority committees.

The NTN Report - Unconventional Gas Exploration & Production – Human Health Impacts & Environmental Legacy Report by Dr Mariann Lloyd-Smith (April, 2016)) has indicated that BTEX (Benzene, Toluene, Ethyl Benzene and Xylenes) chemicals were found in 5 of 14 monitoring wells in Arrow Energy's Queensland CSG fields with **benzene at 6 – 15 times above the Australian drinking water standard**. Toluene was found in a private water bore adjacent to a Queensland gas field. All of these BTEX chemicals are extremely toxic and carcinogenic. In 2010, the Queensland Government passed the *Natural Resources and Other Legislation Amendment Act 2010* which banned petroleum compounds containing BTEX chemicals, from coal seam gas (CSG) fracking operations.

**AUTHOR'S NOTE:**

In the relatively short life of the Queensland CSG Industry there has clearly been an escape of toxic chemicals from hydraulic fracking fluids into the water supply aquifers associated with Queensland's Surat Basin. Examples from America, where the industry is more established, demonstrate that contamination of water supplies in a gas mining district is a real and valid concern for irrigators and other water users

There is potential for similar outcomes of water quality being compromised in the Coastal Wide Bay Burnett Region from an expansion of the unconventional shale gas industry into the Region.

**The recent PFAS leakage incident in the Bundaberg region also highlights that supposedly 'low risk' activities can have long term impacts on affected communities.**

# 11.0 Groundwater Contamination Risks from Flow Back Water & Chemical Fracking:

Fracking involves the use of a fracking fluid pumped into the undeveloped gas well at high pressure to stimulate fractures in the rock layer to release the flow of gas, oil and other fluids. Fracking produces 'flow back' water and drilling mud as a bioproduct. The Australian Petroleum Production & Exploration Association (APPEA) (the Petroleum & Gas Industry's Peak Body) states that the fracking

fluid “is typically more than 99% water and sand plus a very small amount of chemicals” to reduce friction, remove bacteria, dissolve some minerals and enhance the fluid’s ability to transport sand.

Industrial chemicals, including those associated with CSG extraction, must generally be listed on the chemical inventory – Australian Inventory of Chemical Substances (AICS) or notified to National Chemical Notification & Assessment Scheme (NICNAS) before being introduced into Australia. Chemicals that are already listed on AICS (without conditions) may be used for any industrial application—including in coal seam gas extraction—without notifying the Australian Government.

The NTN Report mentioned above outlines that there are many volatile compounds released into the air and water as an outcome of unconventional gas activities. Some are a product of hydraulic fracking and some are naturally occurring chemical substances released from coal seams or shale rock.

The Australian Government (Department of Environment & Energy) commissioned in 2017, an assessment of the above-ground (surface) handling of chemicals used in hydraulic fracking of unconventional gas wells – it did not consider potential risks from chemicals entering deeper groundwater through drilling or fracturing operations. The Australian government has since commissioned additional research into deeper groundwater that found the risks to be very low. The Australian government suggests this is consistent with international studies that had shown that the greatest risk to human health or the environment from chemicals used in coal seam gas extraction is from spills or releases of chemicals during surface activities such as transport, handling, storage and mixing of chemicals. However, internationally, debate still rages on this subject. European countries such as France have banned fracking due to the risks and scientific groups such as the Physicians, Scientists, and Engineers (PSE) for Healthy Energy have published extensive data that brings the Australian government’s position into question.

## Drilling Muds

The NTN report that drilling muds from the drilling of gas wells are also a source of significant environmental impacts. The mud which flows back to the surface may contain significant contaminants from the drilling fluids used as well as contact with coal and its contaminants. Trials undertaken in Queensland have shown that unconventional gas drilling muds contain salts, heavy metals and hydrocarbons and hence they need to be managed and disposed of safely. The NTN report notes that concentrations of aluminium, boron, iron, manganese, molybdenum, vanadium and mercury exceeded the Australian and New Zealand Environment and Conservation Council (ANZECC 2000) Guidelines and detectable concentrations of petroleum hydrocarbons were observed in drilling muds. (***Source:*** NTN Report Unconventional Gas Exploration & Production – Human Health Impacts & Environmental Legacy, April, 2016.)

The risk of harmful metals and chemicals from these drilling muds finding their way into watercourses and rivers discharging into the Great Sandy Marine Park and subsequently impacting on the Great Barrier Reef is acute.

## Flowback Water

Contamination risks from hydraulic fracking "flowback" water can be attributed to the following activities:

- Leakage between aquifers from well failure or flow though natural faults along the aquifers
- Failure of surface water waste ponds
- Inappropriate use of "flowback" water for dust suppression, or
- Human error in the disposal of contaminated "flow back" water

The issue of cross contamination of aquifers from a gas well failure has already been addressed in Section 10.0.

**Given the potential water usage of 26,700 ML for a single hydraulic fracking of 100 shale gas pads in the Maryborough Basin, and given that approximately 30% of this water volume may be retrieved as "flowback" water for use in further hydraulic fracking - there is a significant volume (~8,900 ML) of extremely toxic water that cannot be readily disposed of. This water cannot be cleaned through normal reverse osmosis water treatment processes and it has to be either reused for fracking (where it becomes further contaminated) or injected into deep aquifers with the hope that it doesn't leak into adjoining aquifers (and with the associated seismic risks), or stored in surface waste ponds or above ground holding tanks.**

Due to the toxicity of this "flowback" water, there is normally a requirement for any surface wastewater ponds to be sealed with an impregnable liner. The USA has recorded incidents where the wastewater pond liners have been punctured and toxic elements have contaminated the surrounding soils, adjoining streams and shallow aquifers.

To mitigate these risks – a number of USA States allowed the disposal of hydraulic fracking fluids through injection into deep geological strata. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – pages 11 & 12).

This deep injection option for disposal of fracking wastewater has resulted in some unintended consequences in the US. The US EPA reported that wastewater injection of fracking wastewater into a well has contaminated the Cenozoic Pecos Alluvium Aquifer near Midland in Texas State. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – page 12). The Physicians, Scientists, and Engineers (PSE) for Healthy Energy have also reported on numerous recorded incidents of contamination resulting from wastewater disposal activities (***Source:*** https://www.psehealthyenergy.org/)

In Queensland – Glencore is trialing the deep injection of CO2 into the Precipice Sandstone Aquifer of the Great Artesian Basin at Wandoan – a major aquifer for the supply of Town Water Supplies and Stock & Domestic users in Western Queensland. The risk of this contamination happening to the groundwater resources of the Coastal Wide Bay Burnett region is not acceptable.

There are substantial issues in the US associated with radioactive elements in fracking wastewater, particularly in relation to shale gas operations. As noted by the Compendium of Fracking Risks "*High levels of radiation documented in fracking wastewater from many shale formations raise special concerns in terms of impacts to groundwater and surface water. Measurements of radium in fracking wastewater in New York and Pennsylvania, from the particularly radioactive Marcellus Shale, have been as high as 3,600 times the regulatory limit for drinking water, as established by the U.S. Environmental Protection Agency (EPA)*". Concerns about the risks in Australia have been raised this year, after it was revealed by Buru Energy that testing of flowback fluids from its 2015 shale gas fracking operations in the Kimberley showed elevated levels of the chemical contaminants Boron and Barium and the radionuclide Radium-228 . (***Source:*** https://www.smh.com.au/politics/federal/radioactive-water-reignites-concerns-over-fracking-for-gas-20180622-p4zn4r.html)

**What chemicals are used in fracking fluids in Australia?**

The APPEA would have the public believe that the chemicals used in fracking in Australia are 'non-harming'.

**The NTN Report outlines that many chemicals used in hydraulic fracking have not been assessed for their long term environmental and health impacts. In Australia – only 2 of 23 chemicals identified as commonly used for fracking have been assessed by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Neither of these chemicals was assessed for their use in unconventional gas fracking.**

Cornell University Engineer, Dr Anthony Ingraffea, highlights that the fracking chemicals which must be transported by heavy vehicles to gas fields, are industrial products that do not belong in farming communities.

In fact, Dr Ingraffea believes shale gas development, featuring clustered multi-well pads, using high-volume hydraulic fracturing from long laterals, is a spatially intense, heavy industrial activity which involves far more industralisation of farmlands than coal seam gas development. He discusses the necessity of building pipelines through forests and fields, the construction of compressor stations to compress the gas for transport through pipelines, waste pits, fresh-water ponds and the tremendous amount of heavy truck traffic involved.

In fact, a recent study from Pennsylvania also reports that automobile and truck accident rates in 2010–2012 from counties with heavy fracking activity were between 15% and 65% higher than accident rates in counties without fracking. Rates of traffic fatalities and major injuries were higher in 2012 in heavy drilling counties in southwestern Pennsylvania compared to non-drilling counties (Graham, 2015). (***Source:*** New York State Department of Environmental Conservation A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development). Thus, truck accidents involving the transport of fracking fluids through farming areas are another potential source of groundwater contamination in the Coastal Wide Bay.

Given the close proximity of the Coastal Wide Bay region to the Great Barrier Reef, and the known connectivity between the region's underground aquifers and the ocean, the threat of groundwater contamination is also a very real threat to the reef.

**AUTHOR'S NOTE:**

While P&G Companies (such as SANTOS and ORIGIN) do provide a public list of the chemicals and compounds they use for fracking – many of the products listed are listed under' Halliburton' or 'Schlumberger' product codes and hence the public are none the wiser as to what specific chemicals they contain. Furthermore, the specific chemical composition of most "commercial fracking products" is protected from disclosure through various "trade secret" exemptions under State and Commonwealth laws.

**Australian farmers are subject to various pieces of legislation governing the chemicals they are allowed to use, when, where and how those chemicals are used, and all chemicals need to be approved for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA). It is incongruous that another industry, which also uses potentially harmful chemicals, is protected by trade secret exemptions by law and is not subject to the same legislative responsibilities as farmers.**

The NTN has compiled information (from publicly available sources) on 8 chemicals (Glutaraldehyde, Ethylene Glycol, 2 – Butoxyethanol. Nonylphenol Ethoxylate, Methanol, Sodium Persulfate, Tetrakis hydroxymethyl phosponium sulfate and Naphthalene) used for hydraulic fracking in Australia which are toxic to human health. These chemicals have caused: human carcinogens, cell mutations, abortions and sub-fertility in females, reproduction and birth defects, skin reactions and disruption to human nervous systems. (***Source:*** - pages 6 & 7 of the NTN Report).

The recently released NICAS assessment of chemicals used in the CSG industry, serves as a timely reminder of the harmful potential effects of the CSG (coal seam gas) industry to workers and the public.

The project examined 113 chemicals used in the extraction of CSG between 2010 and 2012, and whether these posed harm to CSG workers health, public health and the environment.

The CSIRO and NICNAS modelled exposure pathways for these chemicals through water contamination and examined the risk of spills, accidents and leaks.

The assessment found that 48 of the 113 chemicals assessed in the project could harm the health of workers in the CSG industry who come into contact with harmful amounts of CSG chemicals when mixing or blending chemicals to produce formulations or in the event of an industrial accident.

The assessment also found that 11 of 21 chemicals used for drilling, and 30 of 58 chemicals used for hydraulic fracturing, were of a potential concern for public health.

The assessment also found that 14 of 58 chemicals used for hydraulic fracturing were of potential concern for public health from long-term exposures from a subsurface leak from a storage pond holding flowback and / or produced water containing hydraulic fracturing chemicals.

An expert review of the Environmental Impact Statement prepared by Santos for their proposed 850 well CSG production gasfield proposed as part of the Narrabri Gas Project, has estimated between 15 & 130 spills of wastewater could be expected to occur during this project. (***Source:*** Analysis prepared by Dr Matthew Currell and submitted to the Narrabri Gas Project EIS by the North West Alliance).

As a result of the CSIRO & NICNAS assessment, an additional 30 substances have been recommended by NICNAS to be listed by Safe Work Australia to the Hazardous Substances Information System – doubling the number of CSG chemicals listed under that system. (Source:

In spite of APPEA's claims that the chemicals used in fracking are non-harming, evidence in the USA also indicates that many of the chemicals used are carcinogenic.

An analysis of fracking fluids used for shale gas well development in the US has indicated that there is a rich cocktail of chemicals used. There have been > 1,000 chemicals identified in fracking fluids with at least 15% of these chemicals being toxic. A 2014 study by scientists at Lawrence Berkley National Laboratory, reported that around 10% of chemicals used in fracking are known to be toxic to humans and/or aquatic life. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling. E. Ridlington, K Norman & R Richardson. (April 2016) – page 10.

As already highlighted in Section 10 - the NTN Report (page 9) has indicated that BTEX (Benzene, Toluene, Ethyl Benzene and Xylenes) chemicals were found in 5 of 14 monitoring wells in Arrow Energy's Queensland CSG fields. Toluene has also been found in a private water bore adjacent to a Queensland gas field. In 2010, the Queensland Government passed the *Natural Resources and Other Legislation Amendment Act 2010* which banned petroleum compounds containing BTEX chemicals, from coal seam gas (CSG) fracking operations. However, the NTN Report clearly indicates that a number of chemicals still used in fracking are extremely toxic and carcinogenic and are a risk to contamination of the aquifers of the Coastal Wide Bay region from the use of fracking fluids.

**AUTHOR'S NOTE:**

All producers of fresh food, or value-added food, are subject to the Australia and New Zealand Food Standards Code which clearly sets out the acceptable level of chemicals, contaminants and processing aids that can be present on food marketed in Australia.

Producers in the Wide Bay region would need to consider the market access issues that may arise if irrigation water contaminated with toxic chemicals (such as those listed above) were used in the region. Toluene, for example, is allowed in the Food Standards Code as a 'Processing Aid' but can only be present at 1 mg/kg. Heavy metals such as Mercury and Molybdenum are also listed in the Food Standards Code at very low levels.

Other chemicals used in fracking, such as Nonylphenol Ethoxylate, are not listed at all. This is potentially a very significant risk to the marketability of Wide Bay Burnett agricultural produce on the Australian and International markets.

## Water Quality Monitoring in Queensland

Given that the Queensland Government does not have any performance indicators or requirements for the monitoring of water quality in its ambient groundwater monitoring networks – its knowledge of what is happening to water quality or the impacts of either the conventional or unconventional gas industry on water quality in the aquifers associated with Unconventional gas operations is extremely limited. This matter has been raised in a number of submissions to the Queensland Government - but to date it has not been addressed.

**AUTHOR'S NOTE:**

To demonstrate the Queensland Government's long standing "lack of political will" in the monitoring and executing of compliance action in respect to Petroleum & Gas incidents – in May 2013 an oil well head burst within Santos' Zeus oil field in the Eromanga Basin. The well head flowed for 6 days before discovery and it had discharged around 240,000 litres of oil before it was contained.

The Queensland Government's Department of Environment & Science (DES) (formally the Department of Environment and Heritage Protection – DEHP) **decided not to prosecute Santos for what was the third biggest oil spill in Queensland's history.** Santos reported that the well did have a "blow out" protection device fitted, and the Company was investigating why it had failed. There are no reports on the outcome of Santos' investigation.

An irresponsible incident such as this, occurring in the Coastal Wide Bay region, could have long-term impacts not only for our land and water resources, but for the Great Barrier Reef as well.

The handling of this incident is a clear indication of the lack of resourcing or "strong political will" for the Queensland Government to undertake compliance monitoring or enforcement operations associated with the P&G industry in Queensland. By allowing Resources companies to self-monitor and report on incidents - it's clear that the Queensland Government's approach to compliance monitoring and enforcement with the Petroleum & Gas Industry is a case of "out of public sight - out of the political mind".

A review of the Department of Environment & Science's (DES's) (formally the DEH&P) Prosecutions Reports between 2011 & 2018, indicates that there were 53 successful prosecutions undertaken by

this Department during this period. Of these 53 prosecutions, only seven related to the Resources Industry – none were for breaches by an oil producer, one (1) was a CSG Company breach for non-compliance with its Environmental Authority, three (3) were for Mining Companies non-compliance with their Environmental Authorities and three (3) were for Underground Coal Gasification related activities with contaminated water.

## Queensland Government Monitoring Standards

In 2017, the DNRM&E was severely criticized in a Queensland Parliamentary Select Committee Report for its performance on the monitoring of air quality in Queensland's coal mines. The Report on an inquiry into the re-identification of Coal Workers' Pneumoconiosis in Queensland – titled ***Black Lung – White Lies***, was particularly scathing of the DNRM&E's actions and the subsequent spread of "Black Lung" disease in coal workers.

In response to this Report - the DNRM&E developed a *2017- 18 - Compliance Plan for Queensland's Mineral and Energy Resources.* A review of this Plan indicates that the Department planned to undertake 30 land access audits and 20 groundwater audits associated with the gas industry and 50 drilling operating plant compliance activities for the 2017/18 year. The Report on these activities is scheduled to be released in August 2018. This data further reinforces the lack of political appetite or will in Queensland, for rigorous monitoring and taking appropriate compliance action in respect to the Resources Industry, where accidents occur or non-compliant activities are detected.

With the lack of political will to actively monitor or take compliance action against the Resources sector in Queensland, it is anticipated that incidents with fracking are likely to equal or even exceed the incident rates experienced in the USA (outlined in Section 10).

## Lack of Scientifically Valid Independent Data

In the United States, the public has been exposed to a phenomenon known as "frackademia" – where Universities have undertaken scientific studies and issued "gas industry" friendly fracking reports in support of the unconventional gas industry. These studies and associated reports have been influenced by the P&G Industry and also used by the P&G Industry to influence the scientific debate around hydraulic fracking.

A review of more than 130 university studies by Robert Galbraith, Gin Armstrong and Kevin O'Connor found:

- 76% of the studies had some degree of ties with the P&G Industry. These ties varied from direct funding for projects to the reports being released by organisations or banks or consultants with direct ties to the P&G Industry.
- Only 14% of studies were peer reviewed. In some cases, studies falsely claimed that they were peer reviewed.

- In some cases, the P&G Industry and the regulators (State & Federal Government Bodies) had contracted the same consultants to conduct studies. Conflicts of Interest were not dealt with.

**The analysis by Galbraith et al also highlighted how different government and quasi government organisations have been influenced by the oil & gas industry. There is strong evidence that the same phenomena is being experienced in Australia as the P&G Industry attempts to influence the Regulatory Bodies and Political decision makers on the benefits & risks of the Unconventional gas industry expanding across Australia. There are also some ties between Universities and the P&G and mining Industry through the funding of research grants and there are a number of Queensland Universities who are receiving research grant funds from the Resources Industry. While the author is not questioning the integrity of the research work being undertaken – the community perceptions and optics of such associations are of some concern.**

**AUTHOR'S NOTE:**

There clearly are potential health risks, and agricultural market access risks, from the use of hydraulic fracking fluids to stimulate gas production from unconventional gas wells which the Queensland Government and the P&G Industry refuse to acknowledge.

We have seen similar behavior by the Australian Government and the Australian Department of Defence denying the contamination of a number of groundwater aquifers from poly-fluroalkyl substances (PFAS) firefighting foam. A number of communities across Australia, including Bundaberg, Oakey and Townsville, are experiencing the consequences of PFAS contamination of their water supplies.

The Coastal Wide Bay Burnett community needs to be fully aware of these risks and apply pressure on the decision makers to reject an expansion of the unconventional gas industry into the Region.

**Impacts of Methane on Air and Water Quality**

A review of data on methane gas impacts has indicated that emissions of methane gas into the atmosphere from gas well development, is a significant issue in the US. In 2014 it was estimated that the fracking of 137,743 gas wells emitted 2.36 billion kilograms of methane gas into the atmosphere. This is equivalent to the annual global emissions from 17 million passenger cars. (***Source:*** Environment America – Research & Policy Centre. Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – page 24).

While US studies have shown that methane levels in drinking water are higher in areas with a high density of unconventional gas wells, and methane levels in US water resources have increased over time, no data on methane gas impacts on the potential contamination of groundwater from unconventional gas development in Australia has been found as part of the development of this report.

# 12.0 Surface Water Contamination Risks due to Flooding and/or Fracking Wastewater Spills:

As outlined in Section 7.0, approximately a third of fracking fluid is retrieved as "flowback" water and is stored in either membrane lined ponds or above ground tanks, some potentially for reuse in further fracking operations.

**The US EPA reported that there were 457 spills of fracking fluids in 11 States between 2006 & 2012 (**an average of 1.3 – 12.2 spills/100 fracked wells). With the Queensland Government's lack of political will to effectively monitor and take compliance action against the resources sector it is anticipated that incidents with gas well failures and fracking fluid leakage are likely to equal or even exceed the incident rates experienced in the USA (***Source:*** Environment America – Research & Policy Centre - Fracking by the Numbers – The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – page 11**).**

In Ohio State in the US where there are no specific regulations governing the disposal of fracking wastewater, 63 incidents of water contamination from fracking waste have been attributed to in-proper construction or maintenance of fracking wastewater facilities. (Source: Fracking by the Numbers - The Damage to our Water, Land and Climate from a Decade of Dirty Drilling – page 12). In Queensland – CSG fracking waste is disposed into a lined waste disposal facility located just outside of Chinchilla.

Professor Anthony Ingraffea outlines, in an interview with Ellen Cantarow (May 2013), that shale gas production involves many gas pads and many wells/pad. He indicates that the highest risk to water resources is when the fracking chemicals are being stored on the surface and the flowback fluids are being stored. He suggests the "heavy industrialization" activity associated with shale gas development and production is the greatest threat to communities and the environment – activities such as well development, gas pipelines, the noise of compressor stations and gas venting and hydrocarbon emissions into the atmosphere are all contributors to these impacts. (***Source:*** Anthony R Ingraffa. Dwight C Baum Professor of Engineering, Cornell University. 2014 – Interview by Ellen Cantarow – May 2013).

Given that the potential water use for fracking of shale gas wells in the Maryborough Basin could be in the order of 26,700 Megalitres for a single hydraulic fracking of 100 shale gas pads, it is conceivable that the volume of "flowback" water needed to be stored may be in the order of 8,900 Megalitres of extremely toxic fluid. There are likely to be multiple locations for the storage of "flowback" water throughout the Coastal Wide Bay region.

The risks of this volume of toxic fluid escaping either from constructed ponds or storage tanks, and contaminating the local environment are real – particularly given the lack of political will for an effective compliance monitoring and enforcement presence by the Queensland Government.

Potential contamination could occur through the following incidents:

- Use of contaminated “flowback” water for dust suppression around drill pads and on access tracks will result in contamination of adjacent areas and cause market access issues for neighbouring crops. This has occurred on a number of occasions in the USA.
- Failure to utilise impregnable liners in the construction of “flowback” water ponds or puncturing of the pond liners will result in leaching into the adjacent soils. This has occurred on a number of occasions in the USA.
- Depending on the construction specifications and the landscape location of contaminated waste ponds – surcharging of these ponds from extreme rainfall events (cyclones or torrential rain) or overland flooding in low relief areas will result in the spread of contaminants. This has occurred with the escape of toxic metals from the evaporation dams in the Surat Basin CSG gas fields as well as a tailings dam of the abandoned Lady Annie mine in the headwaters of the Georgina River and a tailings dam associated with the Palmer River goldfields.
- Leakage from above surface tanks caused by insufficient maintenance or accidents will also result in the spread of contaminants.

The probability and severity of potential contamination will be dependent on the location of wells and “flowback” storage facilities in the landscape of the Maryborough Basin catchments. Given the high density agricultural land use in the Coastal Wide Bay, it would be difficult to position storage ponds without posing a risk to neighbouring crops/water storages as well as associated drainage lines and watercourses.

If the unconventional gas well heads and storage facilities are located on the higher relief areas in the Maryborough Basin, the risk of overtopping of “flowback” storage ponds from flooding is less. However, if the “flowback” water storages are located on the low relief areas, there is an increased risk of overland flows and floodwaters surcharging into them and releasing contaminants into the floodwaters.

An analysis of Bureau of Meteorology (BOM) records on the more recent occurrence of extreme rainfall events and floods in the Maryborough Basin indicates the following “Flooding Potential” for the Kolan, Burnett and Burrum Rivers.

***Kolan River:***

- While the Fred Haigh Dam has a significant effect on reducing flooding in the lower reaches of the Kolan River – record major flooding was recorded in the Kolan River in January, 2013. Major flooding was also recorded along the Kolan River in March/April and October, 2017. Average catchment rainfalls of > 200mm in 24 hours may result in stream rises and the possibility of moderate to major flooding in the lower reaches of the Kolan River. Average catchment rainfalls of > 300mm in 24 hours may result in significant stream rises and the possibility of major flooding in the lower reaches of the Kolan River.

***Burnett River:***

- Major flooding in the Burnett River is relatively infrequent. However a tropical low pressure system can result in heavy rainfalls and significant river level rises and floods. Major floods have been recorded at Bundaberg in 1875, 1890, 1893 (2 floods in 2 weeks), 1928, 1942,

1954, 2010 and 2013. Average catchment rainfalls of > 200mm in 48 hours may result in stream rises and moderate to major flooding in the middle and lower reaches of the Burnett River. Average catchment rainfalls of > 300mm in 48 hours may result in significant stream rises and the possibility of major flooding in the middle and lower reaches of the Burnett River.

***Burrum River:***

- The highest flood recorded in the Burrum River was 13.40m in 1955. The Pacific Haven Estate is susceptible to flooding and backwater flooding from extreme tides and tidal surges. Average catchment rainfalls of >200mm in 24 hours may cause moderate to major flooding and average catchment rainfalls of > 300mm in 24 hours may cause serious flooding. Source – Australian Government – Bureau of Meteorology Website publication – Flood Warning Systems for the Kolan, Burnett & Burrum River Catchments.

While historical data on the occurrence of tropical low pressure systems in the Coastal Wide Bay Burnett Region is not available, the above assessment of flooding potential in the Kolan, Burnett and Burrum Rivers from extreme rainfall events indicates the risks of contaminated waste ponds – surcharging from extreme rainfall events (cyclones or torrential rain) or overland flooding in low relief areas.

In Queensland, the P&G Industry are required to treat wastewater and "flowback" water through a reverse osmosis treatment process before it is used for beneficial use purposes or discharged under a licence. However, it is understood that many of the toxins associated with unconventional gas fracking fluid cannot be fully removed through a reverse osmosis treatment process. Hence there is a possibility that the Queensland Government might resort to the lowest common denominator and allow for "flowback" water to evaporate from ponds – as occurs in South Australia, or allow for the injection of "flowback" water into the deeper geological strata of the Maryborough Basin such as the Duckinwilla Formation. The Queensland and Australian Governments are currently encouraging the trialing of deep injection of CO2 into the Precipice Sandstone aquifer of the Great Artesian Basin and have already allowed the injection of treated CSG water into GAB aquifers – so a precedent already exists in Queensland for these types of actions

These are significant matters which the Queensland Government must address before it issues any unconventional shale gas production leases for the establishment of a gas industry in the Coastal Wide Bay Burnett Region.

# 13.0 Soil Contamination Due to Wastewater Spills:

As outlined in Section 10.0, the incidence of spills of wastewater in the USA's unconventional gas industry ranges from 1.3 – 12.2 spills/100 wells. There is no reason why the Australian occurrence of wastewater spills is any less and it might even be higher, due to the absence of a robust compliance monitoring and compliance action program by the Queensland Government.

Given that the number of unconventional shale gas wells that may be drilled in the Maryborough Basin is still to be known, we are unable to make a prediction of the number of wastewater spills that may occur during drilling and fracking operations.

The severity and consequences of shale gas wastewater spills is dependent on the volume of wastewater spilt and its landscape location in the natural catchments of the Maryborough Basin. If a spill occurs on the higher relief lands (ridge areas), it has a high probability of being leached through the lighter textured or porous soil profiles and contaminating a larger area of soil. If a spill occurs on the lower relief country, there is a probability of less land being contaminated – providing that overland flows or flooding doesn't occur over the contaminated area before it is remediated.

**Additionally – as mentioned in Section 12 - there is a risk of contaminated toxic wastewater spills being discharged into the major watercourses of the Coastal Wide Bay Burnett Region and finding their way into the Great Sandy Marine Park and onto the Great Barrier Reef.**

**AUTHOR'S NOTE:**

The issue of soil and water contamination from wastewater spills containing toxic fracking fluids is a significant matter which the Queensland Government must consider in the non-renewal of parts of the current ATPs held by Blue Energy, as well as the sterilization of those areas outside of these ATPs from further petroleum & gas and mineral exploration.

The risks of the Coastal Wide Bay Burnett Region losing its "clean and green" reputation from chemical contamination by toxic wastewater spills by the petroleum & gas industry are not acceptable to the agricultural industries of the region.

Tom Crothers,
Director - Stellar Advisory Services.
30th August, 2018.

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# Appendix A:

## Provisions of the Petroleum & Gas (Production & Safety) Act 2004 which deal with the renewal of ATPs.

Section 65A of the Act outlines that if an ATP holder does not comply with a relinquishment condition, and is given a notice to comply and still does not comply, the ATP is automatically cancelled.

Section 80 of the Act outlines if an ATP holder does not comply with the lodging of a later work program (for exploration) – under Section 79 (5) (a) the ATP holder must be given a notice to lodge a later work program. If the ATP holder does not comply with this notice – the ATP is cancelled.

The Act outlines (Sections 42 & 85) that the term of a renewal cannot be for more than 12 years, the area of a renewed ATP must not be more than the area of the ATP immediately before the renewal and that the first relinquishment date for a renewed ATP must not be more than 4 years from the date of renewal.

The Act (Section 87) outlines that on refusal of an application for renewal of an ATP – the applicant must be given an information notice about the decision to refuse. The Act also outlines that a refusal of an application to renew does not take effect until the end of the appeal period (Section 88). Furthermore – the Act's Section 818 states that an application for an Internal Review of a decision must be made within 20 business days of the information notice being issued, and Section 824 outlines that an appeal to an Internal Reviewer's decision must be made within 20 business days of the reviewer's decision being issued.

Chapter 12 of the Petroleum & Gas (Production & Safety) Act outlines the Review and Appeal rights as well as processes for decisions, made under the Act.

The Act (Section 817) outlines that a person who has been given an information notice about a decision, may apply for an internal review of the decision. Applications for an Internal Review may only be made:

- If the original decision to which the Internal Review decision application relates to – was made by the Minister or the Chief Executive.

The Act also outlines that a person who is given an information notice about an Internal Review decision on a seizure or forfeiture of a thing (for examples sub-blocks in an ATP), may appeal to the District Court (Sections 824 & 825). Under Section 828 of the Act - the Court may:

- Confirm the Internal Reviewer's decision.
- Set aside the Internal reviewer's decision and substitute another decision, or
- Set aside the original decision and return the issue to the original decision maker with appropriate directions for a new decision.

Furthermore – the Act (Section 830) outlines that an appeal to a District Court decision may be made to the Court of Appeal, and only be made on a "question of law" – not the subject matter or the merits of the initial appeal.

# Appendix B:

## *Extent of Seawater Intrusion in the Upper Elliott Aquifer:*

***Elliott Heads Area:***

Electrical Conductivity's (levels of salinity) in excess of 2,500 µS/cm are restricted to within 500 m of the tidal water bodies. Salt concentrations from seawater intrusion would be expected to decrease with rainfall events. Electrical Conductivities generally increased in 1997 & 1998 but have remained relatively constant since. Monitoring Bores 13700156A, 13700157A, 13700177A and 13700178A demonstrate a sharp transition from low to high conductivity with depth, indicating a density contrast flow regime, classical 'salt water wedge'.

***Bargara Area:***

Electrical Conductivities in excess of 2,500 µS/cm extend to approximately 2 km from the coast. The maximum Electrical Conductivity's are only about 4,000 µS/cm, which is still well in excess of the upper limit of 2,500 µS /cm acceptable for human drinking water. Electrical Conductivity's have remained relatively constant over the monitoring period.

***Kalkie Area:***

Electrical Conductivities in excess of 2,500 µS/cm extend up to 5 km from the Burnett River. The maximum salinity levels are in the range 12,000 µS/cm and have remained relatively constant with the exception of bore 13600216B which doubled in salinity between 1997 & 1998 (an extremely dry period) and has remained in the range of 12,000 µS/cm since. Given the interpreted salinity conditions in areas surrounding Kalkie, the probability of saline intrusion from either the Burnett River or the ocean would appear to be relatively low. Upward leakage of saline intrusion from the Fairymead Beds to the Elliott Formation has been identified as a probable source of salinity. The thinning and absence of the Gooburrum Clay aquitard between the upper and lower aquifers identified in the Kalkie area supports this interpretation.

***Burnett Heads Area:***

Significant seawater intrusion occurred throughout the Burnett Heads area in the 1960's (QG IWSC, Symonds, 1967). The introduction of surface water to the area in 1970 (Bundaberg Water Supply Scheme) was designed to reduce groundwater demand.

The impacts of reduced groundwater pumping and the introduction of surface water were not monitored. Bores in the northern part of the Bargara area were assumed to be monitoring the salt face from the Burnett Heads area. However, analysis of data indicates that the salt is probably of terrestrial origin. Hence, there is no detailed data on which to base an interpretation of seawater intrusion processes in this area.

***Bundaberg Area:***
Electrical Conductivities in excess of 2,500 µS/cm generally extend to only 500 m from the Burnett River. Maximum salinity levels are in the range 4,000 to 8,000 µS/cm and have remained relatively constant over the monitoring period. There is no well-defined relationship between aquifer water levels and conductivity values. There seems to be preferential flow paths from the river causing seawater intrusion. The conductivity profiles often indicate a salt content which is consistently mixed throughout the profile, as opposed to a classical salt wedge.

***Bundaberg North Area:***
Electrical Conductivities in excess of 2,500 µS/cm extend up to 1 km from the Burnett River. Salinity levels have remained relatively constant during the monitoring period, although decreases in salinity levels in response to recharge are apparent. Chemical analysis of water indicates that 80% of salinity is Na-Cl related.

***Fairymead Area:***
Electrical Conductivities in excess of 2,500 µS/cm extend up to 3.5 km from the nearest saltwater sources. Chemical analysis of water samples in the area indicate that 70% to 80% of salinity is Na-Cl related. Salinity levels have remained relatively constant over the monitoring period although decreases in salinity levels in response to recharge events are apparent. The salinity levels increase with depth.

***Moore Park Area:***
Electrical Conductivities in excess of 2,500 µS/cm extend up to 2 km from the coast. Maximum salinities do not generally exceed 7,000 µS/cm. The salinity levels increase with depth.

## *Changes in the Extent of Seawater Intrusion in the Lower Fairymead Aquifer:*

**The major cause of saltwater intrusion is the direct flow of seawater into the lower aquifer. Salinity monitoring bores show that at some locations the salinity concentrations have improved (e.g. the area near Elliott Heads) for the depth-averaged 2,500 µS/cm conductivity contour, for the years 1996, 2000 and 2003.**