

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

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Executive summary

This submission to the *Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*, **is written in full support of a safe and economic beneficial onshore Shale Gas Industry for the Northern Territory**, and seeks to provide:

- clarity on some of the key differences and similarities between ‘Conventional Gas’, ‘Unconventional Coal Seam Gas (CSG)’ and ‘Unconventional Shale Gas’ with regard to the drilling and casing of an O&G well, and to also point out where these activities are identical in nature, yet they don’t seem to raise the same types of issues and levels of concern by the anti-fracking antagonist groups;
- detailed technical explanations on the Oil Country Tubular Goods (OCTG) or in layman’s language, ‘Casing & Tubing’ used in all O&G wells for the well integrity;
- a sense of historical time line for some of the technologies employed for directional/horizontal drilling and hydraulic fracturing to stimulate an O&G well;
- counterargument to some of the more common myths and misinformation arguments, which are regularly made by anti-fracking antagonist groups to the public;
- some feedback on the actual financial, social and human mental health impacts, that the moratorium has caused to local O&G service company SME’s and their skilled workers;

New issues to consider for the ‘Background and Issues Paper’ are:

- Concern on the anti-fracking antagonist groups targeting and preying upon vulnerable groups, such as the remote indigenous communities and remote pastoralists, who may have limited knowledge of the industry and the science involved and be easily misled or influenced by misinformation intended to instil heightened fear and anxiety, so that these people can be easily used as pawns to participate in push-polling, marches or rallies.
- Closure of local SME businesses or business scale-backs brought on by the moratorium, especially where they specialised in service and supply to the O&G industry, and had unique capabilities essential for the safe and effective support the O&G operations in NT.
- Health and wellbeing of the skilled workers who worked in the O&G industry and whose incomes and livelihood were affected by the moratorium.
- The failure by NTG to recognise how the sudden retrenchment of these skilled workers without any form of support to reskill or find new suitable employment, and to mitigate any financial stress during the period of the moratorium, has caused financial stress and mental health issues, especially where the worker was the prime income earner for their family, with school aged children, caring for elderly, a mortgage and/or loans to service.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

- Too many unrelated industries and their associated risks are being wrongfully referenced into this enquiry by anti-fracking antagonist groups. Risks being discussed should only be relevant to Unconventional Shale Gas in the geological context of NT, and all references to other unrelated industries and/or resource extraction methods and their associated risks should be disallowed from forming any part of this enquiry, this includes but is not limited to references to: USA shallow wet Shale Gas, Coal Seam Gas (CSG), mineral mining (underground or open-pit), asbestos, PFOA & PFOS chemicals in firefighting foam, uranium, mangrove die-off, coral bleaching, cigarette smoking in banned locations, etc.

I would hope the outcome of the enquiry would lead towards:

- creating a fact based understanding of the onshore Shale Gas industry in NT, based on its actual risks (not falsely perceived ones), and how these are able to be effectively managed;
- having the moratorium lifted as soon as is practicable;
- for the NTG to be fully and actively committed to develop and implement a sufficiently robust, but fair and reasonable regulatory framework in consultation with the industry, for the industry to operate safely (not unduly onerous);
- for the NTG to have this regulatory framework in place in a timely manner;
- for the NTG to work constructively with the O&G Industry in the development and implementation of any new or enhanced regulations to minimise red tape and hurdles;
- for the NTG to also recognise that as a result of the moratorium, that there has been significant harm done to locally based SME O&G service companies, and the livelihoods of their local skilled employees, which were vital for the industry to be able to function effectively, efficiently and safely, and that it also recognises the need to redress the severe impact that the moratorium has had on the local SME service and supply companies, their capabilities and skilled jobs, by considering what it can do to play a part in restoring these services back to a similar capability to what was in place prior to the moratorium; and
- that the NTG plays a significant role in ensuring the public is not being unduly ill-informed by anti-fracking antagonist groups, in the form of any ongoing myths and misinformation which are contrary to the fact findings of this enquiry.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

In this submission, I wish to speak on behalf of *myself* and on behalf of *Oilfield Connect Pty Ltd*, my own local Territorian O&G Service & Supply company (specialising only in upstream O&G Industry), ... and if permitted, I'd like to be a voice on behalf of other similarly affected skilled Territorian workers from the O&G Industry, especially for my past co-workers / employees who have also lost their livelihoods (some still unemployed to date), and other similarly effected local SME businesses, which have been significantly impacted or forced to close down permanently as a result of the impact the moratorium, which imposed restrictions on the key activities of the prime O&G Industry operators (where they have over the last year expressed their utter contempt towards the anti-fracking antagonist groups, the moratorium and the impact it has had on them).

My core technical strengths lay in 'Oil Country Tubular Goods' (OCTG), which is the standard industry acronym for all tubulars used in a typical O&G well bore, including all 'Casing' & 'Tubing' and their 'associated accessories', which are the key components required for well maintaining well integrity.

I have 35 years of industry experience and have worked in roles ranging from working hands-on as a skilled tradesman, to the management of a leading multinational OCTG facility, performing manufacture, repair, modification, inspection and recertification of a wide range of OCTG and other specialised equipment's which are used in the upstream O&G industry.

My industry experience has exposed me to working with many different disciplines of engineers working for the three tiers of industry, being the O&G operators (geologists, well design, drilling, completions, well control, abandonment, etc.), and the drilling companies both onshore & offshore (1-3 Stand Land Rigs, Jack-Up, Semi-Submersibles, Drill Ships, etc.), and the many specialised O&G service companies (Weatherford, Halliburton, Schlumberger, Baker, FMC, Cameron, Dril-Quip, GE Oil & Gas, Expro Group, etc.)

During my career I have learned in great technical detail, many of the various specialised equipment's typically used in the upstream O&G industry to drill, case, complete, tie-back and to later Plug and Abandon (P&A) a typical O&G well in all manner of applications, including the onshore hydraulically fractured Shale Gas wells, often with access to proprietary technical drawings, specification and procedures, under strict Non-Disclosure Agreements (NDA's).

I have listened to many anti-fracking antagonist groups who freely speak out about various aspects of the O&G industry, often in a capacity of 'self-appointed public educators', but they do so with very limited industry knowledge or experience.

At times I have been seriously shocked by the level of inaccuracy in their statements, and to me this raises serious alarm bells, as they are trying to act as educators to an understandably curious or concerned public, who themselves don't possess industry knowledge, so there is huge scope for unfiltered misinformation to run rampant throughout the community, causing highly emotive, but factually baseless anxiety and fear.

In my opinion this highly emotive anxiety and fear, which has been instilled into the community by the anti-fracking antagonist groups themselves, is in itself an issue of serious concern, with high potential to cause Mental Health Issues, where there should otherwise be none.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Whilst I will touch on the OCTG in some greater detail in this submission, I would like to offer my services to assist the enquiry panel, in the sourcing of technical information pertaining to OCTG, should they need any assistance in this technical field.

In this submission I will also outline some of the real and current impact of financial stress and human mental health and wellbeing on those parties who are negatively affected by the economic impact caused by the NT moratorium, as opposed to the rather perceived ones, which the anti-fracking antagonist groups are claiming may possibly occur, and which has also appeared as a topic in the 'Background and issues paper'.

The following details in this submission are my understanding of the technologies employed by the O&G industry, their risks and benefits, and my counter argument to some issues that have been raised already by the anti-fracking antagonist groups.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Contents

Executive summary	1
Glossary.....	7
Experience and Qualification	10
Risks and Risk Management	11
Oil Country Tubular Goods (OCTG).....	13
Conventional versus Unconventional Wells	19
Drilling Through Aquifers	22
Cementing Casing to the formation.....	23
Evolution of Steerable Drilling for Horizontal Wells	24
Perforation of Casing	27
Hydraulic Stimulation.....	28
Production completion tubing.....	28
Surface Wellheads	30
Hazchem and flow-back.....	30
Summary of Conventional versus Unconventional Wells.....	31
The real impact of the Moratorium	32
Demise of a 32 year, local based O&G Service Company	32
Impact on local support Service Companies.....	33
Local Petroleum Engineering student, unable to graduate	34
Rural civil contractors lost contracts.....	35
Indigenous skilled workers from community	35
Loss of Livelihood for the older workers.....	36
Impact on local Industrial Landlords.....	37
Summary of The real impact of the Moratorium.....	37
Measuring Social License	38
Regulation versus specifications	39
Don't Frack the Territory - fact sheets & pamphlets	40
Issues of Trust	41
Concerns raised on adverse health issues by fracking.....	42
Concerns raised about potential legacy wells	43
Concerns raised by the Tourism Industry	44
Methane versus Carbon as a greenhouse gas	44

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Cattle Industry right of Veto	45
Influence and impartiality of Ministers.....	46
Economist to look at industry wholistically	47
National Gas shortage or plenty	48
Declared conflicts of interest:.....	50

Glossary

OCTG (Oil Country Tubular Goods) - the standard industry acronym for all tubulars used for well integrity in a typical O&G well bore, including 'Casing' & 'Tubing' and their accessories.

Large Conductor or Surface Casing - the OCTG tubular casing used to construct the initial barrier between the upper well bore, through the formation adjacent to surface aquifers, and down past the aquifers to prevent any communication between the aquifer and next hole section ... typically sizes range from 36" – 16".

Casing – the OCTG tubular used to construct a barrier between the well bore and the formation, and is often nested in multiple layers, which can increase in numbers as the well gets deeper ... typically sizes range from 20" – 4 ½".

Tubing - the OCTG tubular used to transfer the oil/gas/condensate resource from the completion assembly area at the bottom of the well, up to the wellhead at the surface, and it is separate from the Casing, and can be retrieved and replaced in a process known as "work-over" ... typically sizes range from 5 ½" to 1.900", but in some cases, based on 'purpose' larger sizes up to 9 5/8" Casing can be used as the production Tubing in very high flow Gas wells.

Completion Assembly – A collection of high-tech specialised interconnecting tools and equipment which isolate the perforated section of casing from the rest of the casing string using Packers, thus preventing any flow-back coming in contact with the internal casing, and it is connected to the base of the production OCTG Tubing string, which is the only pathway to the surface.

Packer – high-tech specialised tools, used in completion assemblies, with the ability to be lowered into a specific location in the well, and then be controlled from surface to activate mechanical position lock and to seal of the well internally of the OCTG Casing, creating a barrier.

Upstream, Midstream & Downstream - Typically the O&G industry is broken up into three sectors:

Upstream O&G industry –Upstream would refer to the exploration, drilling, completion, production & finally P&A (Plug & Abandonment).

Midstream O&G industry would refer to transportation of the resource from the source location to a processing facility, includes pipelines, trucks, ships, etc.

Downstream O&G industry refers to processing facilities all the way to finished products and retail outlets like refineries, petrol stations, fuel & oil depots, etc.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Plug & Abandonment (P&A) – usually a well is abandoned when it reaches the end of its useful life or after drilling is found to have no resources, a dry hole. The OCTG Tubing and completion assembly is removed and salvaged. Cement plugs are placed in the borehole to prevent migration of fluids between the different formations. The surface is environmentally restored.

BHA - (bottom Hole Assembly) refers to the lower section of the drill string, from the point the drill pipe meets the Hevi-Wate Drill Pipe or Drill Collars, all the way down to the drill bit.

TCP Gun - (Tubing Conveyed Perforating Gun) a cylindrical tool, loaded with explosive charges and projectiles in a spiral pattern, lowered into a fully cased and cemented well to the location intersecting the reservoir, and used to puncture through the Casing and the external cement and some distance into the formation of the reservoir to create pathways from the reservoir into the well bore. This is typical of all types of O&G wells including conventional and unconventional / offshore and onshore / vertical, deviated and horizontal, so not a new practice.

Annulus – the empty space between the inside of the Casing and the outside of the production Tubing. This area can be checked or monitored for any loss of well integrity from the Tubing into the Annulus, giving ample time to perform a standard ‘work-over’ to retrieve and replace the production Tubing long before there is a risk of fugitive emissions through the concentric Casing and cement layers .

Shoe Track Assemblies – This is an assembly made up of Casing and special accessories and are run at the very bottom of the Casing string. The special accessories include a Float Collar and a Float Shoe, and there are centralisers attached externally to ensure

Float Collar – a special accessory made of OCTG grade steel cylinder, a Pin and Box thread on each end, has a one-way poppet valve mounted internally which is cemented in place.

Float Shoe – a special accessory made of OCTG grade steel cylinder, Box thread on one end, has a one-way poppet valve mounted internally which is cemented in place and the cement is moulded into a bullnose on the blank end.

Centraliser – an externally mounted array of spring-loaded bows which aid in centralising the Casing to the formation for even cementing.

O&G operator – where more than one O&G company are in partnership, one of the partners will be the one responsible for the operations, and thus termed the ‘O&G operator’, this is still used even if the O&G company is not in a partnership with others.

Conventional– Simply refers to the most common and historical extraction methods and targets, which are predominantly targeted at the migrated oil and gas resources in reservoirs trapped in ‘Anticlinal Traps’ created by and impermeable ‘Cap Rock’ layer typically located above a ‘Source Rock’ layer, such as Shale.

Unconventional – Refers to the most common and historical extraction methods and targets, which are predominantly oil and gas resources trapped *inside* Shale (internal with low permeability) or *onto* Coal (externally trapped by aquifer pressure), known as the ‘source rock’ layer, which can also be found in ‘tight sands’. Each of these source types presents significantly different challenges and

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

therefore different associated risks. The Coal may or may not require re-fracturing, whereas Shale will always require fracturing. Coal will need to be de-watered (suck out the aquifer into large surface storage ponds), whereas Shale will typically be devoid of any local aquifers.

SME – Small and Medium Enterprise

OEM – Original Equipment Manufacturer

Make-up (or Buck-on) – The term used for tightening two sections of OCTG together, using a Torque Turn Machine.

Break-out (or Buck-off) – the term used for undoing any OCTG , using a Torque Turn Machine.

Torque Turn Machine (or Make-up / Break-out / Bucking unit) – A workshop based machine used to Make-up or Break-out any OCTG equipment. These machines must be calibrated periodically and produce graphs which record the torque versus rotation for acceptance criteria.

Iron Roughneck – a machine located on the drill rig floor, designed to make-up the crill string or casing or tubing as it enters the well in a vertical position.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Experience and Qualification

My working life started out as an apprentice in 1982 and later became a qualified tradesman 'Fitter & Turner', where my indentured employer was involved in the manufacture, service, repair, modification, rental and inspection of a wide range of down-hole drilling, casing & tubing for the upstream O&G industry.

During this time I was heavily involved in all kinds of hands-on activities as a skilled tradesman, applying the many types of unique skills, to the many different types of specialised equipment's used in O&G wells, such as:

- EMI (Electro-magnetic Inspection) of drill pipe and OCTG tubing;
- Magnetic Particle Inspection (MPI) & Ultrasonic Inspection (UT) & Liquid Penetrant Inspection (LPI) inspection, and of course full mechanical dimensional inspection, for bottom Hole Assembly (BHA) accessories and OCTG casing & tubing
- inspection/preservation of OCTG casing & tubing;
- manufacture/repairs of new BHA accessories;
- manufacture/repairs of near-bit & string stabilisers;
- service/repair/modification of drilling jars;
- service/repair/modification of coring tools;
- service/repair/modification of directional steering subs;
- service/repair/modification of drilling motors;
- rethreading of casing/tubing/drill pipe/drill collars/etc.;
- manufacture/repair many types of down-hole fishing tools;
- manufacture of API 6A flanges for O&G wellheads; and
- manufacture/repair of many more upstream related products.

As a qualified tradesman 'Fitter & Turner' I was extensively trained in the operation of a very wide range of specialised workshop machinery, such as: conventional lathes; Oil-Country lathes; CNC lathes; vertical & horizontal milling; CNC machine-centres; shapers; slotters; drill-press; hydraulic press; Electric Arc/MIG/Sub-Arc welders; brazing; etc.), which are used for the manufacture, repair and modification of highly specialised equipment's used for drilling, casing and completion of an O&G well.

In order to be able to manufacture or repair any high-tech equipment to be used in the O&G industry, it is necessary to be properly trained and to have access to the relevant detailed technical documentation. Throughout my career I acquired an extensive understanding of the detailed technical aspects and the functional purpose of most of these O&G equipment's and the associated industry standards and/or proprietary specifications.

My career experience has exposed me to both onshore and offshore O&G wells, for both conventional & unconventional O&G wells, including vertical, deviated or horizontal O&G wells, including CSG and Shale Gas wells and covers almost all of the upstream products which are covered under API 7-1/7-2 (BHA); API 5DP (drill pipe); API 5CT & API 5B (casing & tubing); API 6A (surface wellhead & flanges); API 1104 (welding of pipelines) & their supporting sub specifications.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

I also worked overseas for about a decade in Malaysia, Singapore & Vietnam setting up new or enhancing existing O&G manufacturing and repair facilities, during which time I was the technical lead for all requirements necessary to manufacture a host of complex proprietary O&G equipment's, which were manufactured under license or JV (Joint Venture), such as:

- Solid-Block x-mas trees, wellheads (National Oilwell);
- PDC Bits (DBS);
- Gas Lift Valves (McMurray);
- Packers for completion assemblies (SLB under license to OEM).
- TCP Guns for perforations (SLB under license to OEM).
- Casing Spools, Tubing Hangers, Solid-Block x-mas trees, studded cross, gate valves, tree caps, etc. (Ingram Cactus).

My most recent position was here in NT, as the manager of a local based OCTG service and repair facility, which I managed from Feb 2004 to July 2017. The facility was primarily focused on the drill string, casing, tubing & completion assemblies, where it boasted the greatest range of premium OCTG thread licenses in Australia and it supported onshore and offshore O&G operators, however with the facility now closed, there are now significant capability gaps in the Northern Territory.

My 35 years of industry experience and my deep understanding and knowledge of the many upstream O&G technologies associated with OCTG and well integrity, and the rigorous industry compliance standards and the track record of the O&G industry, leads me to believe that there is very little to fear about O&G well bore integrity, and much economic benefit to gain from the Natural Gas resource in NT.

Risks and Risk Management

Firstly I would like to address the *use* or *abuse* of the word 'Risk' as it has been used in the fracking debate, and what it means to me, as this word has been used repeatedly as a pillar argument by the anti-fracking antagonist groups to justify either a moratorium or a permanent ban.

Much has been said by the anti-fracking antagonist groups about their view of the '*potential risks*', and then they always go on to simply say that just because there may be some '*potential risks*', then the only option is to not allow any activity to proceed, and so they then call for a blanket ban on the entire industry, which is driven more by ideology than any science or logic.

If we took this same ultra-simplistic approach towards managing any industrial risks for all other known technologies, we could easily draw attention to the '*potential risks*' associated with almost any activity man does, including: driving vehicles; shipping; air travel; riding a bike; electronic devices; microwave ovens; television; sport; etc. ... even the 'renewable energy technologies' themselves could be banned using this same narrow approach to the management of '*potential risks*', as renewables infrastructure also have many '*potential risks*' which also need to be managed.

The 'Background and Issues Paper' (page 13), was good in providing some basic information on how modern professional industries go about 'risk management', however it only showed the primary tool used for assessing an 'identified potential risk', using a '*risk matrix*' with '*impact*' on one axis and '*likelihood*' on the other axis, to determine the perceived risk level.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

However the full 'risk management' process doesn't begin or end with just this 'risk matrix', in fact the 'risk matrix' is just a small tool in the toolbox for the overall 'risk management' process.

Typically all O&G operators will have a highly developed ISO compliant Quality Management System (QMS), which must include formal 'risk management' policies and procedures, with structured processes to identify, classify, rate and manage any of the identified risks.

There is usually a custom designed 'risk management register' which is used to consolidate all the identified risks for that company activities, detailing the specific risks and recording the inputs from the 'risk matrix' tool, and then comes the most important part ... where the 'risk matrix' tool has identified an adverse level of risk, a solution is then required to mitigate or eliminate that risk element.

Usually when a risk has been identified as unacceptable by the 'risk management' process, these will become highlighted to the key stakeholders in Quality, Health, Safety, Security and Environment (QHSS&E) and the company senior management team, and they will form key topics on a separate 'risk management' meeting agenda, to initiate the secondary processes of delegation of micro managing these risks to the various internal and external resources, so that they can identify suitable options or solutions to mitigate and/or eliminate the unacceptable risks.

This usually triggers the inventiveness and ingenuity of very skilled people, who in some cases come up with new and innovative ways to engineer out a risk entirely, and in other cases at least reduce them down to an acceptable level of risk, with suitable remedial action plans to cater for any unintended events.

Either way, once an acceptable solution has been identified and adopted, the next step is to implement these changes via another formal process known as 'change management', which not only implements the solution, but fully encompasses the wholistic process of removing all aspects of the unacceptable risk and its associated documentation, by a process of obsolescence, and develops the necessary new Standard Operating Procedures (SOP) for the new solution to be implemented and disseminates the necessary SOP details to all the key stake holders through training and formal notification.

'Risk management' is not a once off event, it is a continual and live process, so new risks can be identified at any time, and be put through the 'risk management' process, added to the 'risk management register' and implemented with 'change management', on an ongoing basis, and is typically reviewed by multiple audits, including: internal audit; external audit by HQ for groups or corporates; external audits by ISO compliance auditors; external audits by 'work safe' in the event of an incident; external audits by customers /vendors, etc.

This is generally how formal 'risk management' works in the real world of all modern high technology industries, so to summarise ... simply finding and identifying of 'potential risks' is not a bad thing at all, it is a very important first step in the overall formal 'risk management' process itself, so it should not be used in a narrow simplistic view that if any 'potential risks' was identified, the next step would be to outright ban that activity, with the narrow simplistic view that, any activity is only permissible if it is totally 'risk free', which in itself is a false concept.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Oil Country Tubular Goods (OCTG)

As mentioned in the executive summary, OCTG is the standard O&G industry acronym for all 'Oil Country Tubular Goods' or in layman's language, it's the '*Casing & Tubing and their associated Accessories*', which must comply to the comprehensive international industry standard of API 5CT & API 5B and their supporting standards.

In the O&G industry, the OCTG and accessories are classed as critical components for the well bore integrity and are strictly controlled by a comprehensive set of specifications and procedures which cover all aspects, from cradle (steel mill) to grave (installed in the well) and all OCTG manufacture and repair facilities must undergo strict licensing and qualification and be subjected to ongoing external audits to be able to manufacture and/or repair OCTG accessories.

Notably, there are some anti-fracking antagonist groups who, despite having no actual O&G industry experience or understanding of what is actually involved in OCTG, will still lay claim to many stories of O&G well bore failures, even comparing the OCTG to unrelated stories of rusty leaking water bore casing failures, which rural property, agriculturalists and pastoralists may easily relate to.

However the Australian standard for steel casing used in 'water bores' is only minimum Grade 350 line pipe (mild steel), which also has a much thinner wall thickness than OCTG casing and it's only run in a single layer and it's often not cemented to the formation at all (<https://aditc.com.au/wp-content/uploads/2014/06/Minimum-Construction-Req-Ed-3-2.8MB.pdf> Page 63/146, Mandatory Requirements, 9.2. & 9.3.).

Whereas in all O&G wells, the OCTG casing is made of special high-alloy grades, which are strictly controlled by an international industry standard of API 5CT and API 5B, the wells will typically have 3 to 5 concentric layers of much thicker high-alloy steel OCTG casing, each layer is individually cemented externally to bond with the formation, using a specialised cement formulae, and each layer individually pressure tested for well integrity, before drilling the next well section.

OCTG can be broken down into three major size/purpose categories, Conductor or Surface Casing (16" – 36"), Intermediate/Production Casing (20" – 4 ½"), Production Tubing (4 ½" – 1.900"), and can include some special accessories, like Completion Assemblies, Shoe Track Assemblies, Liner Hangers, Space-out Joints, Transition Subs and many other types of special accessories which make up the final production assembly of an O&G well.

The international industry standard of API 5CT and its supporting standards, detail the approved specifications of all the chemical and mechanical properties of the OCTG, the conformance standards including how those must be measured and the frequency of inspection, and only those steel mills with the required capability and which can pass the strict periodical external audits by API auditors and hold an active API 5CT certification, are able to use an API monogram on their OCTG, identifying their OCTG as being API 5CT compliant.

Whenever an API 5CT approved steel mill manufactures a new batch of casing or tubing, the batch is given a unique '*heat number*', and a section of the material is cut off as a test specimen and dissected in a number of very specific ways, as is detailed in the API 5CT standard, and then analysed under laboratory conditions for both its mechanical and chemical properties.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

The lab results of these tests will form the technical data which is correlated onto a traceability document, commonly known as a MTC 'Material Traceability Certificate' or 'mill cert.' for short, and the MTC will reflect the unique identification '*heat number*' which was stencilled onto that batch of material. This is a bit like a birth certificate for the material batch which follows it for its life cycle.

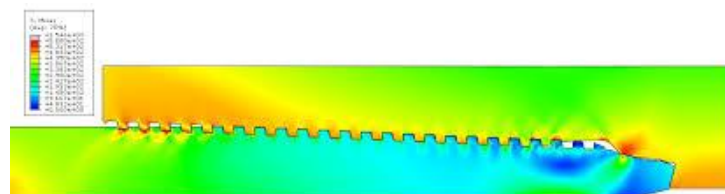
It should be noted that if for any reason, should the '*heat number*' stencilling on the casing body is lost, due to weather fading, abrasion or other method, then the material is deemed to have 'lost its MTC traceability' and immediately becomes scrap steel, as it is not permissible to run non-traceable OCTG into an O&G well.

The API 5C1 standard also covers in detail the 'care and use' of OCTG, including handling, storage and preservation requirements for OCTG, which governs all stages of transporting by land or sea, lifting, storing, or other, periodical maintenance, etc. especially for special OCTG grades like 13Cr-L80 with high levels of nickel chromium which must avoid direct contact with carbon steel and high impacts.

The threads machined onto the ends of the OCTG, which are used to connect and seal the OCTG, can fall into two main categories:

- API 5CT threads (which are suited to seal liquids, such as water, oils or condensates); and
- Premium threads (3rd party proprietary threads with mechanical gas tight seals).

Some of the larger API 5CT accredited OCTG steel mills also have their own R&D design departments which have developed their own premium OCTG threads, with an integral designed mechanical gas seal, and using FEA/FEM computer modelling, they can simulate the thread performance on various sizes and material grades, under different conditions, like: tension; compression; internal (burst) or external (collapse) pressure; bending motion for well deviation; etc.



These theoretical FEA/FEM computer modelling data then need to be backed up with countless mechanical tests, using custom built testing machinery, which can replicate/simulate down-hole conditions, in a laboratory style controllable and repeatable environment to accurately measure the performance of the threads and importantly the gas tight seal under a variety of single or combined stresses.

There are extensive procedures for testing casing and tubing connections as detailed in ISO 13679:2002(en) which the steel mills must be able to comply with regularly

<https://www.iso.org/standard/22603.html>.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory



The performance data for each Casing or Tubing size, material grade, and thread/seal type is fully documented and made available to the O&G well design engineers, who will refer to this technical data to determine if a particular size, poundage, grade of casing and/or the thread type is *'fit for purpose'* for their well design requirements.

These are the links to some of the technical data of the leading Premium Thread Steel mills:

<http://premiumconnectiondata.tenaris.com/index.php>

http://www.vamservices.com/technical_information/connection_ds.aspx

<http://www.jfetc.com/>

As there are no steel mills in Australia capable of manufacturing API 5CT compliant OCTG, all the OCTG used in Australia is procured from overseas steel mills and shipped into Australia, where upon arrival and before use, the OCTG are fully inspected to check for any handling/shipping damage that may have occurred in transit in compliance with API 5A5.

Where there are any threads rejected by the OCTG inspectors, they will need to be re-cut before use, however there is a huge logistical dilemma in sending the damaged OCTG all the way back to the overseas OCTG steel mill for any thread repairs.

As there are a number of competing OCTG steel mills around the world, each with their own thread designs and Intellectual Property(IP), it is impractical for all these steel mills to each have a separate small repair facility in every location around the world (approx. 250 licensed OCTG locations worldwide), hence the existence of the type of local independent OCTG repair facility which we had in Darwin prior to the moratorium, which was licenced and qualified for API 5CT and

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

premium OCTG connections, with all the necessary capabilities for these specialised OCTG repairs to the manufacturers specifications and importantly it was close to the local O&G operations.

This is why it was important to maintain our local Darwin based OCTG repair facility, which filled a necessary gap, as it provided a logical local support solution for the API 5CT & premium OCTG thread repairs and it also provided many other manufacture and repairs of other associated equipment's and accessories as required by industry.

The process of obtaining licenses and qualifications for OCTG premium threads are very expensive both to establish and then to maintain. This involves the OCTG steel mill, that owns the IP commonly known as the '*OCTG licensor*', to first identify a suitable local machine shop facility, with minimum QA/QC ISO:1901 & HSS&E procedures, plus has established a good track record of manufacturing to API 5CT standard, for the local O&G industry.

The '*OCTG licensor*' would enter into a license agreement/contract with the local machine shop facility and thus make them an '*OCTG licensee*' for premium thread. At this point the machine shop still cannot machine a patented OCTG premium gas tight thread.

The next step is for the '*OCTG licensee*' to invest very heavily in many additional specialised machinery, equipment's, tooling, gauges, and train its skilled employees and be able to perform acceptable specimen samples of a particular premium thread type, under the direct observation of a '*OCTG licensor auditor*', in order to become '*qualified*' to offer services for just that particular thread type.

The process of '*qualifying*' for another premium OCTG thread type must be repeated for each and every different premium thread type that the local '*OCTG licensee*' is required to manufacture/repair for its O&G customers.

The process of entering into a formal '*license agreement*' with a different '*OCTG licensor*' must be done separately, with each new premium thread patent holder '*OCTG licensor*'.

'*OCTG licensee*' facilities will typically have ISO 1901:2015 compliant Quality Management System (QMS) with requirements for internal and external audits, these will include:

- their own internal audits;
- external group audits, where they are part of a larger group
- '*OCTG licensor*' audits, for '*OCTG licensee*' compliance audits,
- and some of the major O&G customers will also insist on performing their own vendor audits, for quality vendors

... making this part of the industry very heavily scrutinised from multiple independent sources, which is understandable considering that the OCTG is a critical part of the well bore integrity.

For reference, the Darwin '*OCTG licensee*' facility which I shut down in July 2016, had six premium thread '*license agreements*' and held fifty two individual '*OCTG premium thread qualifications*', with the nearest '*OCTG licensee*' competitor in Australia only having twenty six '*premium thread qualifications*', and the few other '*OCTG licensee*' facilities, with only about a dozen

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

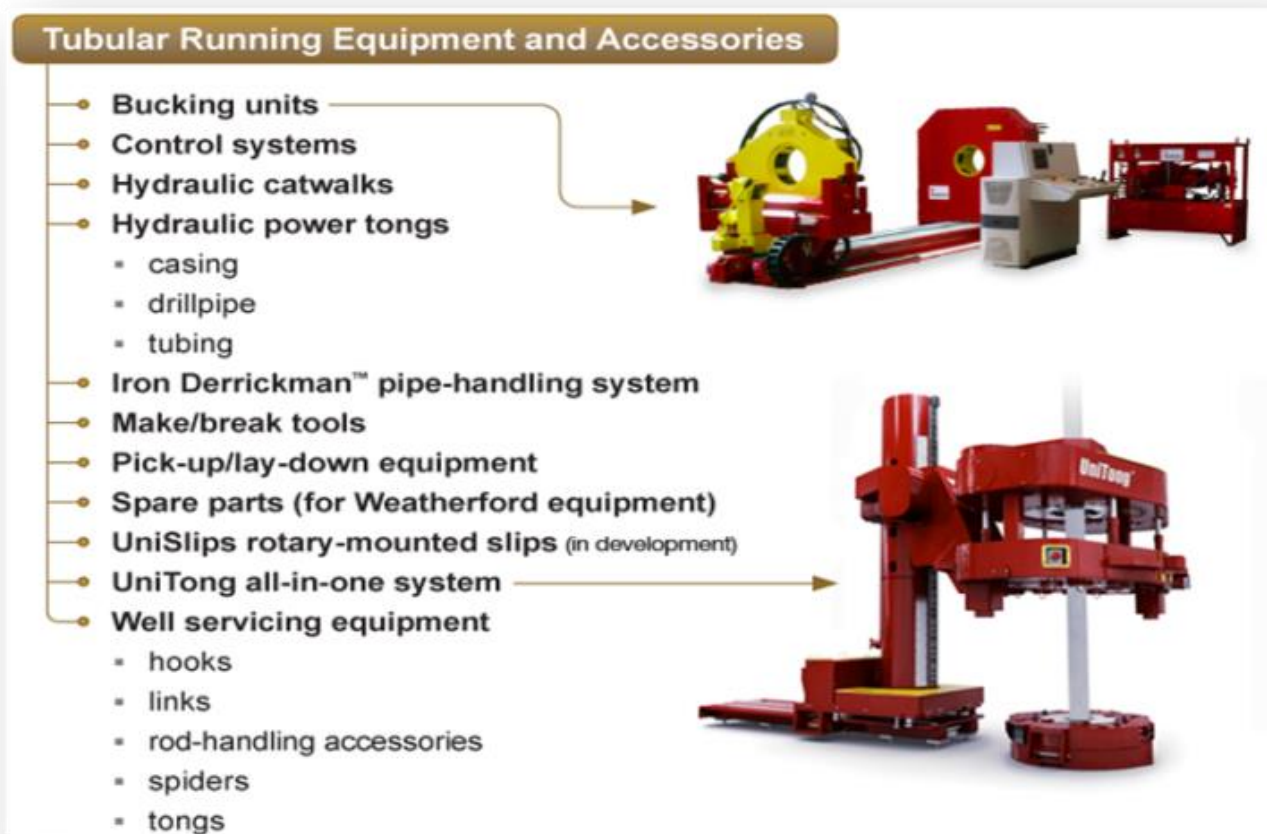
or less 'premium thread qualifications', so in fact losing the Darwin 'OCTG licensee' facility was not only a significant loss to the NT O&G industry, but as some of the premium thread types were only qualified to this facility in Australia, it now means that all O&G operators who need these thread type repairs, will now need to look overseas for support.

The next area of OCTG, which is very critical to the well bore integrity, is the make-up of the premium threads to each other, which can be broken into two key categories:

- horizontal make-up - in a workshop or steel mill; and
- vertical make-up - when run into a well on-site.

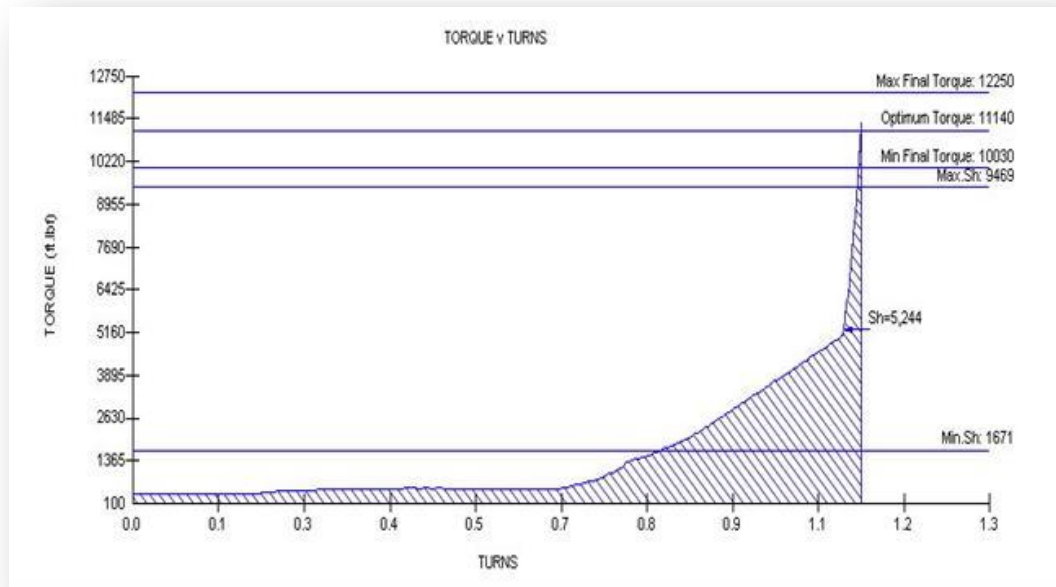
In the OCTG steel mill, 'OCTG licensee' facility or a service company workshop environment some OCTG premium threads will need to be made-up to each other, these would include couplings onto casing, casing hangers onto nipples, shoe track assemblies, and complex completion assemblies.

This is done horizontal by using a 'Torque Turn Machine' in a workshop or steel mill or vertically using an 'Iron Roughneck' or 'Iron Derrickman' pipe handling system.



Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

There are very detailed, but often proprietary processes and procedures for the successful make-up and/or running of OCTG, which covers everything from the frequency of calibration of the torque turn machine, all the way through to selection of correct torque data settings and using and interpreting the acceptance and rejection criteria of a makeup graph.



After make-up, all OCTG thread connections are drifted to ensure there are no issues with mashing or galling causing drift issues, and some large completion assemblies are function tested and pressure tested before going to the rig.



When the OCTG is being run vertically into a well, there is a log record kept of every component being run, which will also record each joint of casing unique MTC 'Heat Number' and its individual 'joint number', its 'tally / make-up length', and its torque turn make-up graph acceptance.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Once the casing has been successfully run and cemented in place, the cement job is verified with a logging tool, and then the casing will be pressure tested along its entirety for overall well integrity as a completed assembly.

Should there be a leak discovered, there are options to isolate an area with a 'packer' positioned either side of a suspected leak zone and pressure test a smaller area to isolate and identify the position of a leak. There are a number of remedial repairs which can be used to address the well integrity at this point, these include using what is called a 'casing patch' which will place an internal sleeve across the leak zone, sealing it permanently.

It should also be noted that as both Conventional and Unconventional Shale Gas wells are typically deviated from vertical to a horizontal direction through an arc, that wherever the casing is subjected to this curvature, there will be compressive and tension forces on either side of the OCTG premium threads, and thus it is critical to ensure that the thread types selected, will have sufficient resistance to these bending forces as to be able to maintain the mechanical gas tight seal and thus the well integrity.

The only caveat of concern that I would raise with regards to the procurement of OCTG in any O&G well, is to ensure that if there are any Chinese or Russian OCTG to be used in Australia, that its authenticity must first be verified as being certified by API, to comply with all the manufacture requirements of API 5CT and have a valid API 5CT monogram on the product to indicate that the product is suitable for use in O&G wells.

This verification process can be done simply with a background check of the OCTG steel mill to ascertain their API certification number and then cross checking it with the API composite list, which is used for identifying active compliant OCTG mills.

<https://mycerts.api.org/Search/CompositeSearch>

There are now a number of quality Russian and Chinese OCTG steel mills, audited and certified by API which are capable of producing many of the most common OCTG grades to the same or similar standards as any the US, European & Japanese OCTG steel mills, however they do struggle with some of the more special grades like 13Cr-L80, which has very high levels of Nickle Chromium to resist corrosive effects of H₂S.

The key is to avoid those cheap OCTG steel mills which are not licensed by API, but still manufacturing and selling OCTG to less scrutinised areas around the world.

Conventional versus Unconventional Wells

I am not sure of the exact origins of these two terms, but despite 35 years in the industry, I have only really noticed these terms being used regularly in more recent times, and particularly by anti-fracking antagonist groups and the media outlets which air their concerns, and where the use of these two terms have been used more often than not, in a mischievous way to categorise certain types of oil and gas resource extraction types as having greater or lesser or shared risks.

The problem with using these two terms to define specific risks and then determine support or opposition of one or the other processes, is that they poorly reflect the actual risks associated

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

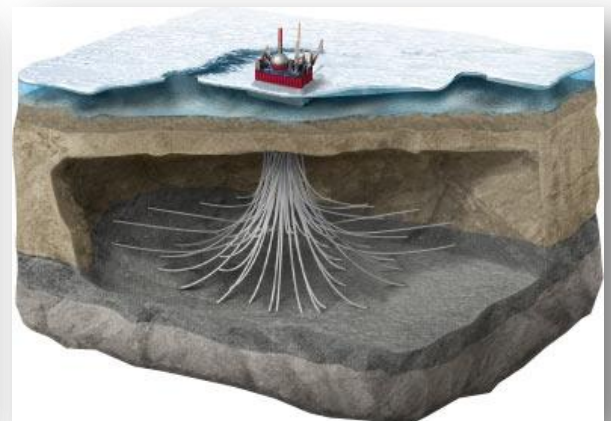
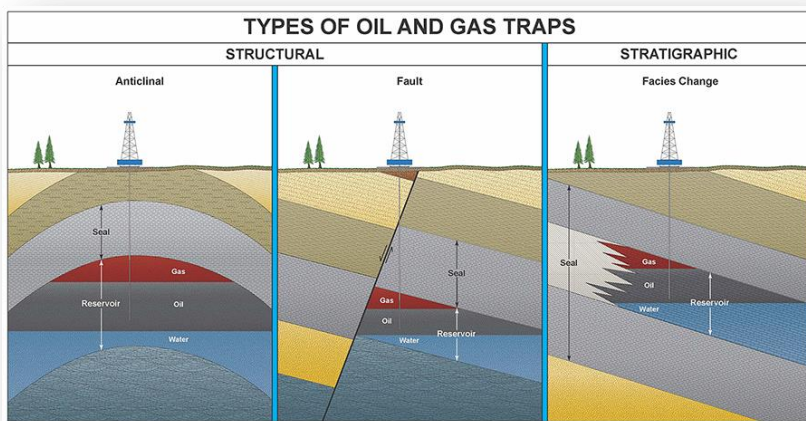
with a particular method of extracting the resource, and thus create wrongful assumptions and erroneous concerns on the actual associated risks and the correct 'risk management' required to manage them.

As in categorising CSG & Shale Gas together into unconventional category, where for Shale Gas doesn't require dewatering of aquifers, and the depth of the source rock 'shale seam' is actually much deeper than a typical conventional gas reservoir, and how a Shale gas well will use all the same drilling and casing methodology of a typical conventional O&G well, making it very similar to conventional with the only exception being the fracture stage.

However Shale Gas has been oddly categorised as having similar risk to that of CSG, despite the significant differences in risk to ground water, like CSG being very shallow, usually has no 'cap rock' layer or 'anticlinal traps' between the 'coal seam' and the land surface, and is often saturated inside an aquifer (which is what contains the Natural Gas to the coal), requiring large scale dewatering of the aquifer.

Conventional – Simply refers to the most common and historical extraction methods and O&G reservoir traps, which are predominantly targeted in extracting the migrated oil and gas in reservoirs trapped under 'anticlinal traps' (in an impermeable 'cap rock' layer), which is typically above a 'source rock' layer, such as shale.

Conventional wells will be drilled and cased in vertical, deviated and/or horizontal directions, and can be a single well or have multi-lateral wells (offshore platforms can have over 30 wells extending out from the one platform). It is not unusual for a conventional well to be stimulated especially towards the end of its life when the reservoir is becoming depleted.



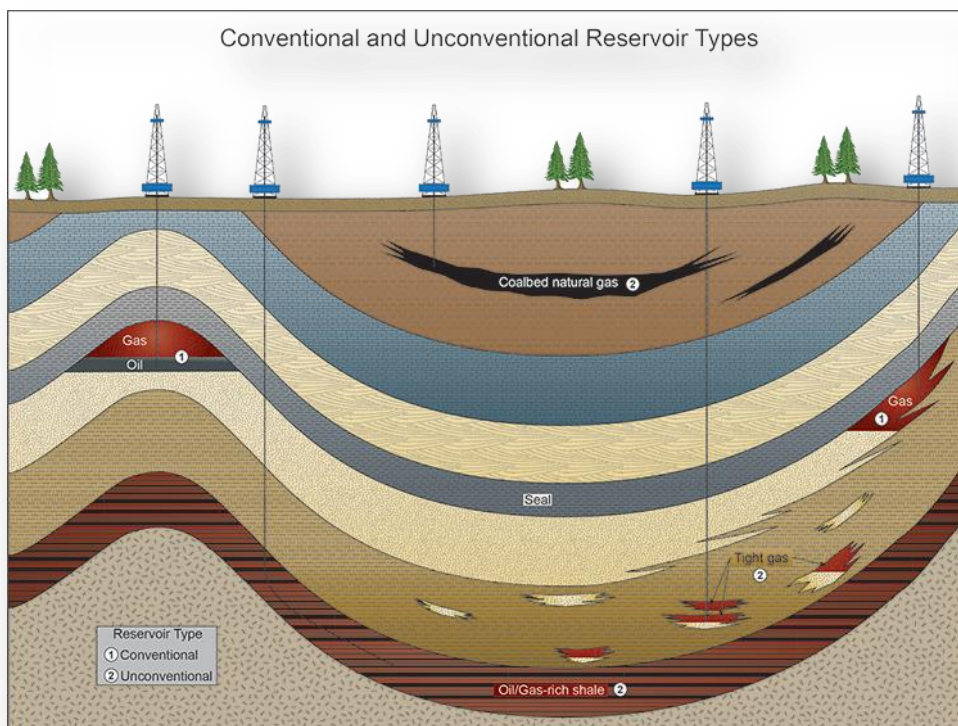
Unconventional – Refers to the extraction methods used and the resource targets associated with the extraction of oil, condensates and gas trapped *inside* Shale (internal with low permeability) or *onto* Coal (externally trapped by aquifer pressure), known as the 'source rock' layer, and unconventional can also be used to define 'tight sands' due to low permeability. Each of these source types presents significantly different challenges and therefore different associated risks.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

- The Coal may or may not require re-fracturing, whereas Shale will always require fracturing.
- Coal will need to be de-watered (suck out the aquifer into large surface storage ponds), whereas Shale will typically be devoid of any local aquifers requiring no de-watering of aquifers.

So whilst 'CSG', 'Shale Gas' and 'Tight Sands' may all be grouped under a common category of 'unconventional gas', the title is in itself, rather meaningless to ascertain specific risks and can be very misleading in a debate, as these all require totally different technical approaches and all have their own unique risks, and different ways to manage these risks.

It would therefore be more reasonable to categorise 'shale gas' and deep 'tight sands' in a very similar grouping to that of conventional O&G wells, with the only exception being any risks associated with the fracturing process itself.



The only one method that does pose some very different set of unique risks is that of CSG, as not only does it reside in an aquifer, but the aquifer is what is actually keeping the Natural Gas hydraulically attached to the coal, and in order to release the Natural Gas from the coal, the aquifer must first be removed in a process known as de-watering, and then this produced water is stored in huge man-made surface dams, where often some basic treatment processes applied before it can be used for other purposes, like irrigating drought affected farmlands (a not so widely publicised, but welcome synergy benefit for some pastoralists in harsh conditions).

In CSG there is usually no 'cap rock' layer sealing the coal seam from the surface, making it much easier for some fugitive gas to escape upwards towards the surface, especially due to the de-watering, which is one of the of the points the anti-fracking antagonist groups like to focus on, ... but it should also be clearly noted, that there is also a natural process of aquifer levels dropping during long periods of drought or heavy agriculture water use, exposing the crown of the coal seam

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

underground and the Natural Gas in coal seam close to the surface becoming naturally fugitive as being not uncommon, and which is why there has been countless historical cases documented from all over the world, going back for many generation of rivers, lakes, and dams which bubble Natural Gas and water bores which can be lit on fire.

I have personally experienced some of this myself in Roma, QLD in the mid-1980's, from the Roma town bore water, with no O&G wells of any kind in our proximity, where the water pipes would hammer in the walls as water and gas would alternate through the plumbing every day ... it was just normal to have Natural Gas coming up with the bore water there.

But the biggest concern has to be the gross misuse of the term 'unconventional gas' in the context of NT Shale Gas debate, as too often the anti-fracking antagonist groups have mixed in the unique risks only associated with CSG, into the NT Shale Gas debate, which has then caused unfounded concerns in the public, on the practices and potential risks that are not in any way associated with the extraction of Natural Gas from Shale. This includes misrepresenting Shale Gas as being close to or inside an aquifer like in CSG.

Drilling Through Aquifers

There is much discussion centred on 'how O&G companies drill through the potable water aquifer, without causing contamination to the aquifer?', which sounds like a very valid question to be asking, however this question is only ever directed towards the drilling activity of the unconventional hydraulically fractured Shale Gas wells, and yet there doesn't seem to be any similar anxiety or concern directed towards how conventional wells also drill through the same potable water aquifers, with many of the anti-fracking antagonist groups public stating on record, that they don't have any issues with conventional drilling practices at all.

The reality is that the entire process of drilling through the potable water aquifer and running the surface casing and cementing it to the formation to create the initial protection barrier and all the associate risk of contamination to any potable ground water aquifer, particularly when drilling and casing the upper well sections, is completely identical in all aspects.

Usually the first hole section is drilled through the potable water aquifer, by using high pressure 'air' or 'water' as the means to jet and clear the drill-bit of cuttings, and this is then cased off with large OCTG casing, often refer to as 'conductors' or 'surface casing'.

Conductor or surface casings range in sizes from 16" to 36", and can have a range of different wall thicknesses and be made of various grades of high-alloy steels, which are regulated under the international O&G Industry specification for casing, API 5CT & API 5B, and any welds used on the connectors are performed to API 1104.

Once the conductor is run and cemented in place, there will be a cement log done to ensure the cement bond is complete from top to bottom.

Next the well will be filled and pressurised to check for well integrity.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Then the drill string will be lowered into the well and drill through the Shoe String and the cement plug between the float collar & Float Shoe, down into 'open hole', for a few metres below the last 'Target Depth' (TD),

At this point, there is another pressure test done, which both checks the formation structure / pressures but importantly it checks for any external pathways around the outside of the conductor cement and formation to surface.

With the conductor in place, cemented, pressure tests both internal and external, the aquifer is now fully protected and the well is safe to continue drilling down to the next TD, where it will be again cased, cemented and pressure tested the same way for each subsequent layer.

Cementing Casing to the formation

Casings are typically run into an oversized pre-drilled well bore with a special assembly on the bottom of the casing string, commonly known as a 'shoe-track assembly'. The 'shoe-track' can be configured in a number of different ways and there are a variety of standard features and options and also manufacturers offer competing technologies and there are continual technical advancements, but they must still comply to API spec 10A, Specification for Cements and Materials for Well Cementing.

Most typical 'shoe-tracks' will be made up of (starting from the bottom) a 'float-shoe'; a casing joint; a 'float-collar' a casing joint ... with all threads made-up using a thread lock/cement compound (to prevent risk of back-off by drilling vibration).

Both the 'float-shoe' and the 'float-collar' have internal one-way poppet valves cemented into them, this allows the cement to be injected through them, but doesn't allow any flow-back.

The cement used to bond the outside of the OCTG to the formation, is usually delivered into the well as a calculated volume slug, sandwiched between two rubber plugs (the bottom plug has a burstable diaphragm, the top plug is mostly solid), and the cement slug and plugs are pushed down the well with a column of water on top, much like a syringe, and when the bottom plug lands on top of the 'float-collar', there will be a pressure spike (of resistance), and then the pressure applied will burst the 'bottom-plug' diaphragm, allowing the cement to inject down through the 'shoe-track' and out into the external region of the casing and will back-fill and rise up the outside, bonding the casing to the formation and sealing off any potential external communication to the well bore.

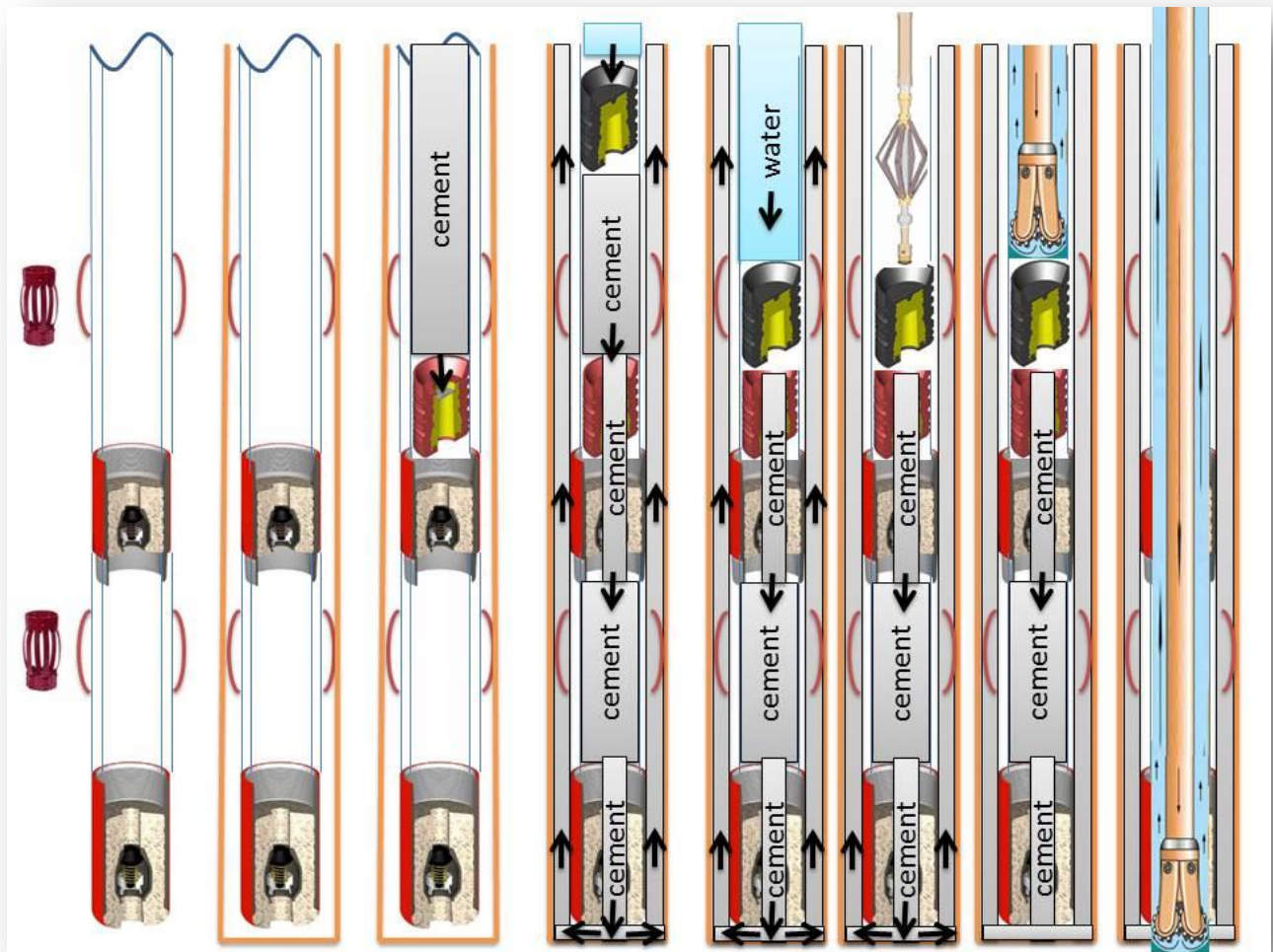
Key point to note is that the cement used to cement casing is NOT the same as the cement you would pour on a typical construction site, this is specially engineered 'fit for purpose' cement, and can actually be of a different formula from one well to another, as some of the parameters which go into deciding the exact formula are: the types of rock formation; compressibility of formation; formation pressures; formation temperatures; etc., even the exact water intended for the mixture must also be analysed by a laboratory to come up with the exact formula, and a sample batch is made in the laboratory and tested for its mechanical properties

Once the cement formula has been engineered, the casing can be cemented in place by the O&G companies and once it is in place, it sets very fast allowing for the next hole-section to be

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

drilled through the remaining cement plug in the shoe track and into open hole, down to the next target depth (TD).

Before they drill the next hole-section, it is important to note that there is a few critical steps of running a wireline logging tool down the cased and cemented well bore, to log the cement bond to both the casing and the formation (log records are kept on file), and if there is for any reason a discrepancy, there are remedial processes to rectify any cavities, and then to pressure test the well bore.



Evolution of Steerable Drilling for Horizontal Wells

Some claims and counter claims centre around whether or not directional steerable drilling or what is commonly referred to as horizontal drilling, is a new or old technology and also if this practice poses any particular or unique risks to potable ground water aquifers.

To best understand the birth of directional drilling technology, and establish a date of when this first occurred, I suggest a read of "Technology and the 'Conroe Crater'" <http://aoghs.org/technology/directional-drilling/>, read down to the section on John Eastman and the Whip-Stock, which will establish the original date of both directional drilling and high pressure water injection in 1934 at the Conroe Crater.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

It should be noted that the original Eastman design whipstock is still used today, particularly used to effectively side-track a well, whether conventional or unconventional.

However like many technologies, there is always a start point and there are always continual advancements, and the art of directional drilling is of no exception, as many companies invent, adapt and developed more efficient solutions to minimise risks, reduce wasted time and save costs.

To give a very basic understanding of how things may be done in the early years, the method of drilling was rather laborious in that a well would be drilled with many steps, meaning many trips in and out of the well:

- First, there would be the upper vertical section of the well, to drill through any unstable surface layers and aquifers, and this is cased off and cemented as usual.
- Then a vertical hole is drilled down to the 'kick-off' point.
- Then a wire-line could be lowered with logging tools to provide a log of the well so far.
- Then casing string would be lowered with a 'whip-stock' on the end, oriented to the intended direction of well deviation.
- The casing and 'whip-stock' is cemented in place as usual.
- Now a drill string can be lowered inside and drill through the cement plug in the 'whip-stock', and as the bit goes through the 'whip-stock', it kicks (deflects) the bit in the intended direction.
- The drill bit can continue to drill at the new deviated angle until it reaches the next TD.
- At this point, the drill string will 'trip-out' of the well, and logging tools lowered on a wireline to log the well again.
- If the well requires further deviation, another smaller casing string with a smaller 'whip-stock' can be cemented in and the process repeated, kicking the drill string again.
- If the TD is successfully positioned in the reservoir then the production casing can be lowered with a 'shoe-track' and cemented in place, ready for completion.

Up to this point, all drill strings were fully rotated from the surface, usually rotated by a 'Kelly' driven by a 'turn-table' on the drill rig floor. https://en.wikipedia.org/wiki/Kelly_drive.

The next advancement was the invention or adaption of progressive Cavity Positive Displacement (PCPD) motors, into the Bottom Hole Assembly (BHA) of the drill string, directly above the 'drill-bit'.

The PCPD, commonly referred to as a Mud Motor (or drilling motor) is able to rotate the 'drill-bit' at much higher RPM, and doesn't require the entire drill string to be rotated, saving on wear and tear and friction https://en.wikipedia.org/wiki/Mud_motor.

Now that the technology allows for only the 'drill-bit' to rotate, whilst the rest of the drill string is stationary, there is now another great advantage towards directional drilling, only now without the need to run a 'whip-stock' to kick the bit, and that is done by placing a 'bent-sub' directly above the Mud Motor.

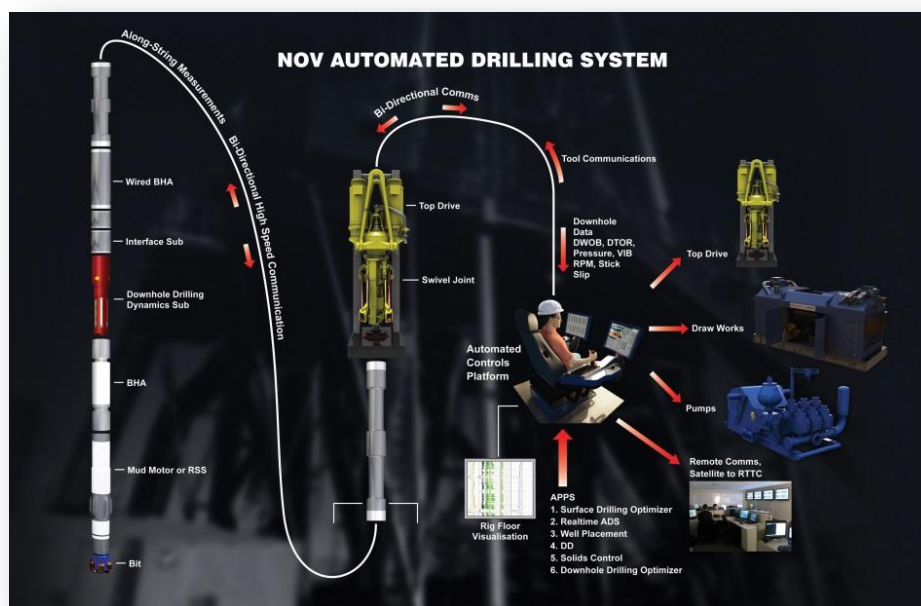
Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

The time lost ‘tripping-in’ and ‘tripping-out’ of wells is one of the very costly non-productive activities on a drill rig, so advancements along the way as technologies developed were intended to cut down the number of times a string had to ‘trip-in’ and ‘trip-out’ of a well.

So one of the next key developments was to LWD (Logging While Drilling) and MWD (Monitor While Drilling) signals to surface by means of drilling mud pulser providing real-time data.

These tools are located in the BHA, and sit directly above the Mud Motor, where they can collect real-time data and using special high temperature electronics and batteries, will transmit the data by introducing pulsers into the drilling fluids that can be detected by sensors at the surface, and this information can be read / interpreted by computer software for geologists and drilling engineers at the surface, without the need to ‘trip-in’ and ‘trip-out’ of a well to perform wireline logging.

It wasn’t long before the technology was developed to be able communicate in the opposite direction, i.e. send pulser signals from surface down to the BHA below. However what this really meant was that it opened up opportunities for many companies to invent steerable technologies to steer the drill bit in real-time giving greater control to the driller to stay in the source rock.



http://petrowiki.org/Directional_deviation_tools#Steerable_motor_assemblies_or_PDMs.

Now that the technology is very refined, and the richness of real-time well logging data and the degree of precision a well can be drilled through a source rock, even following the waves in the geology to remain in the centre of the source rock, the technology is widely used to make both conventional and unconventional wells more economical.

It is probably best to point out here, that many offshore conventional Oil & Gas wells are drilled from a single platform, and are drilled out into horizontal laterals, and it is this offshore usage of the directional drilling technology that has been the key driver of the technology, which is now so

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

advanced that it makes drilling into relatively thin unconventional Shale source rocks with surgical precision relatively easy.

It should also be pointed out at this point that the mere fact of drilling horizontal versus vertical (and whether conventional or unconventional) has no added or unusual negative environmental impacts or associated risks, however it can be argued, that by being able to drill from a single drill pad to reach a wider intersection of the source rock, the environmental footprint of horizontal drilling is significantly smaller, and that as the horizontal wellbores are able to produce along a longer section or greater source rock area, per the amount of time and infrastructure to achieve the same by vertical wells, that this is also significantly more environmental friendly and economical.

Perforation of Casing

This area can become very complex, and is best left to drilling engineers to explain fully, however I will attempt to at least address some more basic points, the main one being, that perforating casing is applicable equally for both conventional or unconventional wells as the main method to create a pathway between the cased and cemented well bore and the source rock / reservoir and the that there is literally no difference in how it's done or any associated risks.

One of the most common systems used to perforate casing is called a 'TCP Gun' (Tubing Conveyed Perforating), however there are many different manufacturers and designs and some are designed for specific applications.



In essence all a TCP Gun is, is a cylindrical shaped carrier, designed to carry a spiral array of small explosive charges and projectiles, with some form of detonation device to fire the charges when the tool is positioned in place where the casing needs to communicate with the reservoir.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Hydraulic Stimulation

This is the only stage of the Shale Gas well that could be considered somewhat unique or different to typical conventional wells, and for that, there needs to be appropriate risk management.

As there is already much details and focus on this area, and the panel was given firsthand experience by Santos of an on-site fracking operation, I will leave it to others to comment on the specifics, of the technology.

However, there are now a string of reputable scientific peer-reviewed reports, focused on proving or disproving the potential links of groundwater contamination caused by Hydraulic Fracturing in Shale, which are all now consistently debunking the earlier claims made by anti-fracking antagonist groups.

The science is now indicating unconventional Shale Gas is not responsible for contaminating groundwater aquifers, the most recent report, co-funded by National Science Foundation and Natural Resources Defence Council (the anti-fracking environmentalists themselves), published 5th April 2017, based on a three year detailed scientific study, using more sophisticated measuring techniques, which are able to identify specific isotopes to positively identify the signature and source of the methane in groundwater, proved it was not coming from the fractured Shale, but rather from other ubiquitous natural biogenic sources.

It further found NO evidence or traces of other chemicals which could be linked to the Hydraulic Fracturing process.

<http://www.sciencedirect.com/science/article/pii/S0016703717302004>

Production completion tubing

After a well is drilled, fully cased & cemented and then perforated (to allow communication from the reservoir to the inside of the casing), the next step is to install the completion and production tubing string.

This area can get very complex as there are countless variables in the requirements for the completion assembly, but to keep it basic, the completion assembly will usually have a packer (tool that locks in place to seal off a well section) above and below the perforated section to contain the resources flowing into the Casing through the perforations, from only the perforated zone.

The completion assembly's main functions are to constrain the extracted resource to the perforated zone of the casing, and then allow it to transfer into the internals of the completion assembly where it has an integral connection to the surface via a string of API 5CT compliant OCTG Tubing. It is this string of OCTG tubing which will contain all the produced material which flows back from the formation to the surface, not the OCTG casing as indicated by misinformed anti-fracker interest groups.

i.e. the annulus, which is the gap between the outside of the tubing to the inside of the casing, is totally void, empty of any production flow or other mater.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

The condition of the completion assembly and tubing are monitored at regular intervals, and at any point if there are early signs of say corrosion to the production tubing, then this will be rectified by what is commonly known as a 'work-over', where the well is first killed (pressure introduced to balance the flow pressure, stopping the production flow), and the old production tubing and completion assembly can be pulled out and fully replaced with a new completion assembly and tubing string and the flow is re-established.

This is a very important point to note! As there have been many claims by the anti-fracker interest groups, that there are about 6% well failures, in these figures they will include all the regular workovers, which are not actual casing well failures, but routine production tubing maintenance.

To call a routine production tubing string 'work-over' a well integrity failure, would be akin to saying all replacements of brake pads on cars are brake failures.

There is another unsubstantiated claim made by the anti-fracker interest groups, which tries to assert that because the horizontal Unconventional O&G wells in shale are fractured in multiple stages, there are accumulated instances of vibration or stresses on the casing and cement bond.

However they make these claims with the assumption that conventional O&G wells are only perforated once, without realising that conventional O&G wells can often intersect more than one reservoir of interest, and that it is not uncommon to perforate the casing in multiple stages, and to run the completion to isolate each separate perforated zone and again all produced material will flow up through the production tubing.

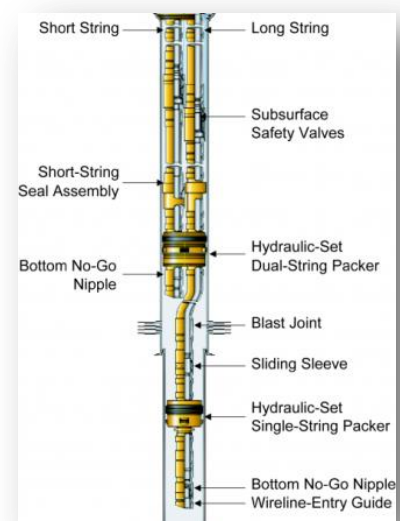
Further, in conventional O&G wells the different reservoirs can be producing different product, as in one could be gas and condensate, whereas the other could be crude oil, and to manage this, not only does the completion assemblies provide isolation of the perforated zones, they can run two tubing strings (dual-completion) which can keep the products separate to surface.

By understanding these technologies and capabilities, we can better understand that the completion assembly and production tubing is key to transporting the product to surface without any contaminants coming in contact with the OCTG casing which only maintains the well integrity.

i.e. one of the key myths born out of the ignorance to well design, is the wrongful assumption that the product flows to surface is via the casing itself, and thus the assumption that if the casing was to fail, then there could be direct communication between the well and the extremities of the well, allowing ground water contamination.

The function of casing is the well bore integrity, and the function of tubing is to flow the produced material.

http://petrowiki.org/Cased_hole_completions



Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Surface Wellheads

Surface wellheads must be compliant to API 6A, which governs the minimum API standards for all Wellheads, and some special accessories, regardless of whether they are used in offshore conventional O&G wells or onshore unconventional O&G Wells.

Wellheads are monitored periodically for their service condition, and will usually have a periodical maintenance program, where some minor wear and tear issues can be easily redressed with field service kits, such as gland packing, gates & seats, 'o' rings, ring gaskets, etc.

Due the complex nature of major overhauling of a wellhead assembly, it is not possible to perform such a major service in the field, so when this is required, a new wellhead is installed, and the used one will be sent back to a specialised service centre (usually the OEM), where it will be fully stripped down and inspected, rebuilt, tested and recertified.

Where there is excessive service wear or corrosion which makes the body non-compliant, the entire wellhead assembly will be scrapped.

Hazchem and flow-back

Whilst this is not my area of speciality, I would like to at least address some simple basic observations from a layman's perspective.

During the previous 'Select Committee on Unconventional Gas Mining' a number of anti-fracker antagonist groups were making ludicrous claims that over 600 different chemicals were used to fracture in unconventional O&G Wells, furthermore they claimed that 'Benzene, Toluene, Ethylbenzene, and Xylene' (BTEX), chemicals were actually being injected in with the toxic cocktail mix of chemicals used to frack, and that 'Volatile Organic Compounds' (VOC) were being vented as fully fugitive as well as 'Naturally Occurring Radioactive' Materials (NORM).

These factually incorrect claims were also being peddled by these anti-fracker antagonist groups to the wider community on flyers and at their education stalls, including organised information sessions in halls, at marches, and out to pastoralists and remote indigenous communities, despite they being informed repeatedly that this was banned in Australia and NT.

I recognise that the 'Background and Issues Paper' has made a special effort to point out that the use of BTEX is banned in Australia, and thank the panel for addressing this misinformation.

This must have had some effect as the anti-fracker antagonist groups have begun to learn a little about the facts, in that they tend not to say that BTEX are injected into the unconventional O&G Well anymore, however they are still talking up that VOC, including BTEX & NORM are flowing back to surface, and suggesting that these are being vented.

In this regard I must point out that whilst it is true to say that naturally occurring VOC, including BTEX & NORM may flow back from an unconventional O&G well, thus creating certain risks which must be managed, however it is very important to also note that the exact same risks applies to each and every conventional O&G well globally, and that as the anti-fracker antagonist groups have already stated on record that they take no issues with conventional O&G wells, we should

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

assume that they are equally comfortable with the current risk management policies and procedures for managing these same hazards, whether they are conventional or unconventional.

Summary of Conventional versus Unconventional Wells

When looking at all the major steps involved in the constructing of conventional and unconventional O&G wells as listed above, we see that at every stage they share all the same technologies and are governed by the same API specifications, with the only exception being the Hydraulic Fracturing process itself.

Keeping in mind that almost all anti-fracker antagonist groups have repeatedly stated on record, that they have **NO** issues with conventional O&G wells, and on that basis alone there should be no cause to question any of the common steps and risks associated with unconventional O&G wells in Shale where they are identical to conventional O&G wells.

Notably, this would include the many misleading claims by anti-fracker antagonist groups of well casing failures into aquifers, poor well construction methods, the cement failures, the perforation of casing, hazardous flow-back management, etc.

This would leave the only possible remaining argument the anti-fracker antagonist groups may have, as being some possibility of communication from the fractured Shale seam directly to the surface aquifer, which up until now has been rather hard to either prove or disprove.

We know that in Beetaloo NT, the Shale is very deep, approx. 1.5Km to 3.5Km, and it's encapsulated in clay rich shales, and is below at least one cap rock layer, making the likelihood of any communication of the Shale seam and the surface extremely unlikely.

However to use a more scientific approach, the new peer-reviewed Duke University-led report on 'The geochemistry of naturally occurring methane and saline groundwater in an area of unconventional shale gas development' which did an in-depth three year study, touted as being the first to report a broadly integrated study of various geochemical techniques designed to distinguish natural from anthropogenic sources of natural gas and salt contaminants both before and after drilling, has concluded that when using isotopes to differentiate between the different sources of contaminants, it showed no evidence of anthropogenic contamination, but instead only from other naturally occurring ubiquitous sources.

<http://www.sciencedirect.com/science/article/pii/S0016703717302004>

It is fair to say that there were three identified cases of surface spills, unrelated to the fracturing process itself, and this is unfortunate, but as with any industry handling of any Hazchem waste, there needs to be both proper formal procedures to handle hazardous substances safely, and effective procedures to clean-up any spills thoroughly.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

The real impact of the Moratorium

In this next section I would like to flesh out some of the real impacts which the moratorium itself has inflicted on a range of local NT businesses and their skilled workers.

With reference to the 'Background and Issues Paper', it was the anti-fracker antagonist groups which first sought to raise 'human wellbeing' as a potential issue or concern, with some references to mental stress and anguish, effects on living costs, property values, business failures, etc. although they have in no way demonstrated how this will actually happen, other than to say, they may feel that they are living in a 'Gas Field' which is more emotive than factual.

My intention in this section is to highlight just a few clear examples of actual (not perceived) impacts which have already occurred on local Territorian businesses and their skilled employees, which are being caused directly or indirectly by the moratorium on the O&G industry.

I would like to stress that the NT government should seriously consider and recognise that the moratorium has impacted significantly on many locally based SME's and micro businesses and their owners and the skilled workers, whose revenues and careers were inextricably linked to the continuity of the local O&G Industry, and that the NT government should recognise its responsibility to redress any unintended harm that the moratorium has caused by the unexpected interruption to businesses and jobs which the moratorium has caused, and also recognise any new associated risks this has inadvertently caused by dismantling high tech capabilities in the region.

Some of the affected parties may need assistance to re-establish the necessary support capabilities going forward, which are vital for safe and economical operations, and others may wish assistance to transition to other industries / occupations, either way, we do see other governments recognise this form of responsibility, such as what happens in the automotive industry down south.

Demise of a 32 year, local based O&G Service Company

From February 2004 until August 2016, I was the manager for the only local NT OCTG manufacture and repair facility, part of the biggest OCTG ('Oil Country Tubular Goods' or 'casing & tubing') manufacturing & repair groups in the Australasia region, a subsidiary of Sumitomo Corporation with world class governance.

The local OCTG facility I managed for over 12 years was established in 1984 at the behest of BHP, and was originally located in Pinelands NT, and remained operational, supporting countless onshore and offshore operations over some 32 years, until I had the unfortunate task of closing down the same business, retrenching all the skilled workers, who I just spent many years training, divesting all the equipment/assets which I spent years acquiring through constant investment.

It would be fair to say that from mid-2014 there was a fall in global oil prices, there had been a tapering in the offshore activity, which stressed the local O&G service businesses significantly, however there was also strong optimism in the ramping up of the onshore activity by the Australia O&G operators, who are well known for actually engaging in local businesses and indigenous communities. During 2015 we saw a significant increase in the activity we received from these

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

onshore operators, where our facility was regularly engaged to provide OCTG Casing services to both Origin and Pangaea.

During late 2015-early 2016 we were in constant communication with both Origin and Pangaea for their upcoming 2016 requirements, and we were already performing inspection and preservation of some equipment's, ... that was, up until the incoming ALP government announced it would impose its moratorium on the onshore activities of the O&G operators, ... then shortly after we received fateful communication from our customers, that unfortunately all the work we were quoting or tendering was now cancelled.

Whilst the ALP NT government may have only thought that the moratorium would just 'pause' the business activities of the O&G operators, they failed to recognise the industry as a whole and the cascading implications that their moratorium would have on the long established local O&G service companies, causing the sudden and total loss of their prime revenue source, leaving these companies no option but to close down their businesses and retrench all skilled local staff.

So in essence what the moratorium has also done, is to inadvertently remove the essential locally based industry capabilities, which in my case, was an OCTG Casing manufacture, repair and inspection facility, which is directly associated with the well bore integrity, so in a post-moratorium era, there will now be no local OCTG Casing service facility in NT for the O&G operators to rely on. Unless that can be restored, they will need to source support from interstate or overseas instead, adding logistical cost, and if there is a well control issue, a greater turnaround time for any unforeseen OCTG Casing requirements.

To date many of my ex-employees are still struggling to find any work, and if they do find work it is usually of a lesser skill and remuneration and only part time and/or casual. Some have personally expressed their difficulties with servicing their mortgage, having a young family of 2-3 children pre-school to primary schools age, and all the usual cost of living we experience here in the NT.



Impact on local support Service Companies

This has too many examples to list them all here, but I will touch on one which should provide some insight, to help understand the depth that the moratorium causes as it cascades down through to many seemingly unrelated SME's and micro-businesses and impacts heavily on individuals within our community.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

It should come as no surprise, that like many upstream O&G service companies, we to engage, support and nurture many local vendors for a wide range of specialised services, like: electricians, plumbers, safety PPE & equipment, hardware, hydraulic fitters, mechanics, fabricators, NDT services, load testing, fire systems, first aid kits, telecommunications, IT, landscapers/gardeners, waste disposal, paint suppliers, packing material suppliers, the list is almost endless, however I will focus on one individual who will remain anonymous for obvious reasons.

Our company employed the services of a local micro-business, the owner/operator who provided specialised trade services on-site to our business for over a decade, and although we had some options to use other larger companies, including a large inter-state firm which setup recently just 2 doors down the road, we continued to support our preferred local NT owner/operator.

This local Territorian service provider has a large family to support, however one of his many children has been afflicted with a severe disability, which requires a very high level of care, which demands a high degree of flexibility with work/life balance. Needless to say, we have always worked around this and continued to support this vendor and he has never let us down.

Again it was with a very heavy heart that I broke the news to him, that we will be ceasing to operate as a business in NT and that we will no longer require his services, which needless to say came as a significant shock to him, and impacted his ability to earn an income.

I don't think I need to elaborate further on this example, but it wasn't the only tough call that had to be made, there were many others with varying degrees of impact, the key point I would make here in relation to the case of human wellbeing as was raised in the 'Background and Issues Paper', is that the economy in a small place like NT is very interconnected yet fragile, and any ham-fisted economic bludgeoning instruments such as a moratorium, will cause significant collateral damage to many small local businesses, only many of these affected parties don't have a voice to speak out in protest, they simply suffer in silence and go looking for another way to survive.

Local Petroleum Engineering student, unable to graduate

In 2011, when the previous ALP party was in power, with Paul Henderson as CM, a local senior graduate, upon seeing how the ALP & CLP both gave bipartisan support for onshore Natural Gas industry, the heavy promotion of this industry by the NT government of the day, including the many new released and granted permits for onshore Natural Gas and the clear future economic opportunities promoted for here in the Territory, he decided to invest in tertiary studies at Curtin University to study Petroleum Engineering.

It must be noted that the cost to support his daily expenses to live in Perth for 5 years (1 year Kalgoorlie – metallurgy + 4 years Bentley Petroleum Engineering) was born entirely by his family, as there is no subsidy to pay for this education, and he like so many other young engineering students, has been left with a hefty HEX debt to pay off.

Now that he has successfully completed his 'formal studies' and returned to the NT, he still requires one more step to complete and graduate, and that is the requirements for 'Industrial Placement', however as there is a moratorium in place in the NT, there are no active operators here

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

able to provide him with that opportunity for him to graduate, let alone the opportunity to be mentored and learn OTJ (On The Job) skills and have a right to a career, just like anyone else.

Instead he has been working in a small restaurant washing dishes and/or serving tables and any other casual non-skilled work he can find.

In this regard, once again there has been a significant impact on an individual's career and livelihood without recognition or compensation.

Rural civil contractors lost contracts

An issue repeatedly raised by the anti-fracker interest groups, is that the volume of road traffic associated with the unconventional O&G Industry will cause damage to the existing roads, degrading infrastructure, however in the context of Northern Territory, many of these remote locations have only poorly maintained dirt roads which are heavily corrugated and pot-holed in the dry season, and unpassable in the wet season.

The anti-fracker interest groups are reading from reports made in high density population areas which had good quality bitumen roads, and are claiming that the increased heavy transport usage was causing these roads to deteriorate, which is of no comparison.

So in reality what has occurred on at least one case that I'm aware of, an Australian operator has applied for and been given approval to build a new bitumen all weather access road, which can be utilised by all the adjacent cattle stations along the route, and they also awarded the contract to construct the road to a local civil firm, who employs locally and will also employ some of the local indigenous youth.

So again the anti-fracker interest groups have got it all wrong, in that the unconventional O&G Industry will actually improve road conditions.

However it is very unfortunate that once again, the moratorium was a direct cause for this project to also become postponed or cancelled and thus it too has not proceeded, denying the business a much needed project and moreover the loss of skilled jobs in a remote region which has very few good opportunities for workers.

Indigenous skilled workers from community

One of my earliest experiences of working in the O&G Industry in the early 1980's, had a profound effect on my lifelong views of working with indigenous workers, and their ability to work, I mean really work very hard, with astonishing work ethics.

I was working with a small crew of six, in a OCTG casing pipe yard in Toowoomba, QLD, where we were tasked with the inspection and preservation of a huge yard full of OCTG casing, and that's where I met a young indigenous adolescent, and to this day I tell others of how he put us, comparatively speaking, lazy bums to shame, as he would start work on time, and work hard all day, and did his work to a high degree of professionalism, ... in a single word 'respect'.

But I have since learned of a new story here in the Territory, which starts off almost as good, but ends very shamefully.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

One of the Australian O&G operators, of its own accord and without any imposed regulatory obligations, had extended its hand to the local remote indigenous community, and offered unique opportunities for a number of young indigenous adolescents to be trained in skills and have opportunities to work in the industry.

These indigenous youth were subsequently trained and licensed in motor vehicle and a number of heavy earthmoving vehicles and worksite 'white card' and first aid, and given police background checks, etc, with a professional resume they were job ready, and the same Australian O&G operator had a project approved to build a bitumen road into the lease and well pads to be civil engineered and this provided a genuine skilled job opportunity, that many remote indigenous youth can only dream of.

However much to my dismay, and with great disappointment, I learned that the moratorium again impacted heavily, in that the moratorium made the road project redundant for the time being, and again the collateral damage was to the contractor and with it these indigenous youths futures.

Again I ask, why the NT government did not have a plan in place to cushion the blow, and to provide some form of retainer or support or transition to those who will be affected.

Loss of Livelihood for the older workers

The sudden impact that the moratorium has had on the careers of older workers between the ages of 45 and 65 is devastating, as these individuals can be discriminated against in 2 key ways, one being the more widely known 'age discrimination' the other lesser known form of discrimination of 'ex-oilfield worker', where there is a false perception that they will have higher expectation of remuneration and more likely to return to the O&G Industry in a recovery cycle.

What makes this situation much worse is that in the case of the NT moratorium, there was no action by the NT government to address these issues, and to provide any form of income support and/or suitable re-training to be able to transition to other career paths.

Another area of serious concern is that these workers are far less likely to find suitable stable income within 3-5 years and are usually less likely to be able to qualify for unemployment benefits and/or any associated support services, and whilst unemployed, they are also no longer receiving superannuation payments which degrades their future retirement funds.

Should these workers have been very diligent with their savings over the years, and worked towards having an investment property for their retirement, they will now be in a situation where they no longer have an income by which to lodge a claim against their income tax to afford to service their investment loan, so instead of having an investment (something which should be encouraged), they now have an unaffordable liability, which further degrades any savings they may have.

The combined impact of sudden loss of a career, loss of income, no superannuation contribution, no income for claimable source to pay for investments, no access to welfare, these individuals are financially impacted very heavily and depending on their level of savings and debt, can quickly experience acute financial stress and when this coupled with discrimination and poor opportunities, can lead to mental health issues, including acute anxiety and depression.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Impact on local Industrial Landlords

The sudden impact that the moratorium has had on local O&G service businesses has had another unintended knock-on effect, and that is to the local Territorian industrial landlords who have invested heavily in industrial premises for leasing out to industrial companies, which in some cases were directly or indirectly connected to servicing the O&G industry.

This sudden interruption to the local O&G service businesses, has also meant a sudden interruption to their leasing arrangements, causing the tenant to notify the landlord of their forced intention to break the lease early, which is another significant incurred cost, when suddenly winding up the local service business, and would also entail costs necessary in making good the premises.

Where a tenant is financially compromised (bankrupted) there may be a significant shortfall in the ability for the tenant to pay the amount owed to make good the premises and terminate the lease, which is then borne by the local landlord.

The loss of an industrial tenant for an industrial landlord can cause other significant setbacks on their business model, by affecting their ability to leaver of a stable tenant occupied facility to build new premises and grow. Another issue is that if too many tenants are vacating at the same time in the area, this also causes a glut of unoccupied industrial premises which can also cause the property price and lease value to drop, again impacting on the industrial landlord.

Summary of The real impact of the Moratorium

When looking at these impacts that the moratorium has had on the owners of small & medium businesses and their skilled employees, whether direct or indirect, it is important to stop and take note, of what is being said by the anti-fracker antagonist groups and what is actually occurring.

There been much shouting from the anti-fracker antagonist groups of there being *potential* for 'Mental Health and Wellbeing' which *may or might* cause these perceived social problems, the reality is that despite there being onshore unconventional O&G activity in Central Australia since 1967, and thousands of similar Shale Gas wells throughout Australia, we don't yet have a single case of medically diagnosable harm caused by unconventional Shale Gas, yet due to the moratorium, many businesses and skilled workers have actually fallen on significant financial hardship, and in some circles are unfairly ostracised in their community for being labelled and associated with ... in the words of the anti-fracker antagonist groups "The Dirty Frackers", which is intended to be inflammatory and derogatory.

From all I have witnessed, I firmly believe the real 'Mental Health and Wellbeing' issues are those imposed onto the owners of small & medium businesses and their skilled employees, by wrecking their business models and creating unemployment in an already tight jobs market.

The anti-fracker antagonist groups should be brought to account for the pain and suffering they have caused to those people who just so happen to have a skilled career in the O&G industry, by intentionally spreading misinformation to create a sense of urgent fear, and blind opposition to the O&G Industry.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Measuring Social License

It is in my firm opinion, that in order to establish the 'existence of' or a 'loss of' a Social License to any industry practice or issue of public concern, there needs to be at least two key components in place:

- firstly the facts must be made freely available and all, and any misinformation exposed or suppressed, so that the public can make factual and informed decision without any bias; and
- secondly, the question of polling the numbers of 'who's for' & 'who's against' the issue, must be done independently and in isolation of any other competing issue (i.e. not in an election), so as not to mix with other issues, and so there can be at least some degree of certainty on whether there is or isn't a loss of a Social License.

To use an election as a prime basis to determine loss of Social License is highly misleading as it doesn't measure the subject matter in isolation, but even more important is that even if you do conduct an independent poll, if the public are voting based on a concoction of misinformation, the results are going to be very unreliable, possibly giving the opposite result.

Whilst the ALP NT government has made their own claim that there was a 'loss of a Social Licence' as a trigger for both the moratorium and the Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, it has not in any way demonstrated how it quantified this statement to be a fact.

It has not yet taken measures to ensure itself and the public is factually informed and ensured that misinformation has been exposed or suppressed, nor has there been an independent poll to assess the actual level of support or resistance in isolation of other issues.

The suggestion that just because the ALP was elected into office, that this can in itself quantify as a loss of 'Social Licence' is rather absurd, especially when during the last election the overwhelming Territorian voter sentiment was all about removing the previous CLP government from office, and the onshore O&G industry was not a centre piece issue, rather a tag-on policy that comes along with the deal, like it or not.

On this basis alone, I would personally reject the premise of there being a measured loss of Social License to support ALP rationale for a moratorium based on the past election.

Further, whilst we can say that the anti-fracker antagonist groups have undoubtedly done an excellent job of penetration at the grassroots of our community and spread their own version of the O&G industry risks and practices, and then they projected a good measure of fear and guilt on the unsuspecting public, that doesn't make their position correct, nor does it support their argument of a loss of Social License.

The anti-fracker antagonist groups have taken it upon themselves, without practical industry experience, knowledge or training, to be the self-appointed '*educators*' to the general public in their understanding of the O&G Industry risks and practices, and once they have given their version to their captured audience and polled them, it is with no surprises they get a near 100% response, which is unsurprisingly aligned with what they have just been told to fear and believe.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

This is how Push Polling works to give a desired result, heavily distorted by misinformation, to their captive audience and then followed by their self-proclaim to have a clear majority, but I would strongly argue that if this debate was cleaned up, so that the facts prevailed and the public were better informed, that this would not only reverse the opinion of most of those who've been ill-informed, but possibly create a significant backlash against these antagonist groups.

So far almost all the argument to support there being any lack of Social License for the NT onshore Shale Gas industry has been based on the self-proclamations made by a rather small number of anti-fracker antagonist groups themselves, based on their own Push Polling results, which then gets echoed in various media outlets, and in my opinion was then erroneously politicised by the ALP during the last election period.

There has been some criticism levelled against the onshore O&G Industry for not doing more work to educate the public on the facts surrounding the actual operational process of Hydraulic Fracturing in Shale, however this criticism is also unfounded, as there have been many efforts made to disseminate the factual information to the general public with geologists, drilling engineers, environmental scientists, etc., and where this happens we did see people become enlightened and are much more comfortable with the O&G industry, but the anti-fracker antagonist groups then claim that these O&G industry sources of information cannot be 'trusted', attempting to turn it into a 'trust issue'.

As an obvious example of how anti-fracker antagonist groups spread misinformation, I would like to refer to the presentation given to the Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory by 'Don't Frack Darwin'. In their own words they said that they "run community stalls, engage with the public, hear their concerns, and have conversations, and help to 'educate' them (the public) about Fracking in the Territory", remarkably these people don't have any O&G industry training or experience and yet they believe they can better educate the public, and they go on to remark in their presentation that they were concerned about "misleading information", which in my opinion is exactly what they are providing.

In summary, I feel that there was no proper independent test of Social License conducted prior to deciding to implement a moratorium, instead the confusion caused by misinformation was capitalised for political gain, and thus this undermines the very foundation argument for the ALP to implement the NT moratorium.

Regulation versus specifications

Whilst this may seem to be rather obvious to some people in the O&G industry, there are many who still get easily confused as to which is which and what is entailed.

As the anti- fracker antagonist groups often try to lay claim that Hydraulic Fracturing is a very new technology, and there needs to be robust regulations to ensure its safe, there is a very big misconception as to what the 'Regulations' will do, and how it will somehow better develop the technology and make it a much safer practice, which is totally wrong.

The technologies used in Hydraulic Fracturing have their origins going back as far as 1934, when John Eastman used a whipstock to kick a well (directional drilling), and then injected

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

thousands of tons of water into the well under 1,400 psi pressure (Ref: <http://aoghs.org/technology/directional-drilling/>), it wasn't until about the mid 1940's that Hydraulic Fracturing was first being trailed and the 1950's it becoming a commercial practice to stimulate an O&G well for better follows.

So the technologies have actually been around for many decades, and like all complex technologies undergo constant incremental improvements to make them more efficient and safe to use.

The advanced steerable directional drilling systems used today are lightyears ahead of what was available to John Eastman in the early 1930's, giving today's geologists live feed on the formations below as they drill and for the drilling engineers the precision control of the drill bit to enter and stay central in the target formation like never before.

All the technical knowhow, specification and standards necessary to safely Hydraulic Fracturing are well refined and reside within the O&G industry custodians of the standards and/or specialised company IP (Intellectual Property).

So the technology and their 'Specifications' are already very refined, it's the 'Regulations' which are being discussed as needing to be made more robust, are those are the regulations that the government is responsible for developing (not the O&G industry), where the NT government has failed to keep pace with technological advancements in the O&G industry, and they needed to update their own Regulations, which in turn created a framework to guide the O&G industry on a range of compliance requirements.

As this is a significant failing of the government to keep pace with industry development, it should have taken a very different approach, by not implementing a moratorium, but instead temporarily adopting the regulatory protocols of say South Australia, whilst working with the O&G industry to develop the necessary NT government regulations in tandem, whilst the industry could maintain momentum under existing best practices, and would have avoided losing local industry support services.

Don't Frack the Territory - fact sheets & pamphlets

There are two key images appearing on the so called fact sheet / pamphlet by anti-fracking antagonist group, don't Frack the Territory (an affiliate of LTGA), which I believe falsely represent the true nature of onshore Shale Gas in NT.

The first is the aerial photo which is used to depict closely spaced well pads, taken I believe from Pavilion, Wyoming USA, there it depicts vertical shallow Shale Gas pads approximately 250m to 500m apart, whereas in NT the well pads will all have horizontal laterals spacing the pads approximately 3km to 5km apart.

We know that this anti-fracking antagonist group had members attend a number of public information sessions, where



Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

this was pointed out very clearly to them, yet this misleading image has been left on their official fact sheet to continue to mislead unsuspecting people.

The second image of concern is the illustration which is notably not to scale, so much so, that it looks much more like CSG than that of Shale Gas, which I assume is to give the impression that the fracturing in Shale is much more likely to contaminate ground water.

The impact notes for are questionable:

- 4) Contamination of underground water resources due to well casing failure.
- 8) Migration of gas and toxic substances into groundwater through natural faults and fracking induced pathways.

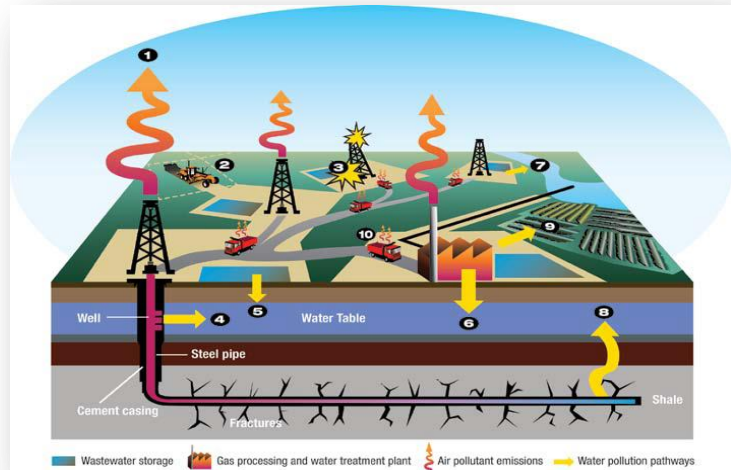


Illustration of impacts of unconventional gas operations, Modified from "Don't Frack the Territory" fact sheet.

In the fine print, at the bottom of the Don't Frack the Territory so called fact sheet / pamphlet it reads ... "Sources for all information provided are available at:

http://www.lockthegate.org.au/about_shale_and_tight_gas

Issues of Trust

The issue of 'trust' was raised repeatedly throughout the enquiry, which is rather interesting thing to raise, as it has much less to do with the science and technology and/or risks of the O&G industry and much more to do with the persons own ability to deal with reliance on others, and this topic of trust issues has kept many psychologists in a handsome income, researchers busy studying and bookshelves filled with countless pages of information on the topic.

The trust issue are usually raised as a point of contention as to whether or not the NT government itself is competent enough to develop, implement and monitor the new more robust regulations which are needed, and in so doing they will claim that the NT government cannot be trusted to do this.

To back this up, they will then point to any unrelated industries, like open pit mineral mines which have been abandoned / orphaned, and that is because there are no such examples which can be used from the O&G industry.

I feel that people, who are already predisposed to having trust issues, are very vulnerable to the targeted misinformation propagated by anti-fracker antagonist groups, and thus I do blame these activists for instilling a false sense of fear and anxiety and exploiting these trust issues, creating compounded mental health issues to these people.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Concerns raised on adverse health issues by fracking

Whenever the anti-fracking antagonist groups share their own version of the facts on what's involved in unconventional Shale Gas in NT, not only do they demonstrate very poor understanding of the technology and cross-pollinate the various methods and risks which are unique to CSG, but they almost always make very frightening claims of serious health issues happening in QLD associated with CSG.

This is a very powerful tool in the anti-fracking antagonist toolbox, as almost all members of the general public in NT will decide to err on the side of caution, especially when listening to stories of little children bleeding from their nose and ears, skin rashes, headaches, nausea to name a few.

Whilst this could be argued rather successfully on the basis that unconventional CSG and unconventional Shale Gas are very different in nature and they pose different levels of risk, or just to simply compare the higher population density in QLD that could be exposed to CSG, as compared to the very remote regions in NT, which could hardly see anyone near a Shale Gas well ... but that is not necessary.

It is possibly more powerful to take a good look at the validity of the original claims emulating from QLD, via LTGA through their Territory based affiliates, and to take a look at what Queensland Health Department discovered with *'The Darling Downs Public Health Unit investigation into the health complaints relating to Coal Seam Gas activity from residents residing within the Wieambilla Estates, Tara, Queensland, July to November 2012'* ... Extract as follows:

"Prevalence, nature and severity of symptoms:

As of 12 November 2012, Queensland Health had received reports from 11 local families representing 56 individuals (of the 56 individuals where information was provided only 46 were reported to have had symptoms). Eleven families reported symptoms through the HCC. Three families reported symptoms to both their local general practitioner and the HCC. Local HCPs reported 16 encounters (nine individuals) who felt their symptoms were related to CSG exposure. The most common symptoms experienced were:

- *headache (34)*
- *sore itchy eyes (18)*
- *nose bleeds (14).*

As of 12 November 2012, there had been no hospital admissions with symptoms allegedly related to exposure to CSG activities. On inquiry there have been no reported presentations by employees of the mining companies with symptom patterns similar to those reported by the residents of the Wieambilla Estates."

<https://www.health.qld.gov.au/research-reports/reports/environmental-health>

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Concerns raised about potential legacy wells

One of the concerns repeatedly raised by the anti-fracking antagonist groups, was about the need for all the O&G operators to contribute to a sink fund of some kind, to pay for restoration of any potential abandoned / orphaned wells in the Territory. This issue is usually raised as a tag-on issue when drawing a line of comparison to the many abandoned legacy open pit mineral mines which are dotted all around the Territory, where the mining company responsible was declared bankrupt and has not made-good the site.

Again this is a very poor analogy as these two industries are very different in many ways, the most noticeable is that the mineral mine itself will take up a massive area of total environmental upheaval, and it then needs some more space to keep the overburden, and some more space to stock product prior to shipping to market, and often has a series of dams which can potentially hold a number of naturally occurring toxins and/or chemicals used in an on-site refinement/extraction process, and they will build significant infrastructure on-site, such as crushers, hammer mills, etc.

To make good an abandoned / orphaned mineral mine can run into many tens or hundreds of million dollars, and as there is a very low probability of another commercial mineral mining company being willing to take over their lease, this is often left to the NT government to pick up the tab with tax payers money, which has created much deserved angst in the general public, prompting the need for these mineral miners to have a common sink-fund to help pay for such incidents in their industry.

In stark contrast, an onshore O&G well, whether conventional or unconventional takes up a comparatively speaking insignificant amount of space, with almost unmeasurable environmental impact, and all O&G wells GPS locations (along with other geological/well data) are provided by the O&G company and recorded by the NT government, and should an O&G operator become bankrupt, it is much easier for the NT government to retender the lease, and the new O&G operator take over the responsibility of the legacy wells in that lease.

One key point which sets the risk of a legacy O&G well apart from a legacy mineral mine is that, often when performing a Plug & Abandon (P&A) on a depleted O&G well, is that in some cases the value of recovered completion equipment from the well can considerably offset the overall cost of P&A, making this a relatively inexpensive exercise, especially when compared to the enormous cost of restoring a legacy open pit mineral mine, where there needs to be millions of tons of overburden pushed back into the pit and extensive soil contamination from leaking tailings dams and a massive area of environmental revegetation.

The logic that the O&G industry needs to have a similar sink-fund to the mineral mining industry is being pushed solely by the anti-fracker antagonist groups in attempt to give the impression that the industry poses a high risk or has a track record of leaving abandoned / orphaned O&G wells dotted all over the Territory, which is completely false and they know it, but they are trying to engineer an additional unnecessary cost and then frame an argument of the industry being unviable.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Concerns raised by the Tourism Industry

The main concern raised repeatedly by the Tourism Industry relates to the perceived impact on the landscape, where it will be littered with dense clusters of Gas wellheads giving a rather negative visual experience for tourists, of visiting an industrialised toxic wasteland of 'Gas Fields', where tourists will potentially be put off by this horrible image and thus will harm the tourism industry with declining visitor numbers.

Proponents of this view, often draw upon high impact images of the more densely clustered vertical CSG clusters, and despite themselves admitting that they are aware that these are images of CSG, and are a basically false representation of the very sparse Shale Gas infrastructure for NT, they nevertheless continue to rely on this imagery to support their concern.

The reality is that the Shale Gas well pads are only about 200M x 200M and spaced about 3.5km apart, and at this distance would be hardly visible from one pad to the next even if in clear line of sight, but furthermore, they will be typically located well off the main tourist routes, often deep in from the boundaries of private property, making it almost impossible for a tourist to even locate a single pad.

Methane versus Carbon as a greenhouse gas

Many anti-fracker antagonist groups are actually advocates for action against foil fuels in all its forms, and have been targeting Natural Gas on the basis of their desktop research that Methane Gas is much more harmful as a greenhouse gas than Carbon emissions.

They present graphs and figures that demonstrate the scientific research of how Methane is much more harmful as a greenhouse gas than Carbon emissions, and I don't seek to dismiss this or to contradict any science that supports this argument, however what I would like to point out, is that the modelling for Methane is being looked at with maximum life cycle and assumes very high levels of fugitive emissions, whereas the comparison of Carbon emissions from burning Coal seems to be only looking at the combustion stage of the life cycle of Coal, let me explain.

In the case of Shale Gas, the principle product is the Naturally occurring Methane Gas itself, and as the goal of any business, they try not to waste their saleable product, as that is their source of revenue and profits they're wasting, so safe to say the end-goal of any Natural Gas operator is to keep the Natural Gas contained in the pipe through all stages of the life cycle.

However, when we take a good look at open pit Coal Mining, where the principle product is the Coal, the Naturally occurring Coal Seam Gas (CSG) is simply allowed to escape as 100% fugitive to the atmosphere and in underground Coal Mines, the Naturally occurring Methane Gas is vented through massive vertical shafts with huge industrial fans and is considered an industrial hazard to be removed to the atmosphere.

So I find it very difficult for these arguments to make any sense at all, that a Shale Gas operator would be potentially delivering more Naturally occurring Methane Gas to the atmosphere than any open pit or underground Coal mine would, and if you look at the full life cycle of Coal and add both the environmental effect of the Coal burning for energy, together with the 100% fugitive of

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Naturally occurring Methane Gas from the Coal, the scientific comparison of effect between Methane and Carbon are meaningless.

Cattle Industry right of Veto

For one business / industry to hold a right of veto over another business / industry, which can be exercised at any time, including midway through the financially committed operations, with a level of impunity, would in this case give, the Cattle Industry requesting power of veto, an unfair tool, which could create an environment which is ripe for extortion ... i.e. "you do this for me, or else, I will exercise my right of veto and shut you down".

This option can be open to all kinds of potentially criminal abuse, especially by the less scrupulous and should not be considered an option at all.

Name any other industry, including the Cattle Industry, that would think it an acceptable practice to operate in a climate where at any point, a 3rd party business / industry could cause total and devastating disruption to your business activity (without needing to show just cause), via a power of veto, regardless of the level of current investment your business has already made to date, the impact it makes on the shareholders / owners of the affected business, the jobs and livelihoods of those involved in the resource Industry, without the property owner being required to justify their decision to exercise a veto?

Frankly speaking, I am somewhat shocked that those in the Cattle Industry would be thinking in this way so soon after their own Industry fell victim to an overzealous animal activist exposé, and the subsequent knee-jerk moratorium by a federal ALP government on the live cattle export industry, and the severe impact that had on their entire Industry.

This power of veto in the hands of the property owners alone would be a huge red flag to all investors to stay away from NT, making this a clear 'no-go' place, as at any time someone can simply pull the rug from beneath your business, without the need to show cause.

Any power of veto or power to call a "stop work order", should only fall into the hands of an independent non-commercial regulatory body, not a private commercial operator or external commercial Industry, and there should be clearly defined circumstances of type of breach to permit the veto or a 'stop work order' to be exercised and a facility for mediation/arbitration.

The NT general public should strongly consider that the NT resources beneath the surface including the potable water Cattle Stations and Agriculture farmers consume every day, actually belongs to the NT general public, not the private land owner/lessee as they only have right to the surface for their business activity.

Currently 100% of the NT resource royalty belongs to all Territorians equally, to be distributed evenly through public services and infrastructure development, however some of these pastoralists or rural property owners are seeking to extend their personal ownership down to the resources below the surface, to lay personal claim to the NT public resources, and to empower themselves with veto powers, to be able to manipulate the resource companies and the NT government into giving them a larger, more generous share of royalties pie, and this means the NT

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

public who would support any special royalties (as in the 10% suggested by SA Gov.) must give up some portion of NT royalties and benefits to this minority.

And this argument of a veto power is at the core of what Lock The Gate Alliance (LTGA) is all about, they are constantly using misleading environmental arguments to facilitate their true agenda, which is in my mind is to extort the public resource royalties, for the benefit of private land owners/lessees.

The general public needs to see through these false arguments of enviro-scare to see the true game which is at play, which is to tip the balance of ownership of resources and royalty away from the NT general public, and into the pockets of a small number of private land owners/lessees.

Ask yourself this question, if the Cattle Industry was to earn a large chunk of royalty from the NT public's resources, how many schools, hospitals will they build?, how many roads, bridges, water storage/drainage infrastructure will they construct? how many police will they employ? what will the royalties be used for? ... I fear this will only serve to enrich a very few property owners, and if the property is owned by a foreign entity, what then?

Influence and impartiality of Ministers

It is not that uncommon to hear anti-fracker antagonist groups making various outlandish unfounded claims of government ministers and other public officials being somehow influenced by big businesses, who they believe may be able to influence these officials in their favour.

However it has come as a point of some concern, to learn that Tristan Sloan, the current Ministerial Advisor to the Minister for Primary Industries and Resources hon Ken Vowles MLA, has submitted a strongly worded anti-fracking document to the previous Senate enquiry, 10th March, 2016, in his previous capacity as the Executive Officer of Amateur Fishermen's Association of the NT Inc. (AFFANT) <http://afant.com.au/wp-content/uploads/2016/04/AFANT-Hydraulic-Fracturing-Submission.pdf> , which some may see as having potential for bias against the onshore Shale Gas industry in NT.

The document submitted by Tristan Sloan in his previous capacity as the Executive Officer of AFFANT, has numerous mentions to CSG which, whilst it may have been relevant to that particular enquiry, it is somewhat irrelevant to the more focused risk and benefits relating only to onshore Shale Gas industry in NT, and too often the CSG risks and concerns are muddled into the NT Shale Gas debate.

With the Ministerial Advisor having previously and publicly displayed his obvious objections and bias against the onshore Shale Gas industry in NT, it would be a better look if the Ministerial Advisor declares that he has a clear conflict of interest in his ability to give impartial advice to his Minister on this matter, and that he be excused from providing any further guidance on the interim and final reports, including any scientific findings as published by the Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Economist to look at industry holistically

As the Enquiry will enlist the services of an expert economist to look at the validity and authenticity of Deloitte Access Economics report on the economic benefits the NT onshore Shale Gas industry will bring to the NT economy, I would strongly recommend the following five areas worthy of consideration in the analysis by the economist for the panel:

- assess the positive impacts that NT Natural Gas will make to alleviating the current and ongoing Australian Natural Gas availability crisis, and how our Natural Gas can assist in lowering the domestic prices (by bringing on more supply), and to ensure ample Natural Gas is available for manufacturing industries, saving Australian businesses and jobs;
- For the economic modelling to look holistically at the entire onshore O&G industry, for both its direct and indirect flow-on / trickle-down benefits to all the Service and Supply side of the industry which will be intrinsically linked to the industry being present, as too often when economists or statisticians will only include core O&G professional job titles, and neglect to count in the many other activities which are stimulated only by the presence of the O&G industry activities. These could be from engaging local SME businesses, employing both skilled and unskilled workers who provide services such as accommodation, catering and room/laundry, transport, warehouse & logistics, they could be suppliers of health and safety PPE, load testing, machine shops, fabrication, NDT inspection, electrical, hydraulics, mechanical, plumbers fitters, gardeners & cleaners, equipment hire, vehicle hire, etc. all of which will be not have titles that would typically class them as O&G workers, but whose employment will only exist, based on the presence and demand of an active NT onshore O&G industry.
- to also consider other spin-off benefits and synergies with adjacent NT industries, such as ... new water bores can be used for cattle in remote locations, any telecommunication upgrades and new bitumen roads or on-farm all-weather gravel roads built by O&G companies for their own needs, however they will also benefit the pastoralists with greater watering points for cattle, and in gaining all year access to markets and health services. There may also be some benefits to tourism operators having better road access to remote sites of interests, and by having reduced wear and tear on their vehicles.
- downstream opportunities for value-added spinoff industries in NT, where the Natural Gas is used for a wide range of modern energy efficient 'manufacturing processes' and extensively as a 'raw feed-stock material' for countless products we all use in our daily lives, and the potential to market these products both domestically and internationally in our region ... (such as Ammonia production https://en.wikipedia.org/wiki/Ammonia_production)
- the economist may be suitably skilled to undertake some basic background investigations of the key donor funding sources of the various anti-fracker antagonist groups, such as LTGA and their affiliates, and investigate the agendas of their financial backers to understand if there is some element of misinformation being driven by external / intentional vested interests? (https://en.wikipedia.org/wiki/Lock_the_Gate_Alliance ...

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

under heading 'Funding' *"Another Notable donor is the **American-based political body "Tides foundation"** who declared funding of \$160,000 in 2013 and \$275,000 in 2012 to Lock the Gate" and "In 2016 Lock the Gate received \$2.1 million from undisclosed grants and donations. Membership subscriptions accounts for 0.2% of their income")* ... and to ensure a level of transparency for the NT public, so they are fully aware of these external donor agenda and contributions, such that transparency runs both ways in this debate.

This background check on the financial backers of LTGA and their affiliates, to review the core agendas, is all the more important to clear up any public concerns or perceptions of there being external / international interests which would like to see our onshore Shale Gas industry in NT closed down to the commercial advantage of these donors, and considering the plight of our local NT businesses and their skilled workers who were negatively affected by the implementation of the moratorium, this is an area of keen interest.

National Gas shortage or plenty

The anti-fracking antagonist groups have been both vocal and misleading in the current debate on whether there is or isn't a Natural Gas shortage in Australia, and they seem to be keen to heighten public outrage at the O&G companies for a perceived preference to sell our Natural Gas resource to overseas markets, whilst our own energy producers and manufacturers suffer under a severe domestic market shortage.

But this is not rocket science ... It is simply a case of the ratio of supply & demand changing in a free market, where the decrease or increase of availability of the product in proportion to the market demand, creates a shortage or a glut, which in turn causes prices to either rise or fall.

The first part of this question is easy to answer ... 'is there ample Natural Gas in Australia to supply both the domestic & international market commitments?' and the simple answer to this question is 'yes', but it's mostly still in the source rocks deep underground, not sitting above ground, in huge storage tanks, so it needs to be extracted as and when we consume it.

A few years back, when O&G industry in QLD had secured international buyer contracts for the three LNG terminals, the QLD government were fully on-board, the projects were approved and operators financially committed in multi-billions of investment to build the LNG export terminal infrastructures, which brought much needed economic investment & jobs for QLD.

Notably that at this time, all the states and territories were pro-onshore Natural Gas and thus there was no moratoriums and ample domestic supply and cheaper prices all-round, however it was warned by the O&G industry and economists that unless there was continual exploration and development, including adding NT into the grid at some point, that there could be future shortages.

Now fast forward to about a year ago, where we have the VIC & NSW governments imposing moratoriums on onshore O&G operations, which equates to the total removal of their own supply of Natural Gas from the Australian domestic markets, and then soon after they start to experience the pre-warned domestic Natural Gas shortages, as their existing onshore O&G wells deplete.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

They begin asking the major manufacturers in their states, who have high Natural Gas usage to cut back on their use, and then they have to do some power shedding (rolling power blackouts) then when it starts to get really bad and people are complaining, they try to cry out that the O&G companies are to blame for a shortage and making the price of Natural Gas too high.

This is where the second part of this question is a bit more tricky to answer ... 'is there ample Natural Gas in Australia to supply both the domestic & international market commitments?' and the answer to this question is 'yes' and 'no', There is ample Natural Gas in the collective states of VIC, NSW, QLD & SA to meet total demand of both international and domestic markets, however as VIC & NSW have moratoriums on their reserves, their Natural Gas is not being made available to the combined market, leaving only QLD & SA to supply the entire market.

So from the QLD (&SA) government perspective, QLD has enough domestic Natural Gas for both their own energy and manufacturing needs, and have enough to support the newly invested LNG export terminals, and thus they have created a very successful business model for QLD to generate much needed resource royalties, so they're all good with the status quo, and argue that VIC & NSW governments need to lift their moratoriums.

However over the borders in NSW &VIC the governments who recently shut down their own onshore O&G industries with moratoriums, are now getting into very big trouble, as there is not enough domestic onshore Natural Gas in their states to meet their own energy and manufacturing needs, so much so, that with both Natural Gas shortage and increased prices, some manufacturers begin to shut down or consider moving offshore, creating huge risk to hundreds of thousands of jobs in the manufacturing sector.

So VIC & NSW still holding onto their moratoriums, are looking for excuses and other people to blame for their mistakes, so they begin to complain about the O&G companies who are still operating in QLD, where there is no QLD state imposed moratorium, and exporting the QLD Natural Gas overseas?

So the NSW & VIC decided to go to the Australian Federal government and to the media to complain about how O&G companies operating in QLD (&SA) are selling their own Natural Gas resources to their international buyers (and in the process meeting their contractual obligations, with penalties for failure to supply as is typical of this type of contract).

So the Australian Federal government seeing the seriousness of the overall Australian risk to 'energy security' & manufacturing, step in and say that the O&G companies operating in QLD (& SA) must divert sufficient amount of their Natural Gas back down to NSW & VIC to avert the Natural Gas shortage crisis in those states.

This directive assumes that QLD (& SA), who don't have any state imposed moratoriums, must ramp up their onshore O&G exploration and development to produce enough Natural Gas to cover both the domestic shortfall in NSW & VIC, their own state needs and their contractual commitments to their LNG terminals so they will not default on their international contracts, putting at risk the viability of these multi-billion LNG infrastructures, which they just built, could possibly taint any likelihood of future major investments in QLD or Australia.

Independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Keeping in mind that there was approx. 180 billion in investment into Australian LNG infrastructure alone, and what that meant to the Australian economy as a whole, and how failure to support these major investments once operational can affect future major investment in infrastructure.

So as I see it, the real problem in this whole calamity, is the negative effect that the NSW & VIC state imposed moratoriums, has had in creating both the national Natural Gas shortage of supply and then this subsequently becomes the root cause for the price of Gas to rise up as high as it has.

Although NT is not currently connected by an onshore pipeline to the main Natural Gas grid which interconnects the eastern seaboard, there is a new pipeline under construction, and this will open up a lot of opportunity for NT to be able to sell its abundant Natural Gas resource to the eastern seaboard, elevating any potential shortfalls in supply, ensuring prices are suppressed.

However if the NT continues to maintain a moratorium on onshore Natural Gas, we will neither play a part in helping secure the national energy security, support Australian manufacturers, and grow new downstream value-added industries and generate much needed revenues to the Territory government.

The peer-review scientific research has already debunked the pseudo-science and misinformation which triggered the VIC, NSW & Territory governments to err on the side of caution and inflict these devastating moratoriums, it's time to lift these moratoriums and support the onshore Natural Gas industry.

Declared conflicts of interest:

Oilfield Connect Pty Ltd is a local Northern Territory based privately owned business, which supplies a wide range of highly specialised products and equipment for the upstream O&G industry; especially products used for the drill string, OCTG casing & tubing and surface wellhead equipment.

It goes without saying that the NT moratorium has meant that this business has suffered immensely, with no commercial activity from the local onshore O&G industry here in the Northern Territory, so it is its best interest to have the moratorium lifted as soon as possible.

Oilfield Connect proudly supports a safe and responsible Shale Gas Industry in Northern Territory, and looks forward to the NTG developing and implementing a suitable regulatory framework and lifting the moratorium and collaborating with the onshore O&G industry to operate in an environmentally friendly way, with economic benefits to the NT economy.



Prepared and submitted by:

Mark Fraser – Managing director

Oilfield Connect Pty Ltd

Darwin, Northern Territory, Australia