

Scientific Inquiry into Hydraulic Fracture Stimulation in WA Broome Public Meeting – 27 February 2018

1. INTERESTS REPRESENTED

- Industry
- Exploration
- Traditional Owners
- Pastoralism
- Local Aboriginal group
- Kimberley Cattlemen's Association
- Farming
- Tourism
- Broome residents

2. SCOPE OF DISCUSSION / ISSUES TO ADDRESS

- a) Scientific analysis of risks: environmental, health, agricultural, heritage and community.
- b) Describe regulatory mechanisms that may be employed to mitigate or minimise risks to an appropriate level.

3. CONCERNS / RISKS

5.1 Water

- Water is main issue
- Where is the water planning?
- Groundwater is very important to the pastoral industry; Pastoralists wells; Anna Plains bores 10-20km separated, between bores – takes a day to check, to do a bore run
- Farm relies on bore water

Water quantity

- Company needs licence so has to justify their modelling through approval process and need to report on water management
- Working in Mid-West – concerns raised on water use; reporting is an issue (no local reps); Perth water shortages – from Mid-West fracking
- 40,000 wells sucking dry the aquifers
- Total amount of water used in this process is massive; will this compromise local/regional needs and that of local industry/businesses?
- What is the scale?
- Water volumes - amount of water needed is minimal compared to what is available

Water quality

- Groundwater contamination – rely on water to survive
- Chemicals used in the process
- Significant contamination risk, with grout seals
- The groundwater for Broome flows from north. Sea water wedge encroaching – 12 mile blocks had to be moved to be oriented along the highway
- If water flow is from fracking well, would be concerned if it is upstream of water supply wells; There should be no impact upstream of town water supply
- Pond integrity: leakages of radioactive water in overflowing ponds by local petroleum company in Kimberley, even at this stage with very few fracks. Have had unpredictable floods recently – need to recalibrate knowledge; prediction of a lot more intense events – serious concern to manage water
- Industry - Provided information on well construction to safeguard aquifers; Waste water requires treatment – regulations exist for this
- Contamination in ponds in Mid-West – dead birds/cows, smell from ponds

Water experiences

- Industry - Transparency with traditional owners; Traditional rangers – monitoring themselves; Includes waterholes
- Yulleroo 2 – fractured it 3 times – don't know contamination of water; No independent person there; Government say little impact on country; Depend on fresh clean water; Should be zero tolerance; Yawuru people want zero impact
- Camped at nearby wells; no perimeter fences, ponds not triple lined but rather single liner with tears in it and dead animals nearby; flowback pond did not have a liner but liquid went into a sump hole

3.2 Air quality

- Air same as in town with car pollution
- Carbon dioxide and methane emissions in light of Paris agreement – development of Canning Basin would push over the limit
- Industry - Air monitoring at frack site; Canisters during fracking; Met station as well – looked down wind

Air quality experiences

- Well leakage issue two years ago; Traditional Owners smelled the gas leaking and reported to Parks and Wildlife (DPaW); Department of Mines and Petroleum (DMP) found out through the news, then attended the next day; Soil samples, water samples taken by DPaW; Took two weeks to repair leak; Told the local petroleum company about leak but they were ignored; Time taken to report the well; petroleum company did not listen; DMP didn't regulate well until there was a leak – regular inspections

- Yulleroo 3/4 - fugitive methane issue; methane is 20x worse than carbon dioxide; see Yawuru independent report

3.3 Human health

- Public health not prioritised
- Has yet to see any serious injury/medical evidence at this stage

3.4 Environmental health

- Environment as a legitimate land use
- This is a type of environmental impact we have not had before
- Quantifying indirect impacts, not well covered by legislation
- Edge effect, e.g. intensive grid of wells, e.g. coal seam gas example; need to know the footprint before approval; how can you condition something when you don't know what the impacts will be
- Concern about the number of wells (40,000 +) compounding climate change
- Protect the landscape; Landscape effect of gasfield development – as in United States of America and Queensland; Savannah in Kimberley is largest and most intact in world; some impact from cattle
- Gasfields would transform Kimberley and impact badly on reputation for ecotourism to see intact landscape
- Fragmentation an issue if a lot of wells
- Pock marked landscape not relevant in Kimberley because different geology to that of Queensland
- Reckless tracks by mining companies ruining bush and aesthetic qualities of the environment
- Industry – landscape not likely to be impacted, limited amenity already, limited water resource
- Risk of massive influx of cyclonic water and impact when the ponds with fracking fluid are flooded with potential environmental toxicity; also potential risk of dams leaking and pipes overflowing
- Concerned that light pollution from floodlights and industry will mean the stars will be lost; Can watch stars set into the water in Broome

Cumulative impacts

- Cumulative impacts not covered by Western Australian legislation
- Creeping impacts – cumulative impacts, well count

Reserves

- Protection of national parks, reserves and ocean; some places more sensitive than others; impact on tourism

Clearing

- Land clearing requires permits
- Issue with land clearing for seismic lines, rehabilitation
- Clearing leading to water erosion
- Land already degraded from cattle
- Industry has rehabilitation plans

Invasive species

- Industry has weed management plans to make sure vehicles don't carry weeds/seeds
- Bulldozing the bush introduces weeds

Terrestrial flora and fauna

- Avoidance by fauna species of wells up to 350m away, shy species;
- Need to understand environment for well location, e.g. Bilby research from Murdoch University
- Species extinction is a concern in Australia

Fire

- Added 'catastrophic' to the fire sign – is this because of industry and gas leaks? Need transparency

Seismic activity

- Micro-seismic monitoring by industry
- Concerned about impact of seismic vibration on wildlife
- Seismicity? worried about stability and aquifer connectivity
- Industry uses micro seismic to monitor fractures

3.5 Fracking process

Well integrity

- Well integrity is a huge issue – well construction, cementing, chemicals used
- Experience from Theia 1, is a 70m thickness zone at 2500-3000m down, amenable to shale gas production; hydrological investigation showed presence of Wallal aquifer 150m down; oil and gas have 1200m separation from shallow aquifer; well integrity is good standard with 3 casing strings; The well management plan is public; There is 100% well integrity. This needs to be, as it is integral to allowing fracking
- Integrity of wells is pretty strict by government – feel comfortable with the hoops companies have to jump through
- Yulleroo 3/4 casing in last 1km has degraded; cement bond issue, leading to fugitive methane issue
- Well integrity: 5-6% of wells fail in first year; eventually all wells fail. Concrete; steel corrodes; Question is now many will vent methane or carbon dioxide?

- Petroleum company tabled picture of eight wells, triple casing of concrete and steel, will run through the primary aquifer
- Leaking well head January 2015, Yulleroo 2; inspected 2 months before – all OK; ABC reported methane detected with meter, investigated – bent/vandalised, trespassing

Materials/chemicals used and managed

- Concerned about chemicals used in hydraulic fracturing, especially carcinogenic chemicals and potential toxic poisoning of groundwater
- Transparency in chemicals used
- Are there problems with evaporation pond liners?
- Disposal of wastes – it is evaporated and sent to landfill
- Test contents of wells before disposal, after it has evaporated - Licenced waste disposal – tox-free
- Never seen tox free come past the gate in the last three years
- Issue about disposal of a liner irregularly - was an issue with the local petroleum company – company put well lining on back of truck and dropped it at dump
- BE9 poison same category of arsenic used
- Drilling down deep NORM (naturally occurring radioactive material) + BTEX (Benzene, Toluene, Ethylbenzene and Xylenes) in the ground, be produced
- Chemicals and radioactivity – whole process
- Industry says fracking chemicals less toxic than swimming pool
- (the petroleum company) Chemicals and mix are publicly monitored, advertised on web; independent assessment and considered safe

Regulation experience

- Department of Mines and Petroleum (DMP) come and do audits (health, safety and environment); well operation lasted 35 days; DMP came out once, thereafter the petroleum company had to submit weekly reports
- Department of Mines, Industry Regulation and Safety (DMIRS) not very regular in inspections
- Only one person from DMIRS in the Kimberley and doesn't have a car – how is it being regulated;
- Concerns about self-reporting
- Lack of capacity in DMP to regulate the industry, e.g. Yulleroo – water came in fault, 2010 fracked, 2013 gas leak found by Department of Environment Regulation, second gas leak; how many site visits did DMP do (not one in 7 years) despite the issues
- Companies write their own approval plans – conflict of interest; DMP environmental management; Leakage reported to Department of Environment Conservation 2013, not correctly recorded by government officer; Mines Department did not inspect that well for approx. 7 years; first frack and believes that there was no inspection by Mines Department and

company filled in holes and ponds, killing animals which fell into ponds; no action was taken until public exposure

- A petroleum company report, approx. 40,000 gas wells. Experience of Yulleroo says DMP doesn't have capacity to manage
- Landowner stopped company representative from servicing well site (DMP, Yawuru leak 2015); companies are responsible for servicing the well heads, and audits are undertaken by DMIRS, but not necessarily well resourced; needs to change.
- Industry is over-regulated
- Australia is the most highly regulated country in the world; takes several months to get approval; held to high standard;
- Yulleroo 4 drilled 2012; bottom kilometre not cemented properly, poor contact; DMP ran logs when cement still wet (should have done it when dry); pressure tests showed all OK

Industry experience

- EP493, one well, Theia 1, exploration well 150km from Broome - There is an environmental rehabilitation plan publicly available which commits money towards rehabilitation. Before 2014 it was not regulated. Since 2014 groundwater monitoring has been necessary. On site bores are monitored on the drill pad. There are more compulsory bores drilled. As regards rehabilitation, conditions are checked each year. Geology was predicted exactly from seismic survey. Geomechanics is done on cores to predict risk
- Field development plan comes after exploration phase; Production phase involves multi-well pads; e.g. 1 pad – 8 wells, 7km between each pad; Might have 100 well pads over 20 years; Should look at how many pads, not how many wells
- A petroleum company has done fracking (Valhalla site); provided fact sheets; quantitative information will be provided; good community engagement; whole of government regulatory process overseen by DMIRS; Environmental Protection Authority determined to be not environmentally significant; frustration with appeals process, used to delay; 4-month process; necessary but open to abuse
- Petroleum company experience – another well – trespass and damage to well; \$360,000 to repair damage; Yulleroo 2, Valhalla North and Asgard 1 successfully fracked;
- Petroleum company management – Rigorous testing regime for aquifers in the general area; bore monitoring to test for chemicals; monitoring all existing station bores and drill additional test bores; 21 station wells monitored and never recovered anything erroneous; no doubts about science or engineering
- All exploration wells are vertical; Production wells will be horizontal

Risk assessment

- Most incidents in oil/gas under high pressure; less concern with shale

- Through good engineering, leadership and planning can avoid problems with fracking
- Fracking occurs well below water table; fracking wells about 3,000m deep; Deepest aquifer approx. 1,000 m (saline) (potable water)
- 600 wells in Barrow Island – successfully fractured in an A Class Nature Reserve with no issues
- Fencing/regulations are there to make safe
- Question of what is failure and what is high or low impact?
- Fracking not worth the risks
- Risks outweigh benefits and regulation won't solve it
- Any threat to livestock and human health is not a good idea;

3.6 Country/community

- Environmental Protection Act (EP Act) can be used to look at community impacts
- Restriction to EP Act/lack of social aspects is problem
- Oil and gas industry sees themselves as part of the community; are extremely qualified scientists and engineers; all want good fresh drinking water
- If fracking is done in town, I'd be concerned; but happy with fracking away from town; 20km out of town and down 3km deep fracking

Aboriginal cultural and spiritual matters

- Cultural spirit
- Land access - Yawuru said no to fracking three years ago; petroleum company said they would talk to Yawuru; only asked 3/30
- Yulleroo 2, fracked in 2010, Yawuru people didn't give consent and didn't have opportunity to do it; free and prior informed consent;
- Another petroleum company has heritage protection agreements with three Native Title groups

Sense of place/community

- Important to preserve the wilderness status of the Kimberley
- Concern that fracking in the Kimberley is the "thin edge of the wedge" and door is opening to major industrial development

Economics/jobs

- Fracking could be a 40-year project with intergenerational employment opportunities, including contracting skills, civil works, apprenticeships, trades, ranger monitoring
- Northern Territory inquiry – jobs created is quite minimal – most fly in fly out workers, so not much for locals;
- Petroleum company hasn't employed locals; not obligated

- Company representative displacing locals; how to enforce employ local
- Queensland experience that promising to employ locals can't be achieved because locals don't have the right skills. Company forced workers to have local addresses to comply
- Broome economy lacks industry; James Price Point has cost jobs; real estate is now half price; need industry in Broome; employment opportunity
- Need to attract investment and development in the north; economic stimulus, infrastructure; takes product to Perth to export to Middle East
- Economics is important, e.g. jobs/business/community; particularly local/remote aboriginal communities
- Employment generated by fracking industry – at end of 2015, 13,500 man hours in manual trades, accommodation, catering for operations and mining camp at Noonkanbah; remote communities are challenged by isolation, lack of jobs and other opportunities and benefit from the industry
- Broome Aboriginal people have mixed views about fracking
- Industry – Pastoral industry generally OK with fracking, due to introduced infrastructure; concerns are with chemicals
- Fracking could impact tourism

3.7 Philosophy/ethics/natural justice/policy concerns

Ethics

- No trust in any petro-chemical company
- Government isn't to be trusted, so independent monitoring required
- 2012: low level of trust when company said they didn't frack
- Is technique just proof of concept? Experiment. Is it proven? Are we guinea pigs?

Natural justice

- Potential land use conflict; concerns about consent of third parties to come on pastoral lands and how that might intersect with new land use reforms; can pastoralists say no re conflicting land use
- Important that pastoralists who have made large capital improvements can say no; it is about land rights and for pastoralists to give consent (or not); lease holders vis a vis land owners
- Companies seem to be exempt from the law, exempt from clearing permits
- Farmers worried about water rights

Policy

- Short term benefit, long term degradation and no opportunity to fix it; who gets the benefit?
- Fossil fuels question - climate change/keeping fossil fuels in ground; fossil fuels is ancient technology
- Need jobs that protect public health, the environment and sustainability

- Shortage of domestic gas but surplus of West Australian gas sent overseas at considerably less cost; Government needs to look at pricing of energy so that local people are benefited; need a domestic gas policy
- Carbon credits – offshore gas capture is not as environmentally damaging

3.8 Information/communication matters

- Lots of different stories on fracking
- Limited understanding of process
- Need to make information transparent
- Independent science rather than industry/media
- A lot of environmental information collected under Environmental Protection Regulations; How is this used in designing project?
- Needs information to make informed decision; to be fully informed/not under duress; misinformation an issue
- James Price Point project had impact on Broome; social media driving information; must have accurate information; Communicate effectively
- Outcomes of enquiry report must be understandable to community; Everyone can understand; 1-pager (sort of); Plain English is a must
- Needs to be open/discussion – whole industry
- Sharing information is important between consultant and transparency with company
- Industry concern that interest groups generating community fear about potential impacts, and not held accountable

Knowledge gaps

- Size of development footprint
- Geographic reporting; Information must be specific to the area
- Habitat mapping of proposed development area
- important to understand what species are currently there, need environmental benchmarking before fracking
- How are wells capped and plugged and abandoned? Transparency to public
- Uncertainty not quantified – not transparent; the problem is not much research on what mitigation works
- Kimberley conditions unknown, in general ecology; new/unknown species; assessment needed; no predictive risk available; independent research body
- Geoscience Australia: independent groundwater modelling as was done for Queensland coal seam gas
- Maps provided at consultation – show the connection/boundary between the onshore and offshore basins
- Good baseline measurement of groundwater and other environmental information so there is a scientific base for understanding and an

information base to identify opportunities for compromise, decisions and impacts to resolve competing land uses

4. Regulatory considerations; What regulatory mechanisms may be employed to mitigate or minimise risks to an acceptable level?

4.1 Regulation framework

- Better practice guidelines needed, prepared by statisticians and terrestrial ecologists working together
- Better training and experience needed for regulators; United States of Australia has more regulatory experience
- Independent consultant rather than relying on company/proponent to do assessment; and for pre-project, monitoring, and post project; answering to government body rather than company
- Recommend that government approve consultant before proponent engages them
- Independent inspectors need to be part of the whole process of fracking, at construction, maintenance and closure; periodic inspections after well has been exhausted
- Transparency and integrity of the regulators, and that they are effective, well resourced, well qualified and have legal 'teeth'
- Consult Commonwealth Environmental Protection Authority
- Decisions made in conjunction with traditional owners
- Decommissioning needs to be regulated
- Use world's best practice; if practice not sustainable and healthy, use other methods
- Current regulation is sufficient; very well regulated; if anything, regulation should be streamlined

Environmental impact assessment scope

- Footprint prior to approval;
- There should be no impact upstream of town water supply
- Project timeline to account for time needed for restoration

Management Plans

- Can the Minister force a proponent to provide an updated management plan? Can the Minister rescind approval if new information comes to light? e.g. Queensland Water Act – didn't realise the impact from 3 projects (new information); 4th project was forced to do work
- Decommissioning plan should include standard and timing of ecological restoration

Rehabilitation/restoration

- Bonds should be sufficient for rehabilitation
- Onus on title holder to take responsibility for ecological restoration
- Rehabilitation is a lower standard than ecological restoration
- Introduction of an adequate bond system held by government/regulator so that the rehabilitation process is undertaken in an environmentally responsible manner
- Offset requirements, under Western Australian EP Act

4.2 Modelling, baseline studies, monitoring, analysis and public reporting

- Companies should commit to baseline investigations and on-going monitoring
- Baseline studies of hydrogeology paramount
- Good baseline measurement of groundwater and other environmental information
- It is imperative there is independent monitoring of private local water bores
- Systematic measurement of groundwater resource and good flora and fauna data
- Transparency - data held by independent body and be open and public

4.3 Insurance/penalties/compensation

- Risk factors reported by companies are not accurate and there needs to be more stringent regulations for companies to compensate communities/industries/people

4.4 Land access

- Land access on pastoral stations as long as pastoralists agree
- Native title granted exclusive possession over country but government say can't say no to fracking; want right to say no
- Protect land access regulations
- Pastoral lease-holders rights to be respected
- Cultural sites – every application must be reviewed by Aboriginal Elders

4.5 Legislation

- Want legislation, not just recommendations
- Need to be much clearer on how various acts work/fit together
- Scale of operation; How do they integrate with other land uses/activities; Fracking not exclusive use of land
- Protect groundwater, especially a town's drinking supply, so no industry development; protecting pastoral water sources
- Yawuru people put submission to 2015 inquiry, Environmental Protection Authority, Water Corporation; Recommendations need to be put into legislation – did that happen

5 REFERENCES, INFORMATION SOURCES CITED/REFERRED TO

- Eric Streitberg – drinking fracking water as a demonstration
- Ryan Vogwill's report- no guarantee there will not be well failure; as time progresses, will have more well failures – will get worse as time goes on
- Fact Sheets provided by Buru
- Yawuru independent report on Yulleroo 3/4 fugitive methane issue (Yawuru website)
- Bilby research from Murdoch Uni

6 ATTACHMENTS

Documents provided at the public meeting

Page	6.1 Date	Subject
13	2015	Buru Energy, Baseline and surveillance water monitoring program results from the Asgard/Valhalla region of the Laurel Formation of the Canning Basin
21		Buru Energy, TGS Exploration Program, Fact Sheets – Overview, Environment, Community
29	2015.09.11	Statement from Yungngora Association supporting Buru (also included in Environs Kimberley documents)
30	2015.09.xx	Finder Exploration, Great Sandy Desert Project (EP 493), Onshore shale oil and gas, Western Australia (51 pp)

Background

During 2015, the Buru Energy/ Mitsubishi Corp Joint Venture undertook a pilot scale exploration program for tight gas in the Laurel Formation of the Canning Basin. Zones in the Laurel Formation, located between 2.3 and 4 km below ground level were tested using hydraulic fracturing (HF) at the Asgard 1 and Valhalla North 1 petroleum wells.

To ensure no impact on groundwater as a result of the activities, a baseline and surveillance water monitoring program was implemented in the Asgard/Valhalla region. The baseline component of the groundwater monitoring program has been occurring since August 2012 with over three years of periodic water quality data collected prior to hydraulic fracturing occurring. As part of the monitoring program, environmental monitoring bores were installed upgradient and downgradient of each of the well site where HF was proposed to occur. Monitoring bores included nested monitoring bores – a shallow bore screened near the water table and a deeper bore screened in a more permeable zone in the upper most aquifer. Shallow monitoring bores screened near the water table were also installed downgradient of water retention ponds. Samples are periodically collected by the Company to meet our regulatory requirements and in accordance with Department of Water (DoW) and Australian Guidelines (ANZECC, 2000; AS/NZS 5667 1998; DoW 2009).

Monitoring bores located both upgradient (control) and downgradient of key risk points were sampled prior to (baseline), during (HF Operations), and following (Post Operations) the activities. This Before, After, Control, Impact (BACI) sampling design allows any impacts on groundwater as a result of the activities to be detected.

Parameters

Collected samples are analysed for over 35 parameters at a National Association of Testing Authorities (NATA) accredited laboratory. While comparisons are made for all parameters, chloride was identified as a key sentinel indicator for monitoring due to the following reasons.

1. Concentrations of chloride in the HF fluid and flowback water are several orders of magnitude higher than groundwater so any potential effects will be readily detected through a large spike in chloride concentrations in the downgradient monitoring bores.
2. Chloride concentrations in groundwater at these sites are relatively stable through time (have low variability).
3. Unlike longer-chain and more reactive molecules, chloride is non-volatile, non-reactive and non-sequestering (does not change form readily).
4. Chloride can be readily analysed in the field and laboratory.

Along with chloride, results for dissolved gases (methane, ethane and propane) are also included in the analysis as these are the constituents of natural gas and so represent key parameters of interest for the monitoring program. The results and summary of the monitoring program are presented below.

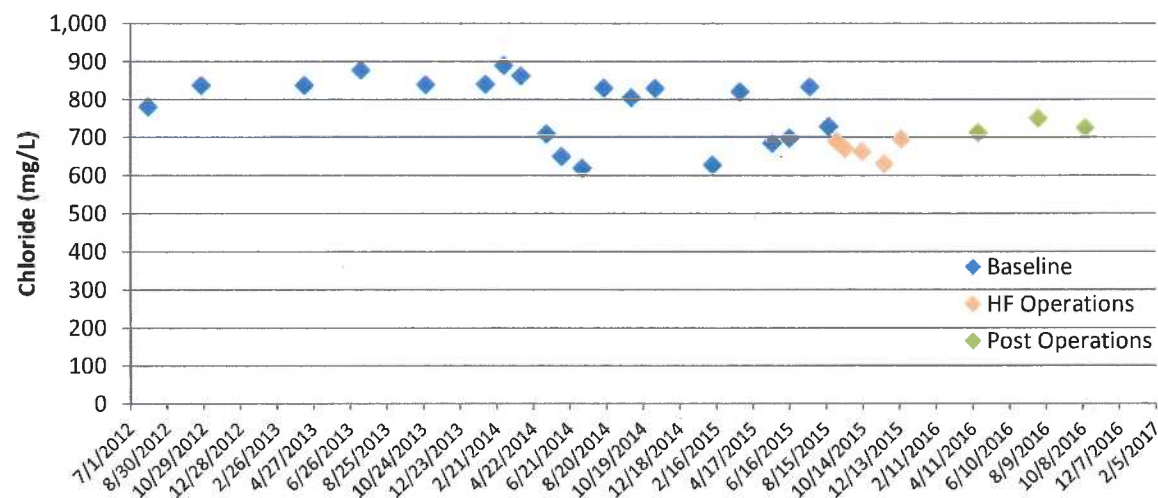
Parameter

Site

Time Series

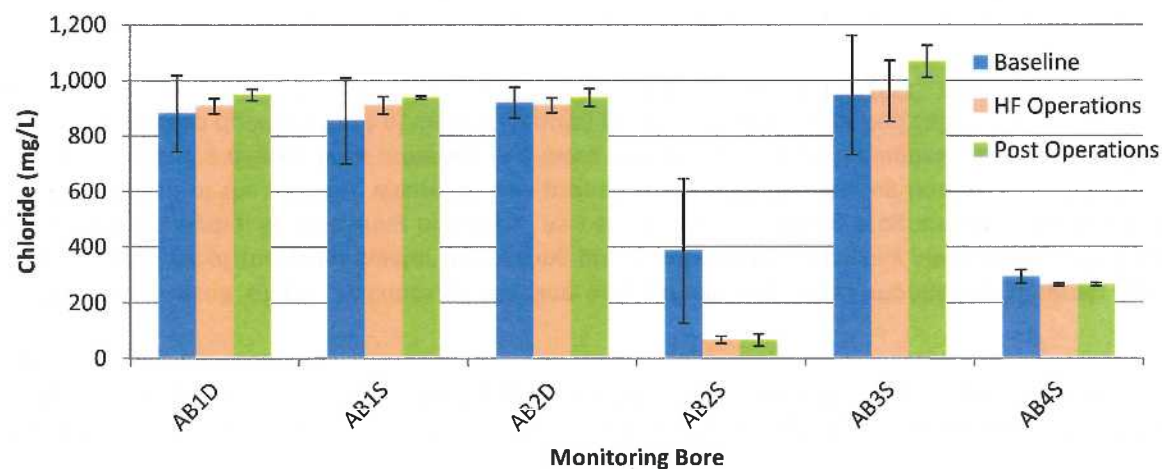
Chloride

Asgard
Production
Bores



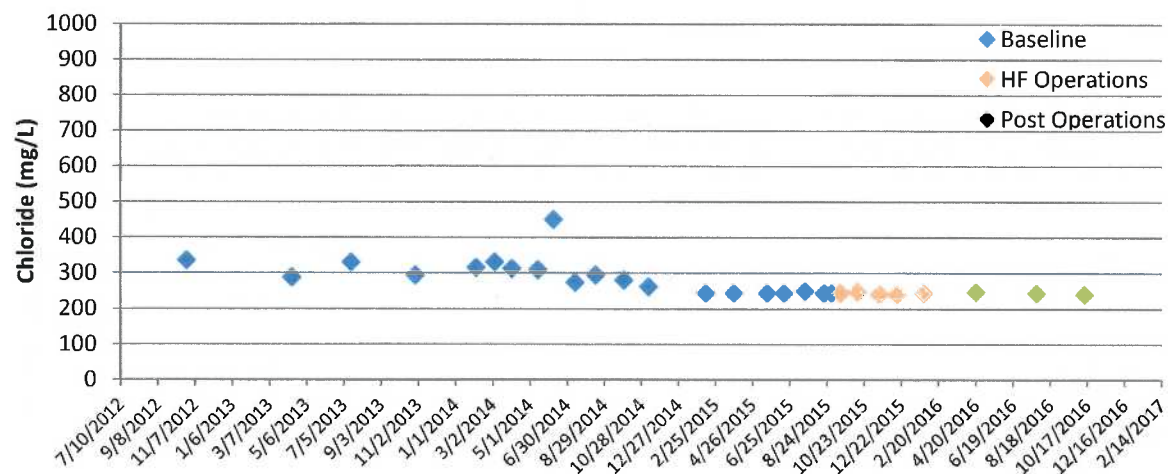
Chloride

Asgard
Environmental
Bores
(Averaged for
the period
May '14 to
Oct'16)

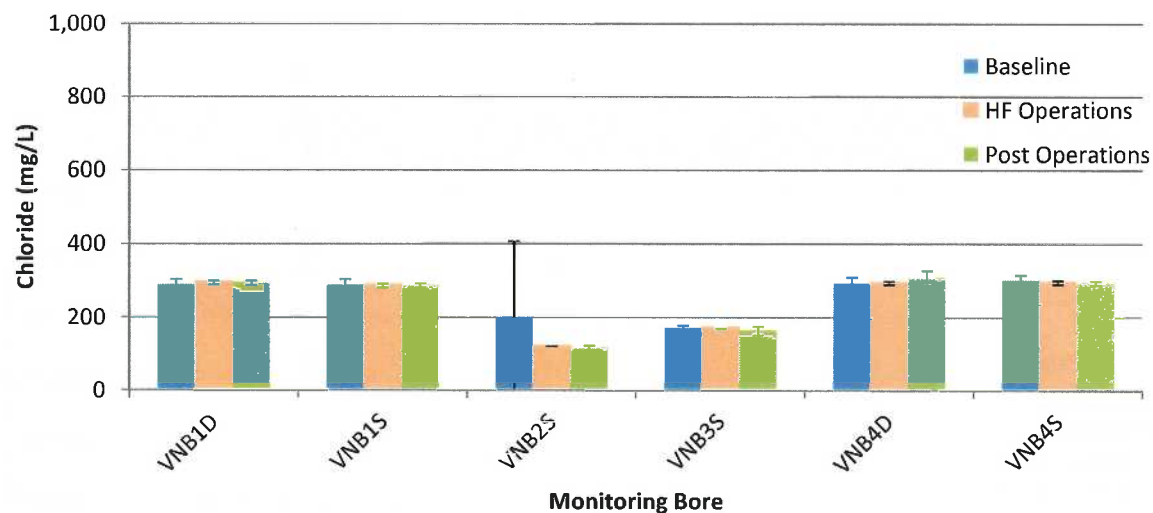


AB1D, AB1S = Upstream; AB2D, AB2S = Downstream well; AB3S, AB4S = Downstream Retention Ponds. Error bars represent Standard Error.

Chloride Valhalla North
Production
Bores



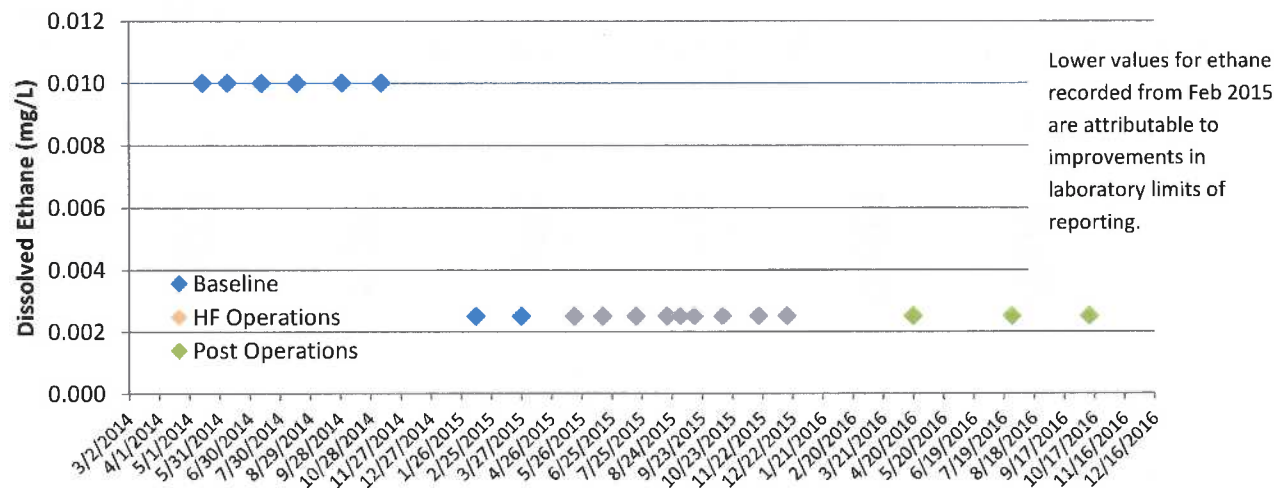
Chloride Valhalla North
Environmental
Bores
(Averaged for
the period
June '14 to
Oct'16)



VNB1D, VNB1S = Downstream well; VNB2S, VNB3S = Downstream Retention Ponds; VNB4S, VNB4D = Upstream. Error bars represent Standard Error.

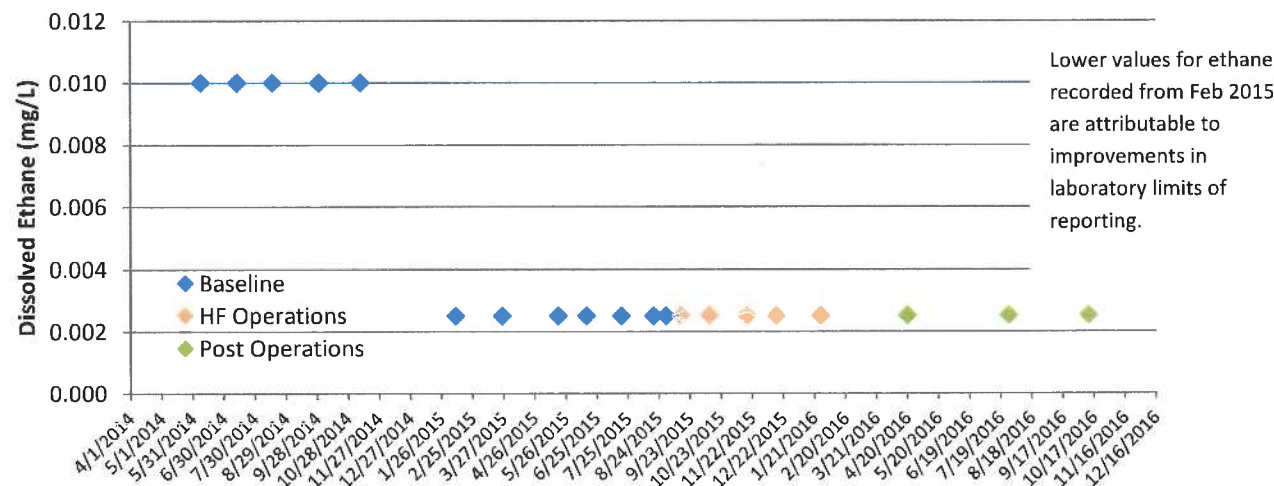
Dissolved Ethane

Asgard

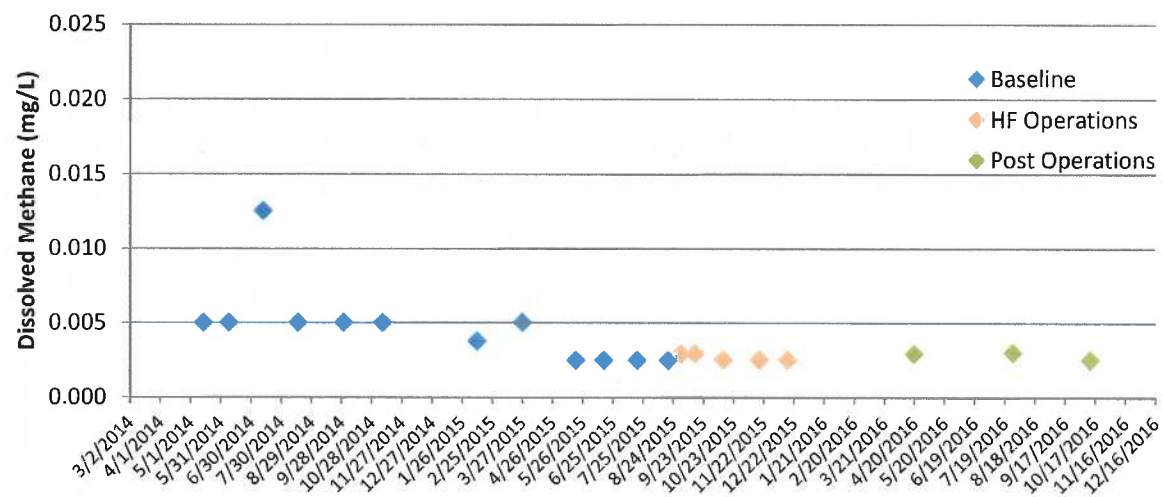


Dissolved Ethane

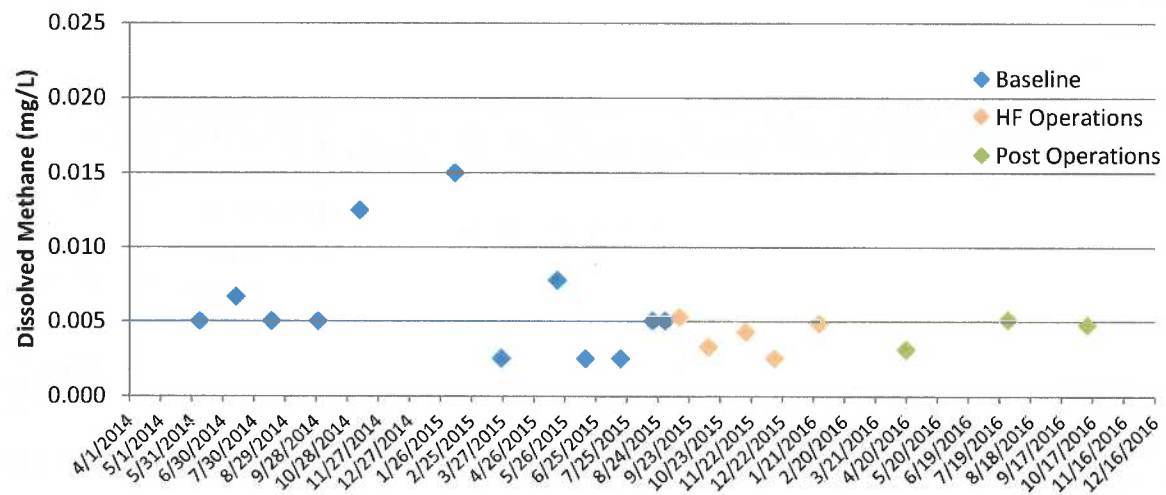
Valhalla North



Dissolved Methane **Asgard**

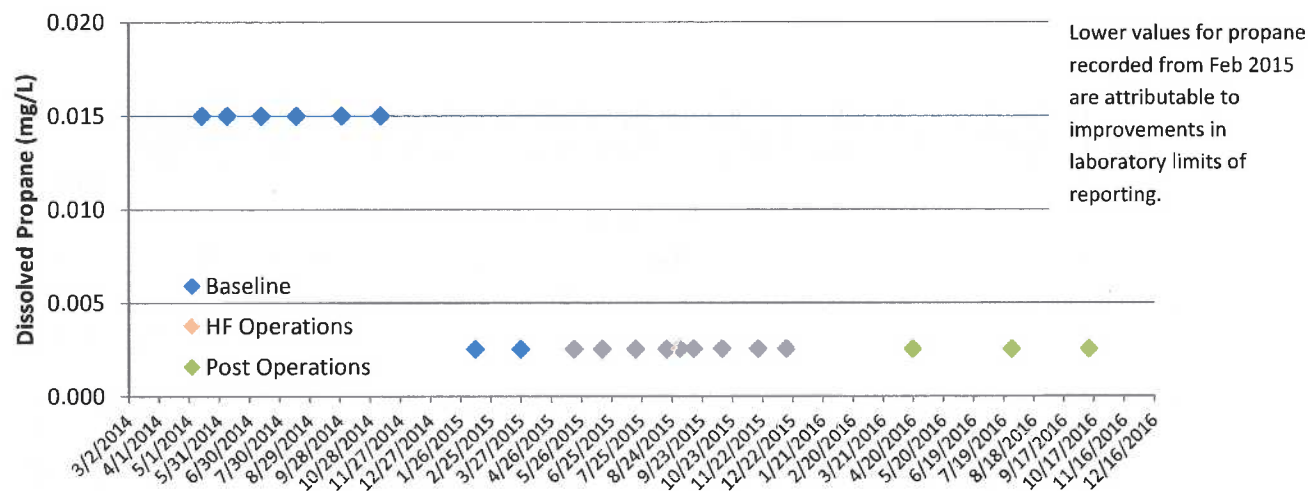


Dissolved Methane **Valhalla North**



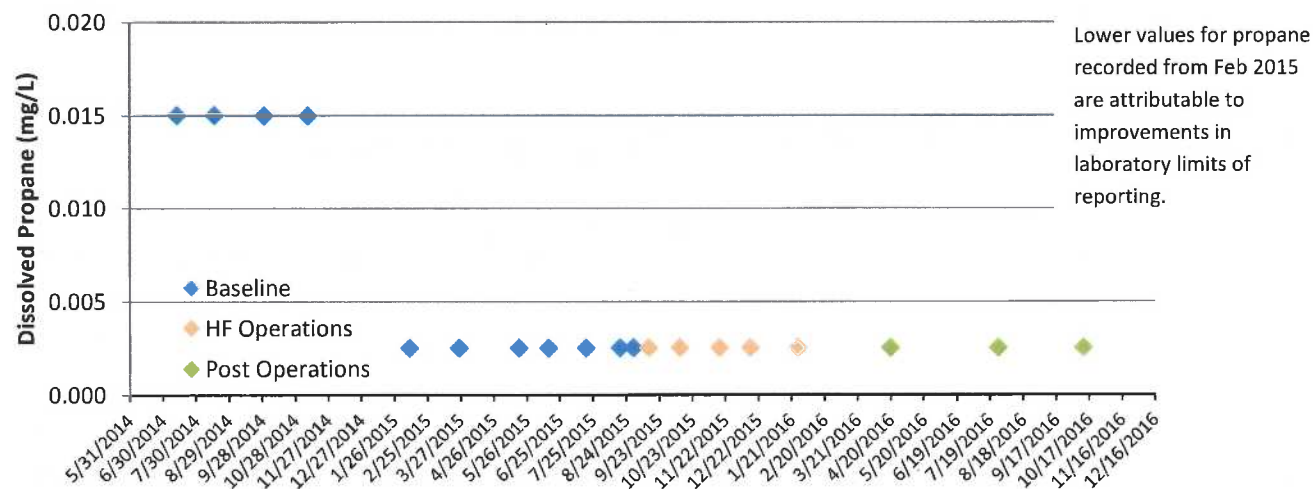
Dissolved Propane

Asgard



Dissolved Propane

Valhalla North



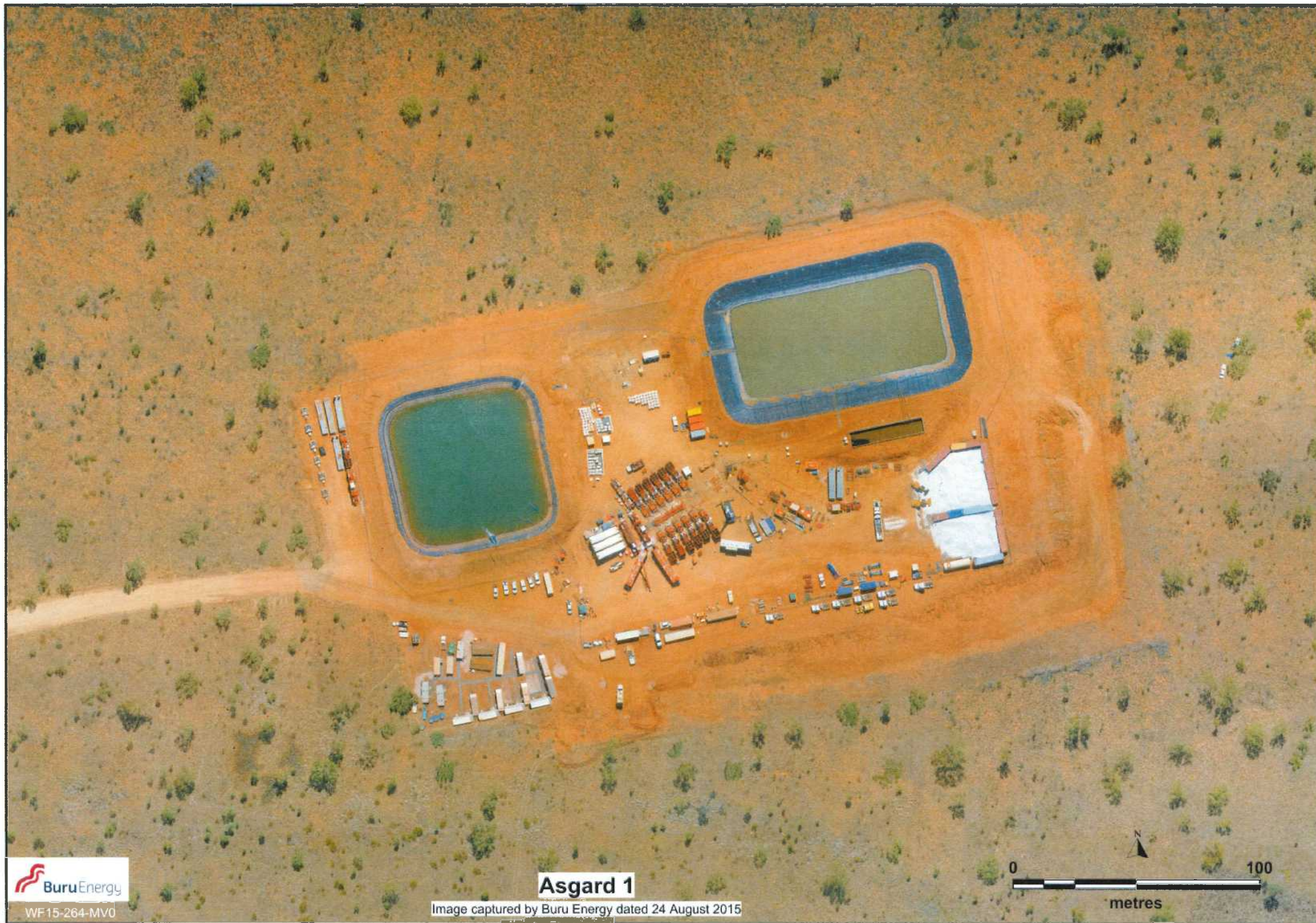
Summary

The monitoring program is robust and able to detect any impacts associated with the TGS activities. The monitoring program was developed in collaboration with the Department of Water (DOW), Department of Mines and Petroleum (DMP), University of Western Australia (UWA) scientists, specialist hydrogeologists and experts advising Traditional Owners on TGS activities.

More than three years of chloride data and 12 months of dissolved gas data was collected from each well site prior to activities commencing, establishing a robust baseline dataset. Hydraulic fracturing activities occurred during late August 2015 at the Asgard 1 well site and early September 2015 at the Valhalla North 1 well site. Water quality data was collected two weekly during the operational program. Results of the monitoring program show that groundwater characteristics during HF Operations at Asgard 1 are within the range and comparable to samples collected during the baseline monitoring program, clearly demonstrating that there has been no impact of hydraulic fracturing on groundwater in the region. The sampling is now continuing quarterly during the post operations phase and continues to show no impact of hydraulic fracturing on groundwater.

References

- ANZECC (2000). Australian Guidelines for Water Quality Monitoring and Reporting.
- AS/NZS 5667.1:1998 Water Quality - Sampling: Part 1 Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.
- AS/NZS 5667.11:1998 Water Quality - Sampling: Guidance on sampling groundwaters.
- DoW (2009) Field Sampling Guidelines for field sampling for surface water quality monitoring programs.
- DoW/DMP (2016). Guideline for Groundwater Monitoring in the Onshore Petroleum and Geothermal Industry.



Overview of 2015 TGS Program



Buru Energy is committed to socially and environmentally responsible development of our projects

Buru Energy's 2015 Tight Gas Pilot Exploration Program

Natural gas produced from the onshore Canning Basin is the same type of natural gas produced from the offshore northwest shelf. This natural gas is one of the cleanest fuels that we currently have available, generating about half of the greenhouse gas emissions of coal. For this reason, the use of natural gas represents a key means of reducing greenhouse gas emissions. The onshore Canning Basin potentially contains natural gas resources with sufficient gas to power Western Australia for more than 50 years.

In September 2015, Buru Energy in partnership with Mitsubishi Corporation commenced its latest phase of appraisal of the onshore Canning Basin natural gas resource. The program involved the hydraulic fracturing of the Asgard and Valhalla North wells on the eastern side of the Canning Basin.



Condor Energy frac spread pumping

This follows a test frac of the Yulleroo 2 well in 2010, located on the western side of the Canning Basin. Taken together, these tests are giving us a better understanding of the Canning Basin resource and are key milestones as we move towards the commercial development of the onshore gas resource in the Canning Basin.



Yungngora community members in the Condor Energy frac van

Groundwater monitoring was continuously undertaken during the 2015 program in partnership with the Yungngora community. The results of this monitoring, when compared against results collected for the three years prior to the program starting, clearly show that the project has had no impact on groundwater. The results of this monitoring program are available on our website. The results of air monitoring and microseismic monitoring also show no environmental impact.

The 2015 program provided considerable training and employment opportunities for the Yungngora people of Noonkanbah. During the program, a total of 33 people were employed by the company for over 13,500 work hours.

Yungngora people were involved in all aspects of the operation including civil works, security and access control, camp support, and working alongside contractors on the frac spread. Increasing the capacity of the indigenous businesses and workforce will allow us to develop the resource in a socially and environmentally responsible way, ensuring local communities benefit from the project.



Yungngora employees working on the frac spread

The fact sheets in this series provide more information on the community and environmental outcomes of our 2015 program.

Further Information

Further information on our Environmental monitoring and Community Engagement programs is available from our website www.buruenergy.com

Groundwater Monitoring

Background

Buru Energy's Tight Gas Stimulation (TGS) Program has been reviewed by the Environmental Protection Authority (EPA) and the Department for Mines and Petroleum (DMP). Both of these reviews included inter-agency consultation with technical specialists from the Department of Water (DOW).



Koolkarriya rangers water sampling

Every review undertaken has concluded that Buru's TGS program poses minimal risk to the environment. In consultation with the DOW, DMP and specialists from UWA and specialist hydrogeologists from Rockwater, Buru Energy developed a robust monitoring program to demonstrate that there has been no impact to groundwater resources as a result of our program.

At each well site where TGS activities took place, the Company installed six dedicated environmental monitoring bores. The location of these bores was determined in consultation with the DOW, UWA, expert hydrogeologists and independent specialists advising key Traditional Owner stakeholders.

The monitoring bores covered both the shallow alluvium and deeper sections of the

water table and were arranged up-gradient and down-gradient of each well site, allowing any impact of our activities to be readily detected.

To date, the Company has collected more than three years of baseline data at each well site. This baseline monitoring has been undertaken in collaboration with Koolkarriya rangers from Noonkanbah community. Koolkarriya rangers are proficient in water sampling and hold a *Certificate II in Conservation and Land Management* from the Kimberley Training Institute. Results have been publicly available on our website for more than 12 months, ensuring transparency with key stakeholders and the interested public.

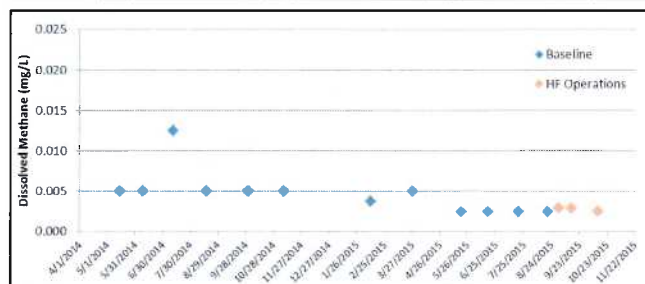
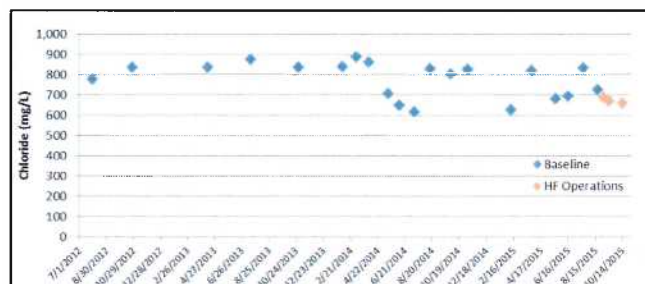
Results of monitoring program

Based on advice received when designing the monitoring program, particular emphasis was placed on tracking chloride concentrations in groundwater. Chloride is an effective indicator of any potential effect of the program on groundwater for the following reasons:

- Both the hydraulic fracturing fluid and flowback fluid are considerably higher in chloride concentration (by several orders of magnitude) than groundwater, meaning any impacts on groundwater will be readily detected through chloride anomalies in down-gradient monitoring bores.
- Chloride concentrations in groundwater at these sites are relatively stable through time (have low variability).
- Unlike longer-chain and more reactive molecules, chloride is non-volatile, non-reactive and non-sequestering (does not change form readily) so that it is readily detectable over time and distance.
- Chloride can be quickly and reliably analysed in the field and laboratory.

Water quality results collected from water bores down-gradient of the well head at Asgard 1 are shown here. Full monitoring results are available on the Company's website. No anomalies in chloride concentration have been observed and the results are consistent during baseline and operational phases so it is clear that our activities have had no impact on groundwater resources.

Similarly, there has been no increase in methane, ethane or propane from background levels during the monitoring program.



Water quality results for chloride (top) and dissolved methane (bottom)

Further Information

Further information on our Environmental Monitoring and Community Engagement programs is available from our website www.buruenergy.com

Hydraulic Fracture Fluid and Chemicals

Background

Chemicals are added to hydraulic fracture fluid (HF fluid) to help suspend sand (proppant) in the fluid, to reduce friction in the well bore during pumping, to prevent corrosion of the equipment and piping, and protect hydrocarbons in the reservoir against introduced bacteria. The frac fluid used in our program comprised 93% water, 5% sand and 2% chemicals.

Chemicals in the HF fluid are readily biodegradable and are quickly broken down in the formation. These chemicals are dominated by common salt and food acid (1.76%) with chemicals derived from common household items contributing the remaining 0.24%. Salt is an important constituent of the fluid as it helps to

prevent clays in the formation swelling when they come in contact with water.

The types and use of HF fluids has evolved significantly over the last 60 years and continues to quickly evolve through the investment in significant research by the service companies that provide the additives. This has led to the development of "green" HF fluids that optimise operational and environmental outcomes. Selection of suitable chemicals was a key consideration during selection of services for our 2015 program.

The toxicity of a substance is determined by the effect of a substance on an organism and the extent to which it

enters the body. Concentration is also important. Many common substances such as salt and sugar can be harmful in high concentrations. Toxicity tests are used to identify adverse effects of a substance on various organisms by exposing an organism to varying concentrations of the substance. These tests are undertaken in accordance with regulatory guidelines.



Testing of our HF Fluid

As part of the selection process for the additives, an ecotoxicity test of the fluid system was undertaken using juvenile rainbowfish (*Melanotaenia splendida splendida*) by Ecotox Services Australasia. Rainbowfish were chosen as they are common in freshwater areas of the Fitzroy River and other Kimberley catchments. The ecotoxicity test used all of the constituents in the HF fluid system and was undertaken using the test protocol ESA SOP 117 (ESA 2013)¹, based on USEPA (2002).

Results of the ecotox test indicated that the fluid system is ten times less toxic than the lowest toxicity rating in Australia for acute toxicity. This means that the HF fluid mixture that is injected into the formation more than 2.5 km underground during the TGS program is essentially non-toxic. Considered another way, the fluid is 30 times less toxic than swimming pool water.

All chemicals used in the program have also been fully disclosed online via the DMP's website in accordance with regulations under the *PGER Act* (1967).



Source: www.ecotox.com.au

Further Information

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¹ ESA (2012) SOP 117: Freshwater and Marine Fish Imbalance Test. Issue No 9. Ecotox Services Australasia, Sydney, NSW.
<http://esi.ecotox.com.au/Home>

Independent Specialist Peer Reviews



Buru Energy is committed to socially and environmentally responsible development of our projects

Background

Hydraulic fracturing (fracking) has been undertaken safely and effectively on many millions of petroleum wells since the 1950's. However, public misconceptions caused by misinformation regarding the effects of fracking on groundwater and the environment makes it difficult for people to make informed decisions about responsible land management and to balance economic prosperity and opportunity with environmental and cultural considerations.



Specialist reviewers presenting to Noonkanbah community

Native Title rights have been determined for much of the Canning Basin, making aboriginal people key stakeholders in our projects. Aboriginal people have deep cultural connections to the land and water so ensuring aboriginal people have access to clear and independent information regarding the impacts of our projects is paramount in helping communities make informed decisions. To assist Traditional Owners make these decisions, Buru Energy has supported three independent specialist reviews of our activities with the Yungngora (Noonkanbah) people, Yawuru people and the Nyikina Mangala people, Karajarri people and Ngurrara people represented by KRED Enterprises Pty Ltd.

Each Traditional Owner group made their own selection of independent specialists to advise them on our hydraulic fracturing activities. The reviews included 11 specialists from four different universities and the CSIRO. Buru Energy provided funding for the independent experts to review our activities and also made available all relevant approvals documentation during the process. The reviews were undertaken independent of Buru Energy and included collaborative risk workshops, community meetings and information sessions.

Outcomes

The outcomes of the specialist reviews are outlined below.

Yungngora (Noonkanbah)

"We have been very thorough in our assessment of this project; we have appointed independent experts to provide us with technical advice; their advice is that this project will have very low risk to country." "We have accepted their advice." Caroline Mulligan from Noonkanbah Community (The

West Australian, June 25, 2014).



Community meeting at Noonkanbah community

Yawuru

The Yawuru specialist reviewers determined the *Environment Plan* used best available techniques and met the requirements of the *PGER Environment Regulations (2012)*. The objective of the regulations is to reduce environmental impacts and risks to As Low As Reasonably Practicable (ALARP). This report is available on the Yawuru website at:

<http://www.yawuru.com/information-hub/useful-documents/>

KRED Enterprises

The KRED reviewers determined that the potential risks to groundwater and surface water are low due to both geological barriers and engineering controls in place. The KRED review further determined that below ground pathways pose a much lower risk than above ground operations such as transport of materials or surface spills. These surface operations can be effectively managed in the same way as risks associated with other industries in the region such as the pastoral industry.

Summary

The reviews were successful in providing independent and accurate information to Traditional Owners regarding the effects of fracking on the environment and country. The outcomes of all three review processes clearly demonstrate that Buru Energy's activities pose low risk to the environment, are undertaken in compliance with stringent regulatory requirements and use best available techniques. With this independent advice in hand, the Yungngora people of Noonkanbah supported the Company's activities, which have led to significant

economic benefits and job opportunities for their community.



KRED specialist reviewers presenting to KRED's members. Source: KRED Enterprises.

Six Separate Reviews in WA now show Hydraulic Fracturing is Low Risk in accordance with reviews in other jurisdictions

The outcomes of the independent specialist reviews undertaken to support decision making by the Traditional Owners are consistent with three other reviews into hydraulic fracturing in Western Australia in the last two years. These reviews came to the same conclusion as other independent reviews in other jurisdictions. These reviews in WA included the:

- Department of Mines and Petroleum's (DMPs) assessment of *Buru Energy's Laurel Formation Tight Gas Pilot Exploration Program (TGS) Environment Plan* which determined that environmental risks associated with Buru Energy's TGS program could be managed to As Low As Reasonably Practicable (ALARP).
- Environmental Protection Authority's decision of 13 January 2013 to not assess *Buru Energy's Laurel Formation Tight Gas Pilot Exploration Program* as it did not meet their criteria for environmental significance as defined under the *Environmental Protection Act 1986*.
- *Report 42 by the Standing Committee on Environment and Public Affairs on the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas* (Parliamentary Inquiry Report) tabled in the WA Legislative Council in November 2015 which determined that hydraulic fracturing in Western Australia posed negligible risk.



Condor Energy on location at Asgard 1 well site on Noonkanbah station.

The Parliamentary Inquiry report followed a two year Parliamentary Inquiry that carefully considered all of the evidence regarding hydraulic fracturing in Western Australia and called a number of expert witnesses and key stakeholders including conservation groups. In addition to determining that hydraulic fracturing posed negligible

risk, the final report recognised the potential benefits of a shale gas industry "as an employer, an investment generator and a provider of future energy security."

The outcomes of the six separate assessments and reviews along with the Australian Council of Learned Academic's (ACOLA) report *Engineering Energy: Unconventional Gas Production – A Study of Shale Gas in Australia* and the outcomes of the Northern Territories *Independent Inquiry into Hydraulic Fracturing* by Dr Allan Hawke further demonstrate that the risks associated with hydraulic fracturing have been grossly exaggerated and that much of the opposition to hydraulic fracturing in shale and tight gas is driven by deliberate scaremongering by conservation groups with anti-fossil fuel agendas. Reflecting this, the Conservation Council of WA (CCWA) was singled out in the Parliamentary Inquiry report for making claims about hydraulic fracturing that were "greatly over-stated" and "not based on evidence".

These misinformation campaigns potentially affect opportunities for people in regional areas to benefit from an onshore gas industry. Potential benefits are significant with many of the support services for onshore gas projects provided locally, including mobile camp accommodation, civil works, sand supply and haulage, trucking and transport, cranes, waste disposal, fuel distribution and security.

These opportunities will make a significant difference to the viability of regional and remote communities. This was perhaps best summarised by the Yungngora (Noonkanbah) community media release from 11 September 2015;

We want to keep this place going. We want to keep our young people safe from alcohol and the new drugs coming into the Kimberley. This is what is killing our people. Mining is giving us job opportunities to work our own land. We need training and job opportunities for our kids future.

Alcohol and drugs is killing our people – not mining or oil and gas

Further Information

Further information regarding our Community Engagement programs is available on our website at: www.buruenergy.com

Training, Employment and Contracting

A Local Project for Local People

Buru Energy is targeting tight gas in the Laurel Formation – a large basin centred gas system in the Canning Basin. The Laurel Formation is an extensive continuous gas resource that could provide energy security to Western Australia for over 50 years. Development of the resource will also provide significant employment and business opportunities to local Kimberley people and communities. The infrastructure associated with onshore oil and gas is relatively straightforward and will be located out of town on remote pastoral stations. Any potential project will not require a large Fly In, Fly Out (FIFO) workforce and will complement and provide opportunities to existing businesses in the region.



Environmental Cadets from KTI

This benefits Buru Energy as there won't be a need to fly our workforce in and also benefits local people as it allows them to balance work with family and cultural commitments.

While many Companies view the Canning Basin as remote, Buru Energy recognises that there is a ready-made workforce on our doorstep. The couple of years it will take the company to appraise (prove up) the resource provides us with an ideal opportunity to train and employ local people and businesses in providing specialist services to our projects. This training will be aligned to future job opportunities in the industry with much of the training provided to date undertaken "on the job". This ensures the training is accessible, interesting and relevant, and allows the local workers to earn a wage as they develop the skills of a healthy and balanced work and family lifestyle in the modern economy while continuing to live and enjoy life in their homelands. Buru Energy kicked off the training of local people in November 2013 with the establishment of our environmental cadetship program. Twelve aboriginal participants from across the Kimberley started the program, with four Noonkanbah and two Yawuru participants graduating in December 2014 with a *Certificate II in Conservation and Land Management* from Kimberley Training Institute (KTI). The participants at Noonkanbah have been assisting the company with ongoing water sampling and environmental monitoring for the past 18 months.

Training and Employment during our 2015 program

The 2015 TGS program at Noonkanbah provided Buru Energy and the Yungngora Community with a great opportunity to significantly progress the training and employment program. A pre-planning phase was conducted with the Buru Energy team, our service providers, KTI and most importantly, the Yungngora Community. Potential work scopes, skill sets and on the job requirements for trade tickets were identified in this phase, together with a list of participants selected by the Community.



On ground activities for our TGS program started in June 2015. To date, 33 workers from the community have put in more than 13,500 hours on the project. As this is all paid employment, it provided a significant economic boost to the community. To ensure the workers had the required skill sets, we are partnering with KTI to deliver on-the-job training.

Fifteen people were trained and ticketed in security, the operation of excavators, water carts, dump trucks, front end loaders and bobcats with a total of 32 tickets awarded to date.



The Yungngora community was responsible for delivering the access control and ranger scope during the TGS program, in partnership with security specialists. This included maintaining a 24 hour ranger presence of operational areas and involved a workforce of over 30 community personnel. Noonkanbah workers were also seconded to the service companies during the TGS program to get hands on experience. The workers were responsible for equipment maintenance, loading sand, road watering, refuelling and related jobs, and worked alongside the Condor Energy frac crew for the duration of the program. Opportunities were available for all members nominated by the community and included providing support to the camp that was on location during the program.



Yungngora security personnel

The workers stayed in camp during the program which provided them with valuable experience learning what camp life at a petroleum site is like. It also gave everybody involved in the operations the opportunity to get to know each other on site and continue their learning after hours.



Yungngora employees working on the frac spread

All of the work during the 2015 program was undertaken under fee for service arrangements with the community. This supported the establishment of indigenous businesses in the community and allowed them to develop the experience and expertise required to manage these types of businesses.



Yungngora employees undertaking equipment maintenance

Other Opportunities

The program developed jointly by the Yungngora community and Buru Energy provides a model for engagement in training and employment that encourages local business development in remote Aboriginal communities. Many of the skills and experience gained by the team who have been working on the project are transferrable to other industries in the Kimberley such as civil works, construction, working on pastoral stations and industries like road maintenance. Getting involved in related industries in the Kimberley will increase the opportunities available to Noonkanbah businesses and ensure ongoing work for them.

Buru Energy also supports a number of other initiatives in the community, including the re-establishment of the Yungngora artists group. In the last few weeks, more than 130 artworks centred around traditional dreamtime stories of their country have been produced and sold to Buru and Mitsubishi people as well as personnel in the camps and are now being distributed to a wider audience. The community is now working on an art training program with KTI to broaden and enhance their art group.



Yungngora artists group

Further Information

Further information regarding our Community Engagement programs is available on our website www.buruenergy.com

Traditional Owner Engagement

Respect for Culture

Buru Energy is a small West Australian oil and gas exploration and production company with offices in Perth and Broome. Our exploration portfolio in the Canning Basin of Western Australia covers lands that are generally subject to native title rights. We have a positive working relationship with Traditional Owners based on transparent exchange of information, mutual respect and understanding of traditions, culture and heritage, and working together on country.



Cultural inductions with Condar Energy contractors on site

Buru Energy conducts all of its operations in a manner which has regard to the cultural values of Traditional Owners. Our heritage clearance teams undertake a process of consultation and approval with Traditional Owners before commencing any ground disturbing activities.

We recognise that landholders and native title parties having ready access to accurate information is a fundamental part of decision making and Buru Energy has supported independent specialist reviews to ensure Traditional Owners are properly informed about our activities. We also invite landholders to visit our sites to monitor our activities to ensure our impacts on country are minimised as far as practicable.

Buru Energy respects and acknowledges the traditional custodians from across the Canning Basin, and elders past and present.

Cultural Appreciation during TGS Program

Our recent TGS program at Yunggora (Noonkanbah) provided a good example of this collaborative approach. The program was undertaken on and nearby to Noonkanbah pastoral station during 2015. This followed a review by the community of their own independent specialist advice regarding the effects of the TGS program on country.

During the program, a cultural induction was undertaken by all contractors who worked on site. This cultural induction was delivered by senior members of the community who spoke for the area where operations were occurring. It spelled out the Community rules and described the importance of country to Aboriginal people, including culturally important plants and animals in the area.



Community visit to TGS site

The workers enjoyed hearing about the importance of the areas to the community and came away with a new appreciation for aboriginal culture and the beautiful landscapes of Noonkanbah station.



Sunrise on Noonkanbah Station

A site visit to our TGS sites was also arranged for community members. During the visit, community members received a tour of the site, heard about the work that was being completed by the Company and shared a cup of tea with our contractors on site. This continued the transparent sharing of information that was a feature of our TGS program.

Further Information

Further information regarding our Community Engagement programs is available on our website www.buruenergy.com

11 September 2015

The following is a joint statement released today by Yungngora Chairwoman, Caroline Mulligan and Koolkarriya Committee Chairman, Ronnie Lormada.

We the Yungngora People are the recognized Native Title holders for Noonkanbah Station. Our lands around Noonkanbah have been our traditional lands for many thousands of years.

Buru Energy has recently completed their fracking operation on our country. We allowed this to happen after speaking to many experts about the effect of this activity on our country and the environment. Our experts looked at Buru's plans and let us know this is a safe activity if it is done properly. We trust Buru to do this properly.

"My hope and dream for the community and for the people as well is mainly getting young people involved in the workforce, getting them involved in looking after their country and with Buru it has been a really strong start with us and for the future."

"It has been great to see our young people work closely with Buru and we have that connection."

The following is a statement from Thomas Skinner, Chairman of the Yungngora native title corporation.

We are the new generation of Aboriginal owners that speak for our country and have the support of our old people. We have set up Koolkarriya as a business council that represents the seven clan groups of our Traditional Lands. The council really connects with Buru Energy so that we can have future work and opportunity for our young people.

The reason we selected the people on the business council is so that they can feed back to their own people that they can have their own business going as well. If Buru Energy get cranked up, that is really good for us.

We really want to keep this place going. We want to keep our young people safe from alcohol and the new drugs coming into the Kimberley. This is what is killing our people. Mining is giving us job opportunities to work on our own land. We need training and job opportunities for our kids future.

A mining company like Buru Energy come in here, they give opportunity and work. We want this.

Alcohol and drugs is killing our people – not mining or oil and gas.

WE NEED THESE NEW OPPORTUNITIES.

We welcome Buru.



Yungngora
ASSOCIATION INC



Great Sandy Desert Project (EP 493)

Onshore shale oil and gas, Western Australia



Petroleum Exploration Permit EP 493

Great Sandy Desert Project (EP 493) – Shale oil and gas

1. Background, location & shale play model
2. Well planning and WA state regulatory approvals
3. Groundwater usage and waste management
4. Well construction, well integrity
5. Below ground geological setting and HFS risk assessment
6. Well site remediation and site rehabilitation
7. Project development utilising current horizontal multi well pad drilling methods
8. Community and Social Impact
9. Finder Concerns

WA's next mega project (100% Australian owned)

FINDER
EXPLORATION

Petroleum Exploration Permit EP 493

- Population, Zero
- Pastoral Leases, Zero
- Traditional Land Owner Groups, Three
- 100% unallocated crown land



Great Sandy Desert Shale Oil and Gas Project

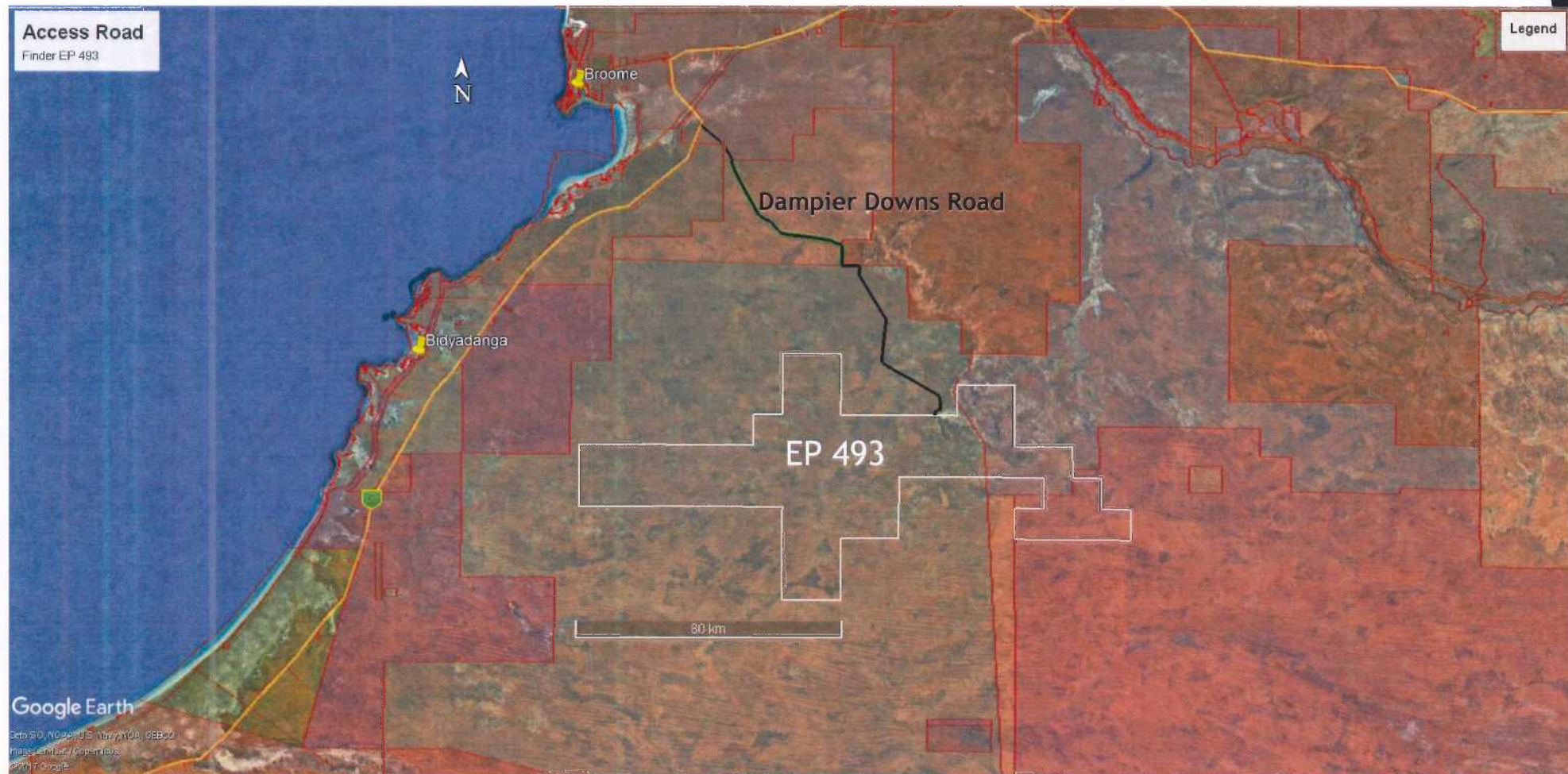
- Finder have \$17 million invested in the project and the next phase, +\$35 million, is fully funded
- Potential of supplying a quarter of Australia's oil & half WA's domestic gas needs for decades to come
- Potential to double Australia's daily oil production providing domestic energy supply security
- Economic stimulus for the region and state (over 20 to 30 years),
 - State royalties ~\$29.5 billion
 - Crude oil excise tax ~\$132 billion
 - Project related costs ~\$156 billion majority spend in Western Australia
 - Over 5000 direct and indirect long term Australian jobs
 - Job opportunities for local indigenous people on their land

PHOTO - EP 493 - Great Sandy Desert, WA - September 2015

Slide 3

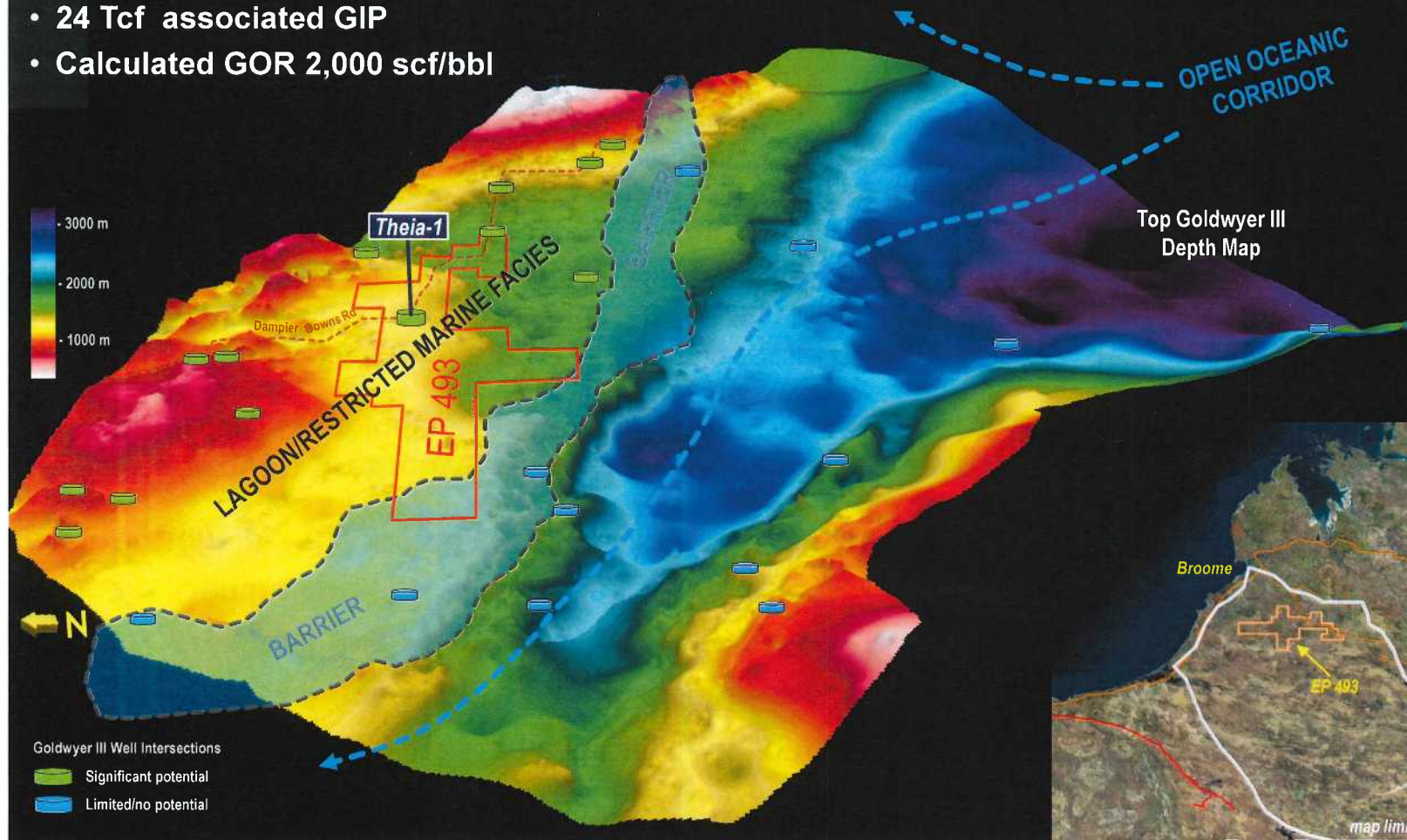
Petroleum Exploration Permit EP 493, Location Map

FINDER
EXPLORATION



Finder geological model (onshore Canning basin)

- Unrisked OIP ~ 35 billion bbls, plus
- 24 Tcf associated GIP
- Calculated GOR 2,000 scf/bbl



Data driven analysis

Twenty five wells intersecting the Goldwyer III shale analysed

Numerous studies commissioned incorporating all available well data (core, cuttings, logs, drilling information)

Regional seismic data reprocessed and detailed geological interpretation carried out and integrated with gravity and magnetic data

OIP – Oil in Place, GIP – Gas In Place, GOR – Gas Oil Ratio

Robust Goldwyer III regional geological model

- The regional Goldwyer III geological model has **successfully predicted the results of four wells**:
 - ✓ • Nicolay-1 (high oxygen depositional environment with low Total Organic Carbon (TOC));
 - ✓ • Cyrene-1 (high toc, shallow, lower reservoir temperature and overpressure, lower gas oil ratio);
 - ✓ • Commodore-1 (shallow barrier, high energy, oxygenated environment, low TOC); and
 - ✓ • Theia-1 (Lagoonal anoxic depositional environment, high TOC).
- The **proven predictive accuracy of the model** provides increasing confidence in the models robustness and indicates that the Goldwyer III shale properties are highly predictable
- Theia-1 was drilled by Finder in September 2015 and fulfilled its objective of collecting the maximum amount of geological information to access the Goldwyer III shale oil with associated gas resource potential. Theia-1 succeeded in confirming Finders pre-drill geological model
- Due to the success of Theia-1 a **follow-up horizontal well (Helios-1) is planned to drill and complete using HFS** in order to test production flow rates to access commerciality. The surface location of Helios-1 is within the existing Theia-1 well pad

2015 Theia-1 petroleum exploration well

FINDER
EXPLORATION



Slide 7

EP 493 Goldwyer Resource Technical Summary

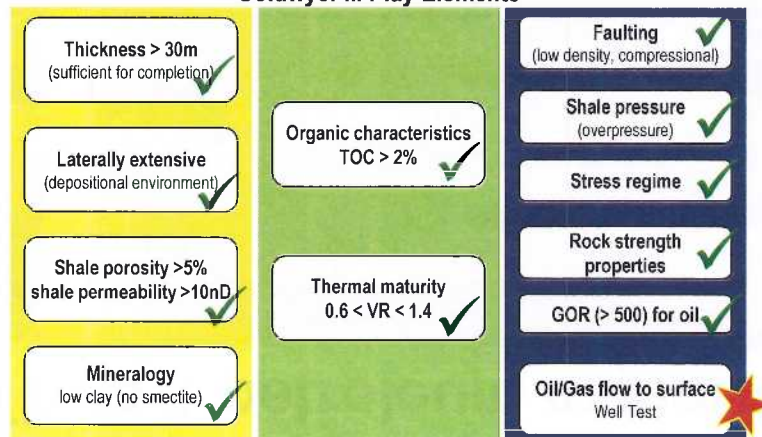
Theia-1 highlights during drilling

- high wet mud gas readings
- a visible gas haze escaping from the cores at surface
- Fluorescence (direct oil indicator) with strong hydrocarbon odour

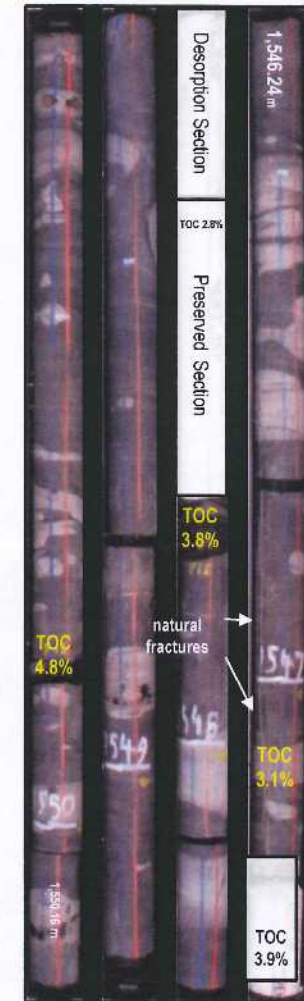
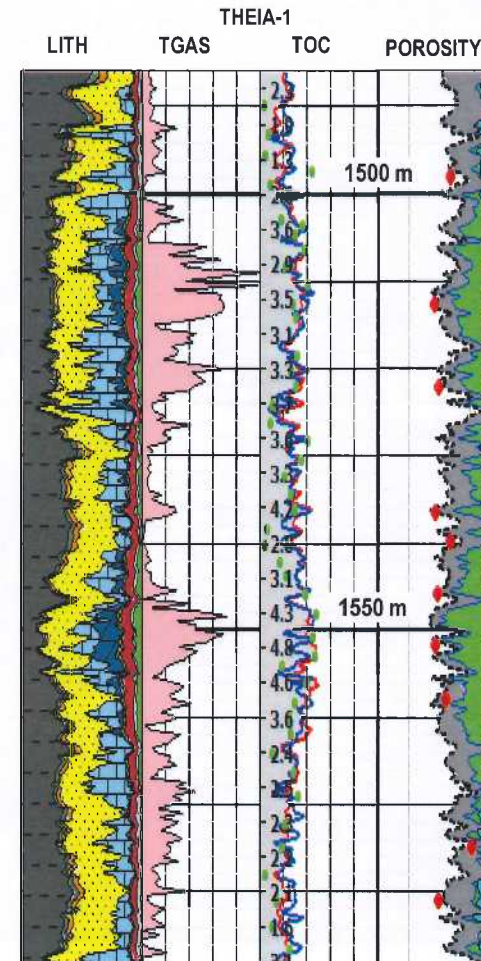
Post well analysis (performed by Weatherford & Schlumberger)

- high TOC (geochemistry)
- light oil (~45° API) with low wax content (geochemistry)
- high porosity (10%) from core
- geothermal gradient and kerogen maturity indicating peak oil window at uniquely shallow depth of 1,500m
- over-pressured, 1.22 sg (10.15 ppg)
- rocks prone to vertical fracture propagation (geomechanics)

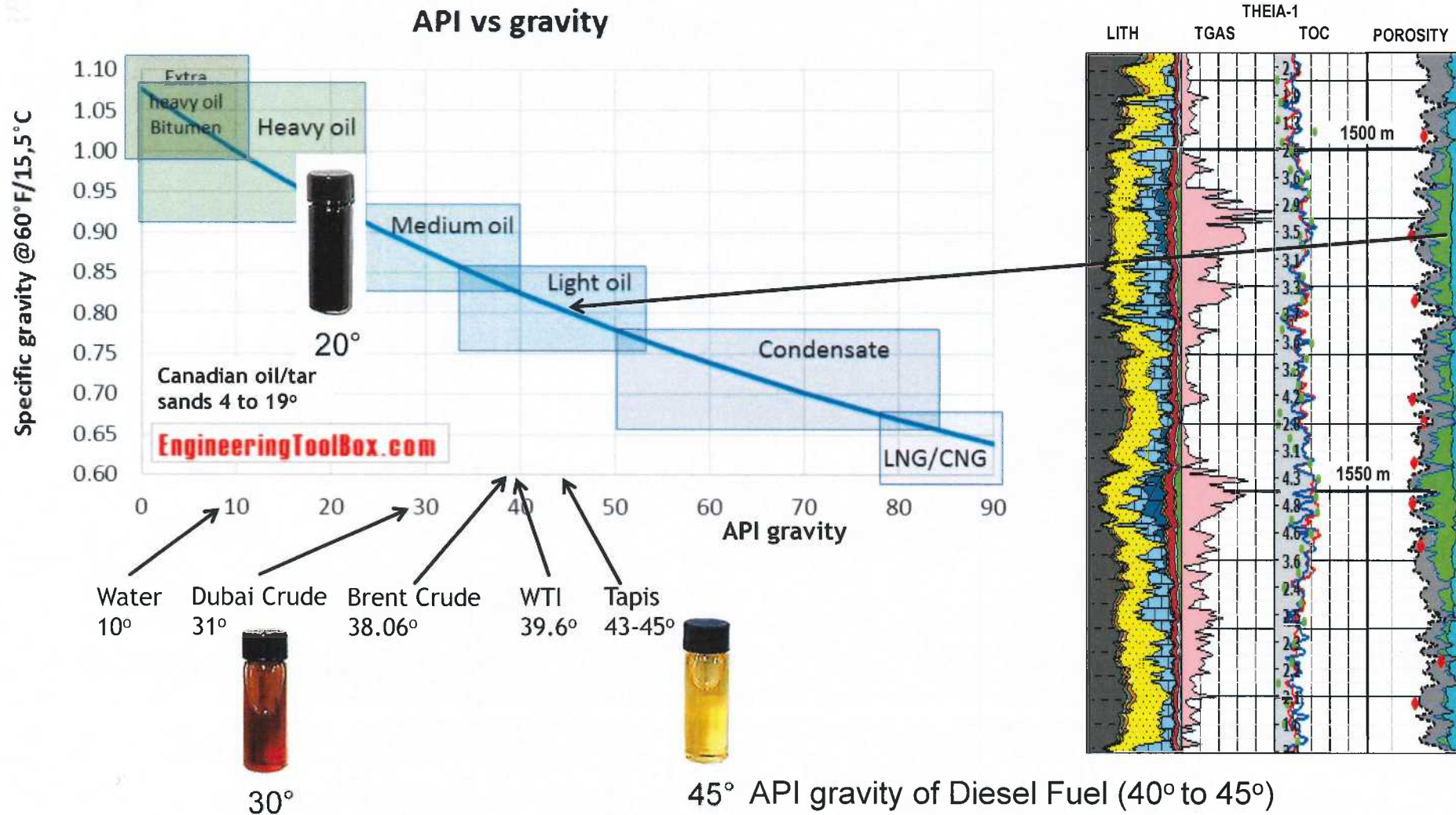
Goldwyer III Play Elements



Next Step



EP 493 Goldwyer shale oil 45° API, no sulfur, no CO₂



Great Sandy Desert Project (EP 493) – Shale oil and gas

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Planning to drill and complete a well – existing WA regulatory approvals

Summary of regulatory requirements for exploration activities:

1. Well Management Plan (DMIRS assessment and approval)

- describes detailed well engineering design, risk assessment of the well integrity and HFS activities and provides well-specific management control

2. Safety Management System (DMIRS assessment and approval)

- details the health and safety management requirements for project personnel, contractors and sub-contractors, how hazards are managed on-site and defines project-specific roles and responsibilities and how incidents are reported

3. Environmental Management Plan (DMIRS and OEPA assessment and approval)

- describes environmental aspects, risk assessment, mitigation strategies, management control and reporting arrangements

4. Chemical and Other Substances Disclosure Statement (DMIRS assessment and approval)

- provides details of all substances that will be used on-site and publicly available on DMIRS website

5. Oil spill contingency plan (DMIRS assessment and approval)

- outlines how project personnel will respond to a spill incident, describes preventive measures and management controls

6. Groundwater Baseline Assessment and Groundwater Monitoring Plan (DMIRS and the Department of Water assessment and approval)

- operator required to gather baseline groundwater data/samples and to undertake groundwater monitoring pre, during and post operations (including HFS) which are evaluated and compared against the baseline and monitoring data

7. Rehabilitation Plan (DMIRS assessment and approval)

- describes rehabilitation scope of work and incorporates a site rehabilitation monitoring program to verify rehabilitation completion criteria are achieved

8. 26D and 5C licences to construct a water bore and extract groundwater (approval from the DoW)

- the assessment process takes a risk-based approach and considers the quantity of water available, whether the action would prejudice other current and future needs for water, and the potential risk of surface or groundwater contamination

Health, Safety and Environmental Management

Environmental Management includes:

1. Cultural Heritage survey with indigenous owners and an anthropologist. Carried out prior to clearing any native vegetation
2. On-ground ecological (vegetation/flora and fauna) survey and report in accordance with the EP Act guidelines
3. Consultation with relevant stakeholders prior, during and post on-ground activities
4. Environmental risk assessment - identification of potential impacts and associated risks that may affect the environment
5. Development of mitigation measures and management controls that include:
 - Cultural Heritage Management Plan
 - Soil and Erosion Management Plan
 - Native Vegetation and Flora Management Plan
 - Fauna Management Plan
 - Weed and Pest Management Plan
 - Surface and Groundwater Management Plan
 - Groundwater Baseline Assessment and Groundwater Monitoring Plan
 - Air Pollution Control
 - Waste Management Plan
 - Fire Response Plan
 - Contamination and Spill Management Plan and Oil Spill Contingency Plan
 - Decommissioning and Maintenance Plan
 - Rehabilitation Plan
6. Environmental compliance and reporting criteria

Safety Management includes:

1. Well engineering and design
2. Well Management Plan
3. Training and competencies of personnel are verified
4. All personnel undergo site inductions
5. Toolbox meetings are held to discuss environmental issues
6. Weekly HSE meetings and daily workplace inspections are conducted by the site manager and HSE coordinator
7. Emergency Response and Incident Management Plans with daily emergency drills conducted
8. Regular internal audits and reporting are carried out and logged

Cultural heritage survey 2016



Ecological survey 2016



Environmental compliance and reporting criteria

- API and ISO International best-practice and operational standards for petroleum activities are required to be met or exceeded in WA
- Comprehensive, effective, transparent and accountable legislative framework in place to regulate petroleum activities in WA
- Decision making authorities adopt risk and outcome-based approach to assess projects
- Transparency with approval processes, Environmental Plans are publicly available on DMIRS website, referral and assessment process under the EPBC Act and EP Act are made available for public consultation
- External environmental & safety audits and inspections by regulatory authorities and independent authorities
- Operating Management System & HSE Management System is a mandatory requirement for petroleum operators
- Regular review of Operating Management Systems and continual improvements
- Training, drills and exercises
- Internal compliance audit and inspections
- Mandatory monthly and annual reporting to the regulatory authority:
 - any recordable or reportable incidents including all facts, actions taken and preventative actions implemented
 - GHG emissions
 - Waste generation and disposal
 - Results of groundwater baseline assessment and groundwater monitoring
 - Water consumption
 - Annual environmental report
 - Rehabilitation progress and close-out report

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Hydrology - Surface water

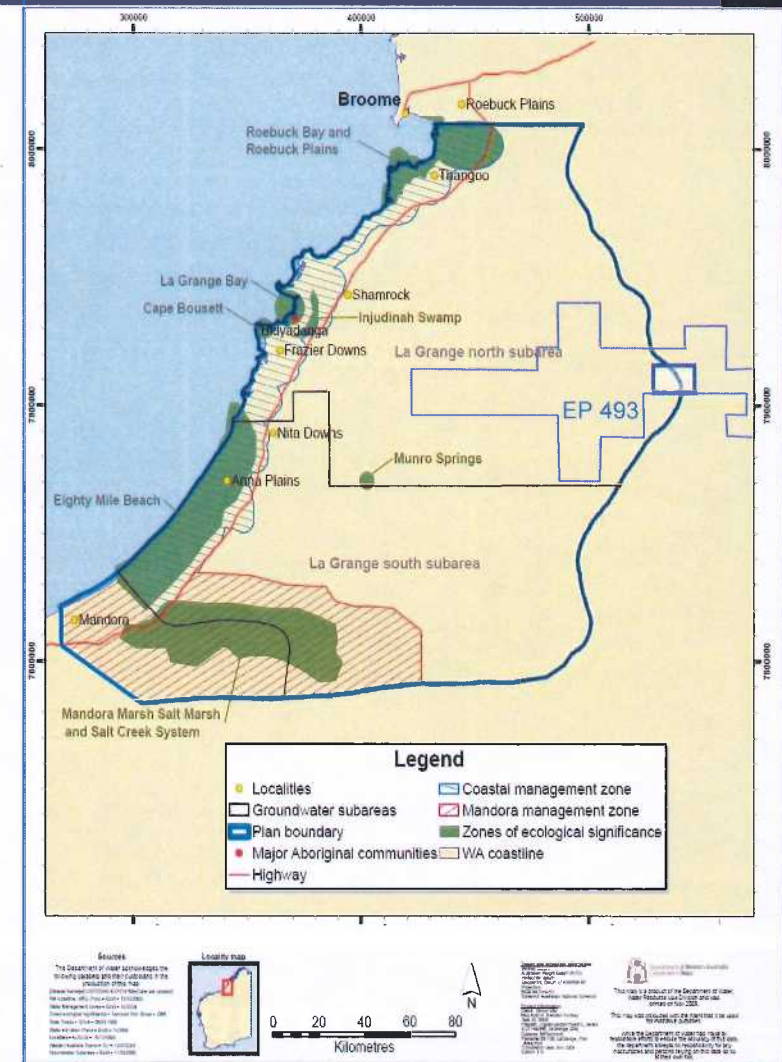
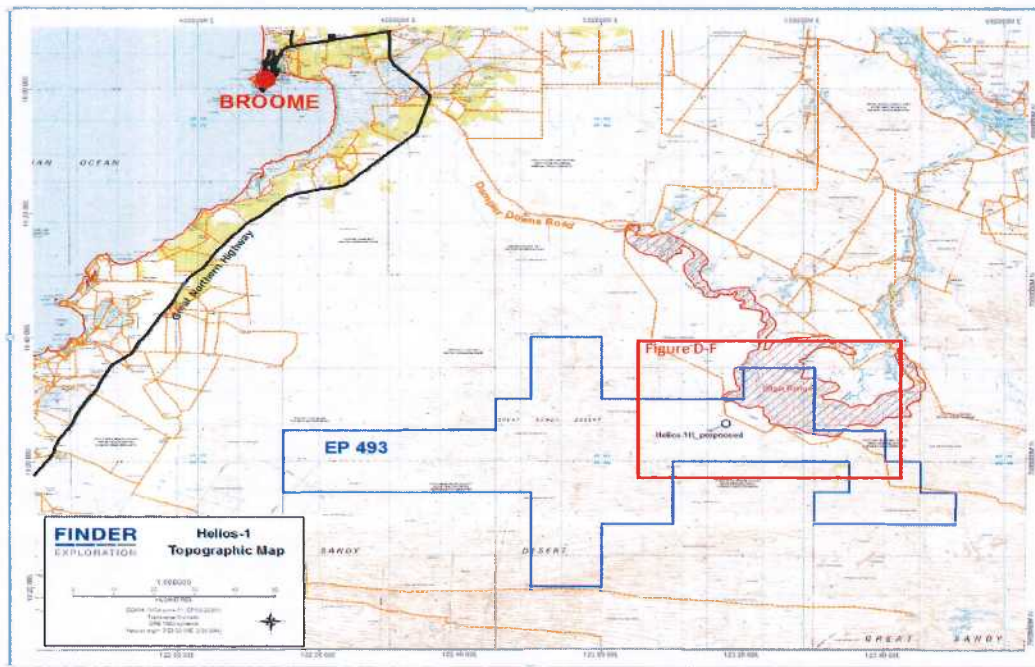
Within the project area no permanent surface water features or systems other than ephemeral are present.

The nearest landscape feature that contains ephemeral watercourses and a chain of waterholes is the Edgar Ranges, NE corner of permit EP 493.

The Geegully Creek, Woolonwarra Creek and its major and minor tributaries (including ephemeral systems) and waterholes are wholly contained within the Edgar Ranges.

No wetlands which are Ramsar listed, Conservation Category, or listed in the Directory of Important Wetlands are present within EP 493.

No groundwater dependent systems.



Map is a product of the Department of Water, Nov 2009

Hydrogeology - Groundwater

Hydrogeological investigations:

- understand geological and hydrogeological settings of the existing environment
- regulated under the PGER (Environment) Regulations 2012 and s.38 of the EP Act

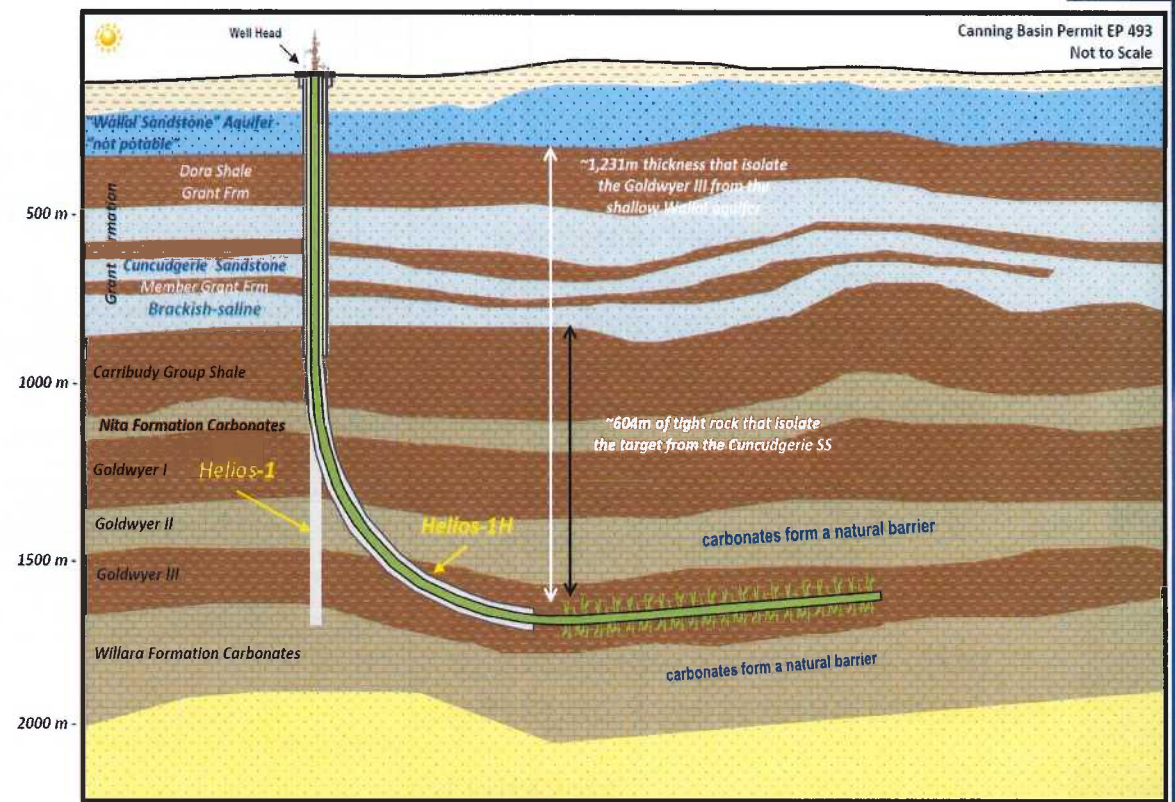
Groundwater Baseline Assessment:

- regulated under Section 4.5 – Provision of Information, Guideline for Groundwater Monitoring in the Onshore Petroleum Industry Guideline, DMIRS, August 2016
- establishes groundwater conditions before petroleum activities commence
- gathers sufficient baseline data – field parameters, the groundwater level, chemical analysis of water quality and the construction details of water bore

Groundwater Monitoring Program:

- requirement of the Petroleum and Geothermal Energy Resources (Environment) Regulations 2012
- regulated by DMIRS's Guideline for Groundwater Monitoring in the Onshore Petroleum and Geothermal Industry, August 2016
- establishes surveillance monitoring through the life of the project and beyond site decommissioning and rehabilitation
- demonstrates that groundwater resources are monitored and provides evidence whether groundwater has or has not been affected by petroleum activities

Conceptual hydrogeological profile of the Canning Basin



The geology of the Canning Basin is well understood at a regional scale through petroleum and mineral exploration wells and various hydrogeological investigations.

Water bore at Theia-1 well location

example of groundwater baseline sampling and assessment

GTP002: Theia-1 Exploration - Water Bore Test Results (2015)

Reference		168790	16889	170333	170333		
Description		Water Analysis	Water Analysis	Water Analysis	Water Analysis		
Sample		Bore 2 [Drill Pad]	Bore 2 [Drill Pad]	Bore 2 [Drill Pad]	Bore 2 [Drill Pad]	Australian Drinking Water Standards	PAGE 203 - 216 OF 'AUSTRALIAN DRINKING WATER STANDARDS 6'
Sample		1	1	1	1		
Date Sampled		20/07/2015	23/07/2015	27/08/2015	27/08/2015		
Potable water source							
Drilling water source		X	X	X	X		
Type of sample	Units	Water	Water	Water	Water	ADWS mg/l	Comments
pH in water	pH Units	6.3	6.1	6.7	6.7	6.5-8.5	<6.5 may be corrosive. No health guideline value
Electrical Conductivity water	µS/cm	2700	2500	2700	2700		No health guideline
Total Dissolved Solids (grav)	mg/L	1600	1500	1600	1600	600	For good potability, not a health requirement
Total Suspended Solids	mg/L	68	34	9			No health guideline
Turbidity	NTU	53	18	29		5	Based on aesthetic considerations turbidity should not exceed 5NTU
Colour (True)	HZU	<3	<3	22			No health guideline
Aluminium-Total	mg/L	0.16	0.04	0.02	0.02	0.2	No health based guideline currently; <0.1mg/l desirable
Cadmium-Total	mg/L	<0.0001	0.0001	<0.0001	<0.0001	0.002	
Copper-Total	mg/L	0.036	0.003	0.007	0.006	2	
Iron-Total	mg/L	2.3	1.4	6.5	6.1	0.3	Taste threshold; insufficient data to set a health guideline value
Lead-Total	mg/L	0.002	<0.001	0.002	0.001	0.01	
Nickel-Total	mg/L	0.024	0.002	0.02	0.02	0.02	
Zinc-Total	mg/L	0.066	0.055	0.066	0.062	3	Taste threshold; insufficient data to set a health guideline value
Calcium - Dissolved	mg/L	58	57	58	59		Not included in ADWG document as not necessary.
Potassium - Dissolved	mg/L	52	49	50	51		Not included in ADWG document as not necessary.
Magnesium - Dissolved	mg/L	40	39	38	39		Not included in ADWG document as not necessary.
Sodium - Dissolved	mg/L	400	390	400	400	180	Taste threshold
Bicarbonate HCO ₃ as CaCO ₃	mg/L	53	53	58	57		No guideline
Carbonate CO ₃ ²⁻ as CaCO ₃	mg/L	<5	<5	<5	<5	200	
Hydroxide OH ⁻ as CaCO ₃	mg/L	<5	<5	<5	<5		No guideline
Total Alkalinity	mg/L	53	53	58	57		No guideline
Chloride in water	mg/L	700	700	700	710	250	Aesthetic guideline
Sulphate in water	mg/L	240	240	230	230	500	
Nitrate as NO ₃	mg/L	<0.5	0.8	<0.5		100	50 for infants under 3 months
Nitrite as NO ₂	mg/L	<0.5	<0.5	<0.5		3	
Hardness as CaCO ₃	mg/L	310	300	300	310	60-200	Good quality 60 - 200 mg/l
Ionic Balance	%	-2.2	-2.8	-2.5	-2	10%	<10% considered acceptable for a good test
Ammonia as N	mg/L	0.005	0.027	0.009		0.5	Aesthetic; insufficient data to set a health guideline value
Total Cyanide	mg/L	<0.004	<0.004	<0.004		0.08	
Fluoride in water	mg/L	0.2	0.4	0.2		1.5	
Sulphide in water	mg/L	<0.01	<0.01	<0.01			
Antimony-Total	mg/L	<0.001	<0.001	<0.001		0.003	
Arsenic-Total	mg/L	0.002	0.001	<0.001	<0.001	0.01	
Barium-Total	mg/L	0.075	0.055	0.053	0.05	2	
Boron-Total	mg/L	0.3	0.27	0.24	0.22	4	
Chromium-Total	mg/L	0.024	0.01	0.003	0.002	0.05	
Manganese-Total	mg/L	0.064	0.043	0.089	0.089	0.5	>0.1 mg/l causes taste and staining
Molybdenum-Total	mg/L	0.001	<0.001	0.001	0.001	0.05	
Selenium-Total	mg/L	<0.001	<0.001	<0.001	<0.001	0.01	
Silver-Total	mg/L	<0.001	<0.001	0.001	<0.001	0.1	
Tin-Total	mg/L	<0.001	<0.001	<0.001			Not necessary, conc in water very low
Uranium-Total	mg/L	<0.0005	<0.0005	<0.0005		0.017	

Exploration program 2015 (Theia-1)

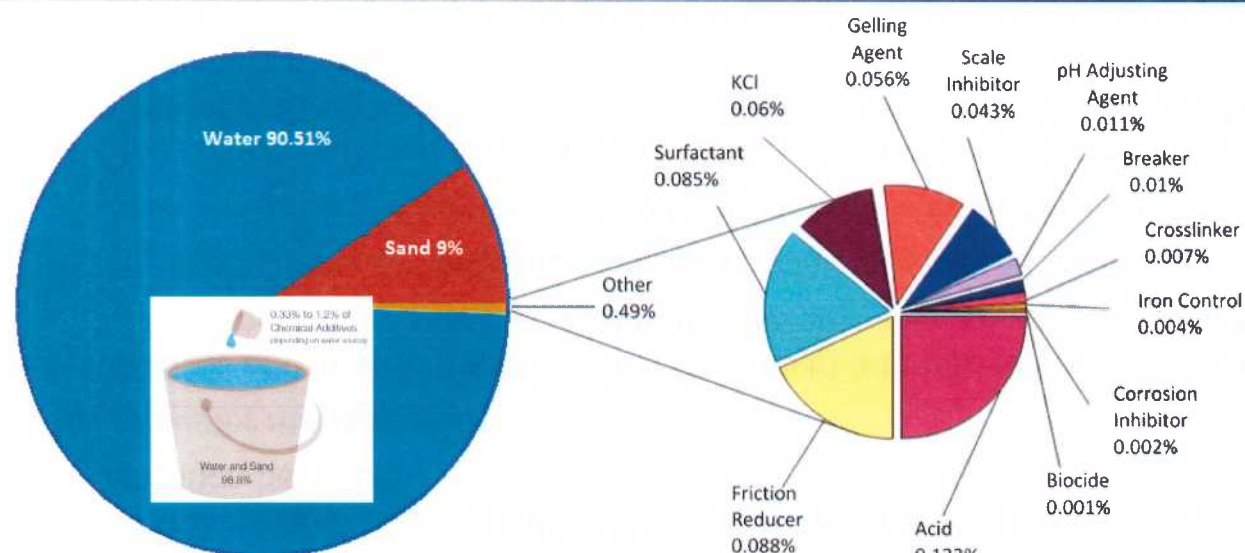
Baseline assessment summary of the Wallal Aquifer, central Canning Basin:

- water bore depth 160m
- samples were taken before and after drilling
- water is not suitable for human consumption
- no impact to/changes in groundwater quality due to petroleum activities

RED indicated values outside
Australian Drinking Water
Standards

WATER IS NOT SUITABLE
FOR HUMAN CONSUMPTION

Hydraulic Fracturing Fluid Composition



Reference: http://www.aplng.com.au/pdf/factsheets/Factsheet_Fracking-APLNG.pdf



Proppant/Sand ~9%

HFS fluid injected into the formation ~1.5km underground is ~30 times less toxic than swimming pool water (Ecotox Services Australasia, test protocol ESA SOP 117 (ESA 2013)¹).

All chemicals and other substances introduced to a well or formation require DMIRS approval. All information is publicly disclosed and available on DMIRS website.

Chemical type	Use	Common application
Friction reducer	Reduces the friction forces of fluids being pumped to increase flow rates	Food and pharmaceutical industry, mineral turpentine, clothing manufacturing, cooling systems
Biocides	Control growth of bacteria and control well corrosion	Common use disinfectant, bleaching agent, cleaners, water treatment, cosmetics, dishwashing liquids
Corrosion inhibitors	Removes oxygen and control well corrosion	Shampoos, cosmetics, perfume production, plastics, dyes, food preservatives
Iron control/ scale inhibitors/ acids	Limits the build-up of iron and mineral scale and control well corrosion	Anticorrosion products, detergents, cleaning products, pharmaceutical applications
Cross linkers/ Gelling agent	Increases the thickness of fluids which allows more proppant to be carried into rock fractures	Cement, adhesives, ceramics, detergents, cosmetics, food additive and thickener
Breakers	Breaks down the gelling agents and releases the proppant into rock fractures	Food industry, washing powder, cements, antacid medicine
pH control	Adjusts the chemical and physical properties of the fluid	Household cleaning, food additive, swimming pools, drinking water
KCL	Increase viscosity of the fluid	Table salt
Surfactants	Reduces the stickiness of fluids to improve flow rates	Cleaning agents, Laundry detergent

¹ ESA (2012) SOP 117: Freshwater and Marine Fish Imbalance Test. Issue No 9. Ecotox Services Australasia, Sydney, NSW

Water requirements and Wastewater Management

Baseline conditions:

- No public drinking water source areas or potable water supplies
- Limited beneficial use of groundwater - Unallocated Crown Land and not suitable for human consumption
- Water allocation in the West Canning Basin ~41,000ML annually is available for various activities
- Current cumulative consumption of groundwater in central Canning Basin – 0.17ML

Water requirements once per well (Helios horizontal well HFS fluid design):

- 1,200kL-1,400kL per HFS stage (~2.5 times average household annual consumption)
- 12,000-14,000kL for the Helios-1 horizontal well (a 1200 hectare horticultural farm uses ~20,000,000kL for irrigation per year)

Wastewater management

- 40-60% of hydraulic fracturing fluid (flowback) returned to the surface. The flowback is treated as “wastewater” in accordance with waste management hierarchy – re-use, recycle, treat and dispose:
- Re-used during further hydraulic fracture stimulation (reducing water requirements)
- Stored in lined and bunded water storage facilities for further reduction via evaporation
- Solid phase is tested for contaminants to determine disposal options in accordance with the **Landfill Waste Classifications and Waste Definitions 2010** and the **Environmental Protection (Controlled Waste) Regulations 2004**
- DMIRS conducts regular site audits of hydraulic fracture activities to ensure operators are complying with approved plans for chemical use, storage and disposal

Examples of key environmental protection measures

Water storage facilities

- designed to accommodate maximum amount wastewater produced onsite
- lined with HDPE plastic liner 0.75 mm to prevent soil contamination from wastewaters
- have an earth bund at least 0.5m in height
- overflow line to divert excess water
- wastewater tested at a NATA certified lab to determine contamination and subject to evaporation
- solid phase/remains are tested to determine landfill class and disposal options

Water for operations is sourced from onsite water bore

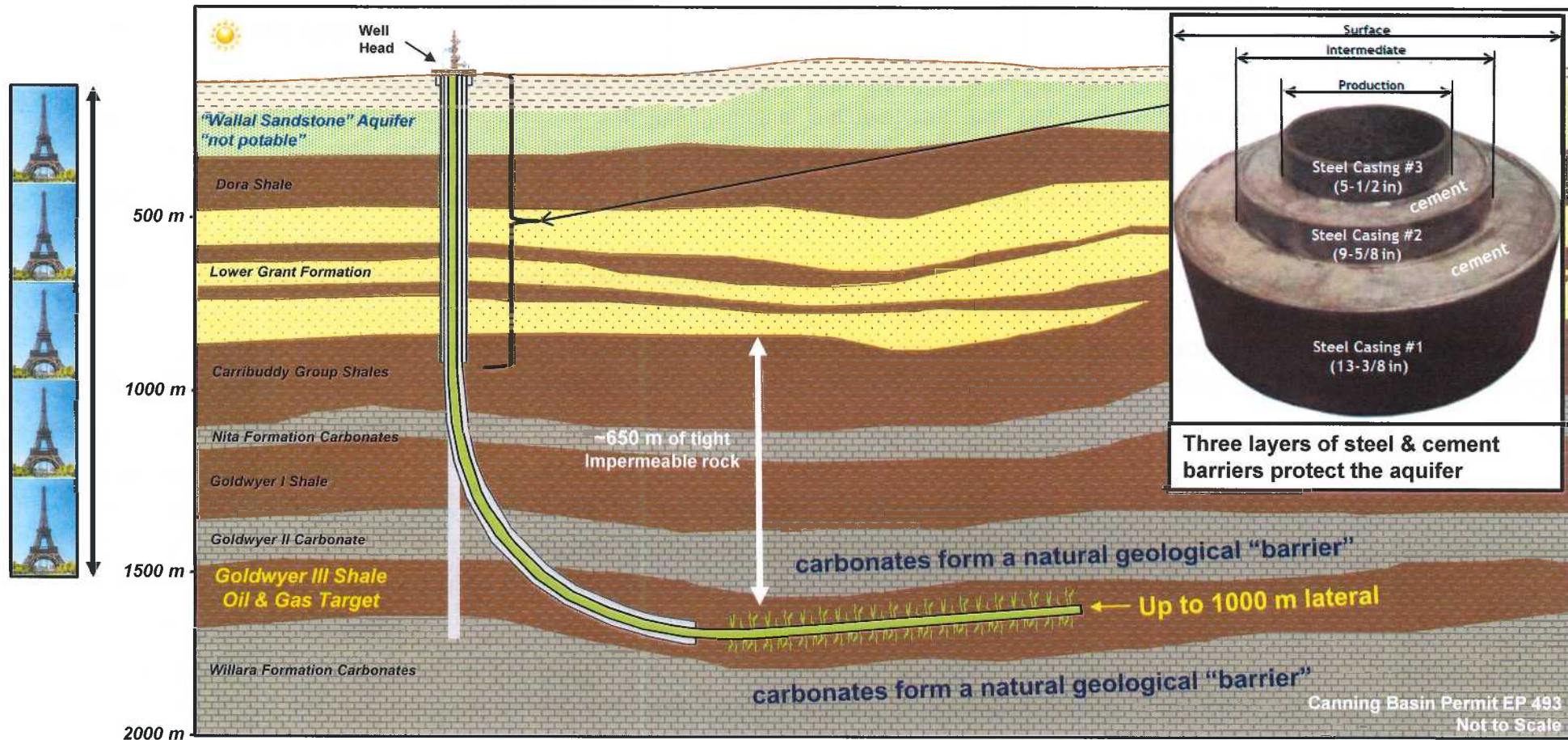
Chemical storage areas

Fencing and animal mesh used to prevent fauna entrapment

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Onshore Canning basin HFS & production test (horizontal well)



Wells are designed and constructed to ensure well integrity under all operating conditions over their life cycle which includes drilling, fracture stimulation, and subsequent production operations.

Typical Goldwyer III horizontal shale well construction

20" conductor pipe

- installed at the surface and set at approximately 30m where it is cemented back to surface. This provides the initial stable structural foundation for the well

13-3/8" surface casing string

- which extends from the surface to approximately 870m where it is set in a laterally continuous shale in the Carribudy and cemented back to surface. This isolates the near-surface groundwater in the saline Grant sandstone aquifers and brackish Wallal sandstone aquifer, neither of which is being used for agricultural or other non drilling purposes at present

9-5/8" intermediate casing string

- set inside the surface casing and extends from the surface to approximately 1500m vertical depth cemented back to 1150m (50m above sealing shale formation). It is not cemented back into the surface casing annulus so that pressure monitoring of that annulus is possible during fracture stimulation and so it is possible to confirm that fracture stimulation pressures or fluids are constrained in the deep reservoir and are not transmitted up the well into the near surface formations

Production casing string (typically 5-1/2" casing with high strength and high pressure rating)

- run and cement inside the intermediate casing from the surface to the end of the lateral (reservoir vertical depth of 1550m and lateral distance of 600m or greater). This is cemented back 150m into the intermediate casing to ensure isolation of pressures seen deep underground in the reservoir from higher up the well

Well Management Plan

Includes a specific section on risk assessment of well integrity – is developed and submitted for approval by the Regulator (DMIRS). At each casing point the well is pressure tested prior to commencing the next stage of operations (drilling or fracture stimulation) to confirm the integrity of the casing and cement

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Theia-1 (2015) Positive Geological Assessment

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EXPLORATION

*Theia-1 September 2015
Petroleum Exploration Well, Great Sandy Desert, WA*



Theia-1 recovering deep core

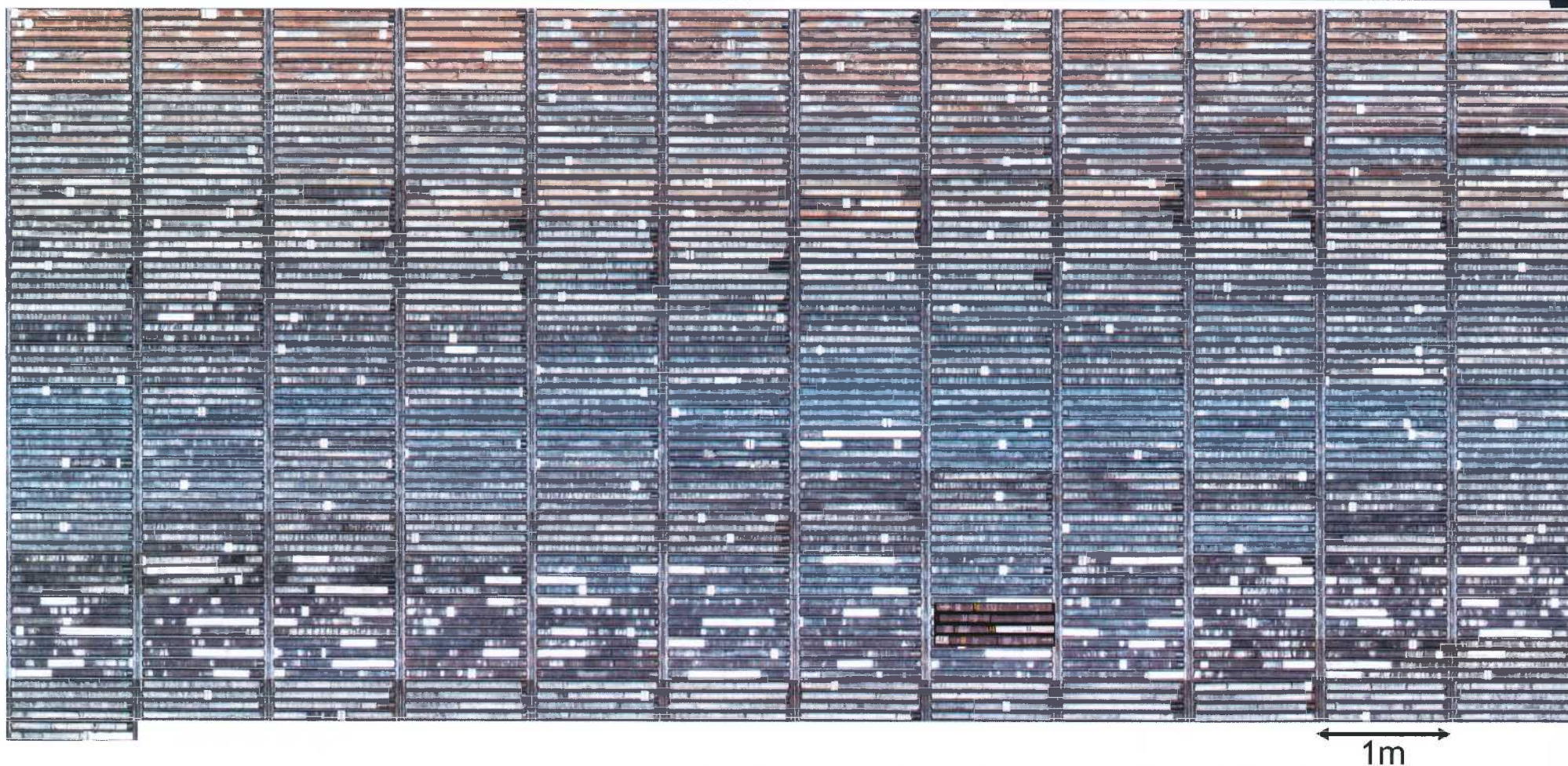


Theia-1 Geo Shack

Theia-1 intersected ~70m oil and gas column within a shale reservoir at 1,550m depth and confined within thick (650m) impermeable geological rock barriers

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Theia-1 – lots and lots of core (continuous rock samples)



lots and lots of real rocks! (778 metres of core = 6.5 tonnes)

Theia-1 data acquisition and post well analysis

Wireline Data acquisition

Gamma Ray & spectral gamma logs, Cross Dipole Sonic, Resistivity, Neutron, Density Log, Image Log
 Checkshot/Vertical Seismic Profile

Integrated post well analysis of core, data and drilling information

Analysis	Description	Interval	Data	Appendix
Shale Analysis (Weatherford Laboratory)	Desorption Analysis Crushed Gas Analysis Gas Composition Analysis Gas Isotope Analysis Spectral Core Gamma Crushed Density Analysis Geochemistry – TOC, Rock-Eval, HC Extract – GCMS (whole, aromatic, saturate) Organic Petrography Thin Section Petrography Field Emission SEM XRD Rock Mechanics Shale Rock Properties (bulk density - porosity-perm-saturation)	1,450 – 1,608	Basic report and Data	Appendix N
Cross-Dipole Sonic Anisotropy Processing (Weatherford)	Shear Anisotropy Fast Shear Azimuth direction	870 - TD	Report, LAS, PDF logs	Appendix O
Tight Rock Analysis (Schlumberger Terratek)	Retort Porosity, Saturations and Permeability Liquid extraction porosity and saturations Pulse Decay permeability	1,511 – 1,556	Data	Appendix P
GeoMin (FTiR) (Ana-min)	Wellsite FTiR	Entire Well	Report, Data Tables	Appendix Q

Core sample analysis

Petrophysical analysis

Core sample analysis

Core sample analysis

WADMP GSWA geologists have also conducted a suite of analysis on the Theia-1 core (not included) to better their knowledge on the regional understandings of the Ordovician rock sequence in the onshore Canning Basin. Their studies cover the entire well and include a detailed sedimentological core log, HyLogger, palynology, conodonts, geochronology, geochemistry, routine core analysis and petrography. The data from these studies will be submitted in accordance with the government sampling guidelines.

Theia-1 Post-well analysis – assessing well results

- Detailed analysis on core and cuttings samples, wireline, gas samples.....
- Schlumberger SIS team provided analysis and interpretation of the data
 - Petrophysics
 - Geomechanics modelling
 - HFS modelling



Sample	Top Depth (m)	Bottom Depth (m)	Desorption Analysis (Q1, Q2)	Crushed Gas Analysis (Q3)	Gas Composition Analysis	Isotopic Analysis	Core Handling/Slabbing	Core Gamma	Detailed Core Photography	Crushed Density Analysis	TOC Determination	Programmed Pyrolysis	HRGC & GCMS	Organic Petrography	Thin Section & FEESEM	X-Ray Diffraction	CT Scanning	Rock Mechanics	Shale Rock Properties
Total			25	25	10	10	36	50	31	25	99	38	8	11	15	11	10	5	11

Chemostratigraphy
Fluid Inclusion Technology
Image log interpretation
Core interpretation

Petrophysics
Geomechanics and MEM
Fracture modelling
Production forecasting

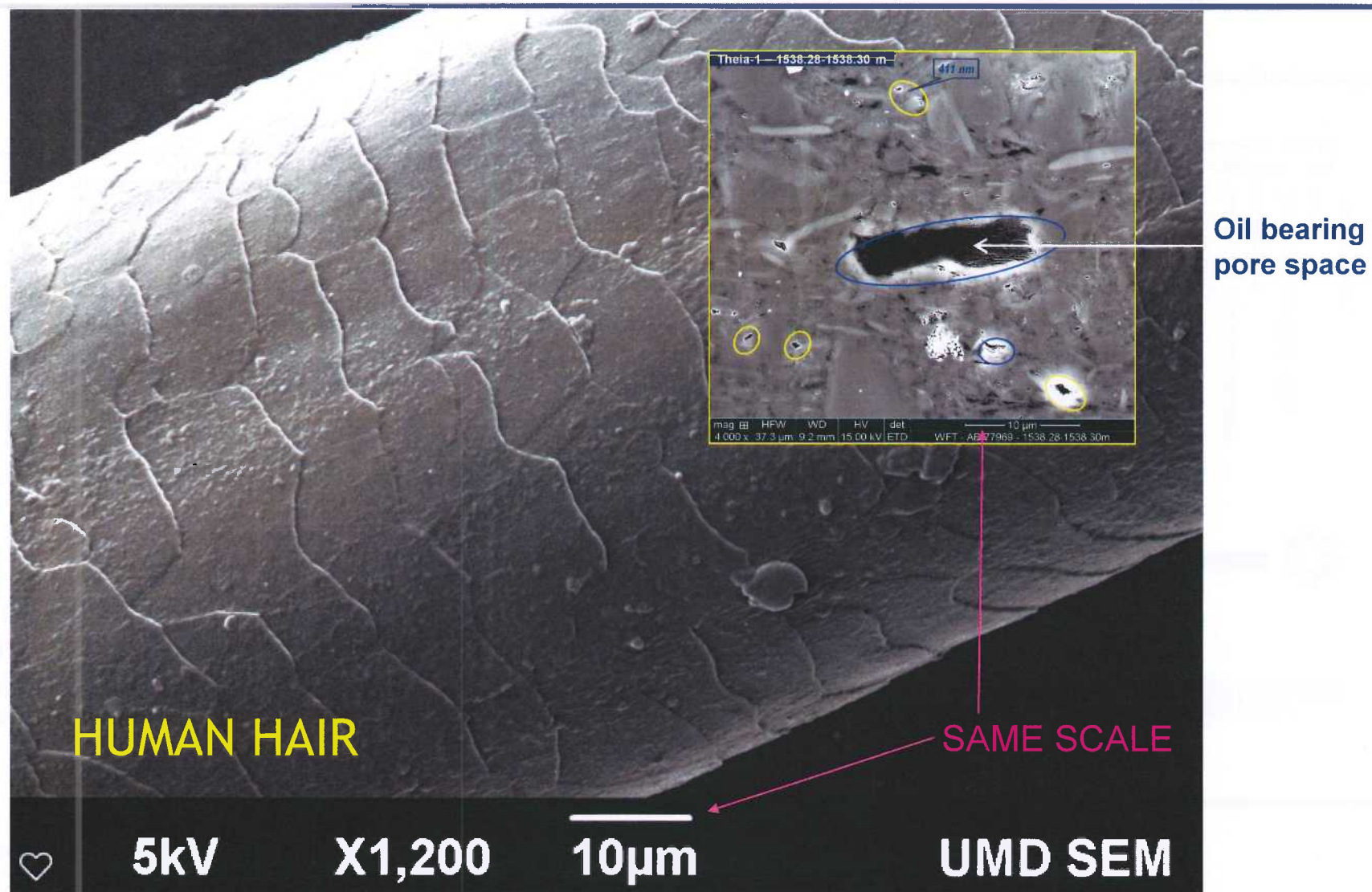
Palynology
Geochron - Zircon SHRIMP
Conodonts
Petrography, SEM, XRD
SCAL
Geochemistry

GSWA EIS – not
Goldwyer specific

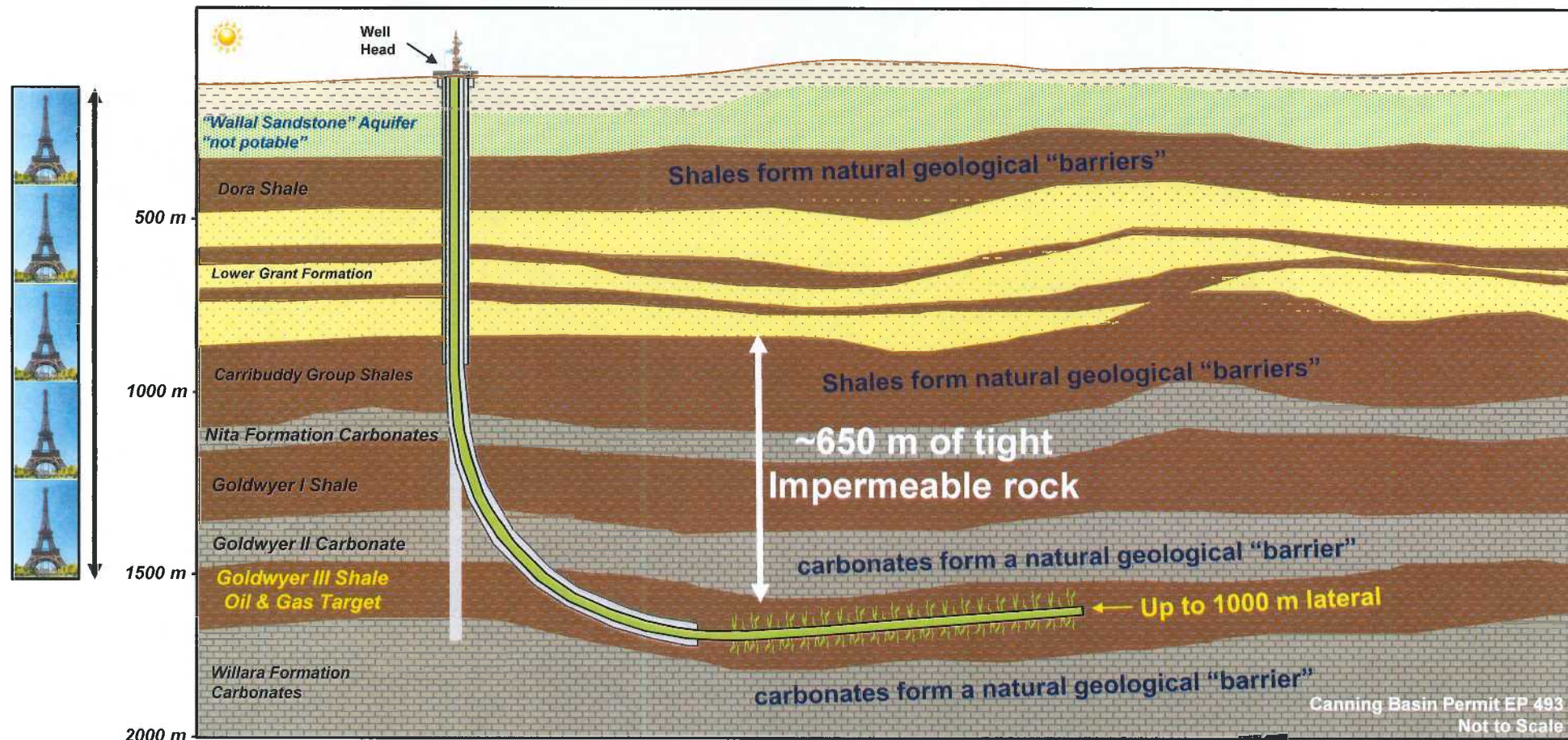
Dr Ray Johnson
(Consultant HFS modelling and design specialist)

Steve Broome
(Consultant Reservoir Engineer)

Theia-1 – Microscopic Images – comparison with human hair



Multiple HFS fracture barriers separating the aquifers



Formations above the oil and gas bearing Goldwyer III shale are thick, impermeable and form natural HFS fracture barriers. The geomechanical stress properties of the Goldwyer II and Willara Carbonates form stress barriers immediately above and below the shale. No highly overpressured formations (pressures either normal or slightly over pressured) are encountered in the basin (based on regional well review) which significantly reduces well control incident risk.

Laterally extensive thick impermeable HFS fracture barriers

Geological Fracture Barriers

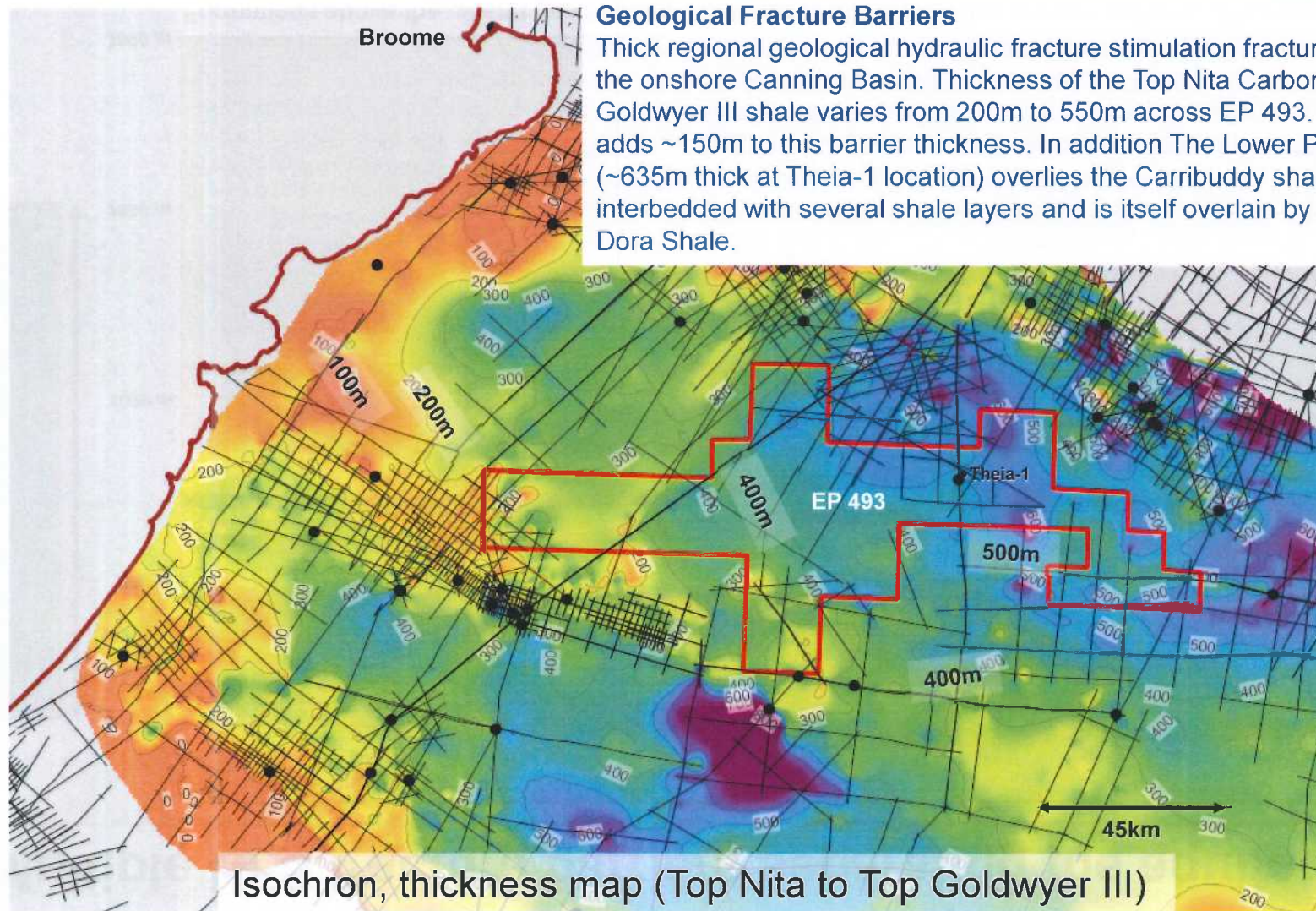
Thick regional geological hydraulic fracture stimulation fracture barriers extend across the onshore Canning Basin. Thickness of the Top Nita Carbonate to the Top of the Goldwyer III shale varies from 200m to 550m across EP 493. The Carribuddy shale adds ~150m to this barrier thickness. In addition The Lower Permian Grant Formation (~635m thick at Theia-1 location) overlies the Carribuddy shale. The Grant is interbedded with several shale layers and is itself overlain by the laterally extensive Dora Shale.

Summary

The Goldwyer III oil and gas bearing shale is separated from the near surface Wallal sandstone aquifer by numerous thick impermeable geological barriers which are present across the onshore Canning Basin

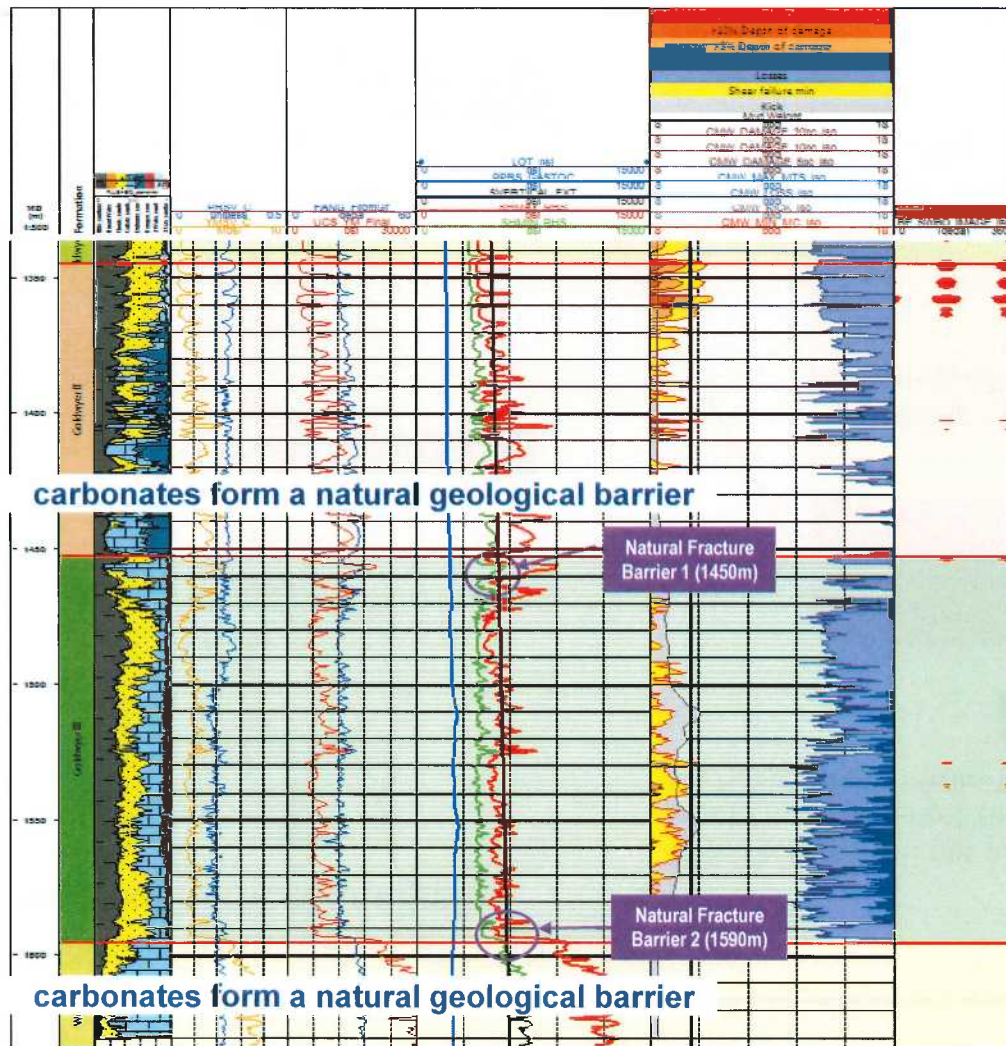
Input data

2D seismic + wells



Isochron, thickness map (Top Nita to Top Goldwyer III)

Theia-1, Geomechanical Earth Model (Schlumberger Analysis)



The Goldwyer III shale is located at a depth of ~1.5km overlain with thick (~650m) impermeable geological formations.

The tight carbonate formations above and below the Goldwyer III shale form natural stress barriers to vertical hydraulic fracture growth.

The above conclusions are derived from analysis of all available regional data and extensive data and analysis carried out on the Theia-1 well drilled within EP 493:

Regional data

- well wireline & core data and drilling information integrated into petrophysical evaluations, plus non well data such as regional reprocessed seismic, gravity and magnetic data

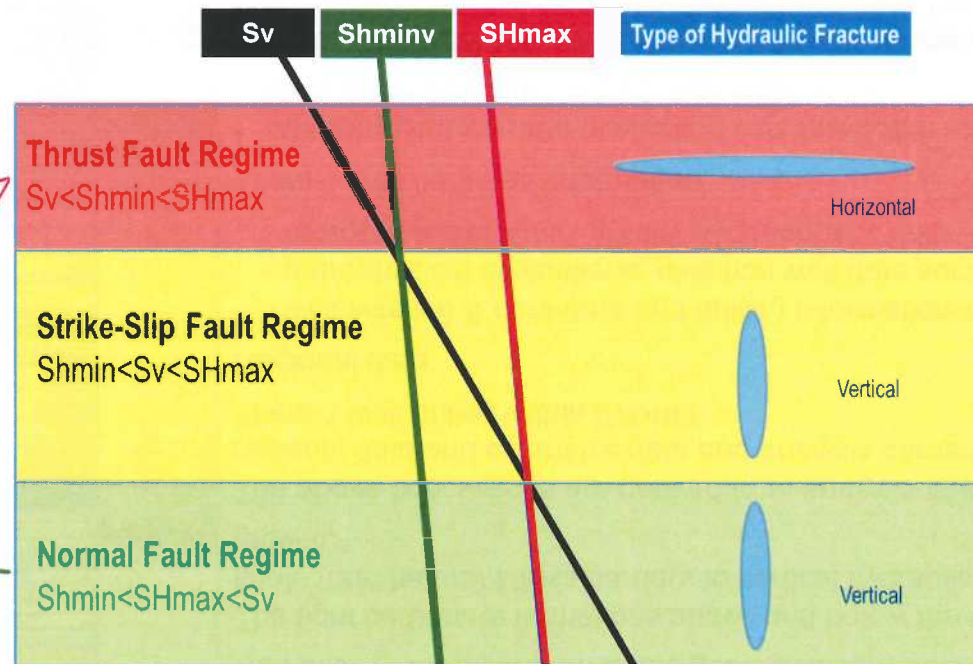
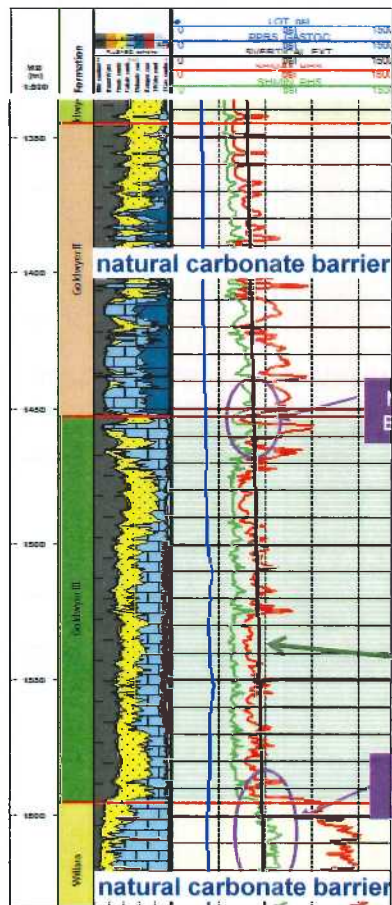
Theia-1 well data and information:

- petrophysical log data evaluation calibrated with rock mechanics core data, and drilling information
- calibrated geomechanical stress profiles show the target shale is contained within carbonate formations which form natural barriers to vertical hydraulic fracture growth

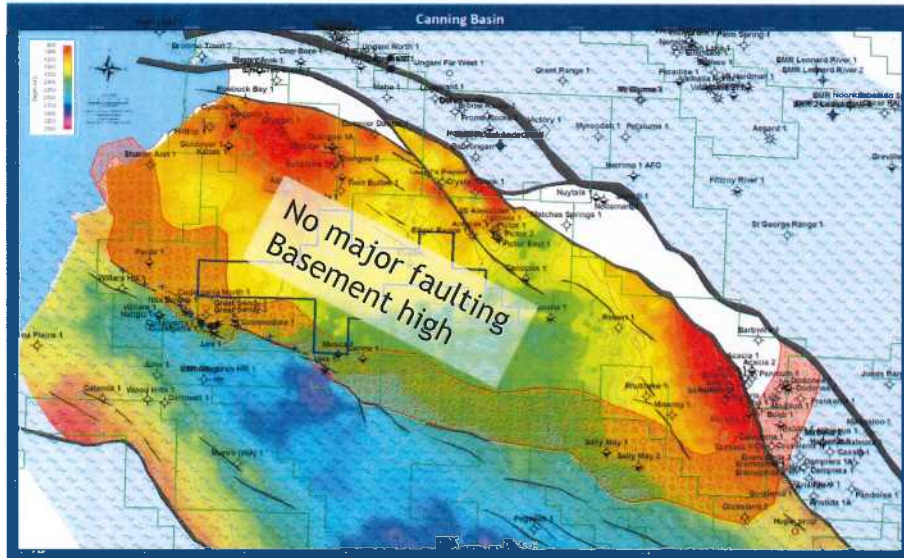
Theia-1, Geomechanical Earth Model (Schlumberger Analysis)

Theia-1, sonic data calibrated with core Geomechanical analysis

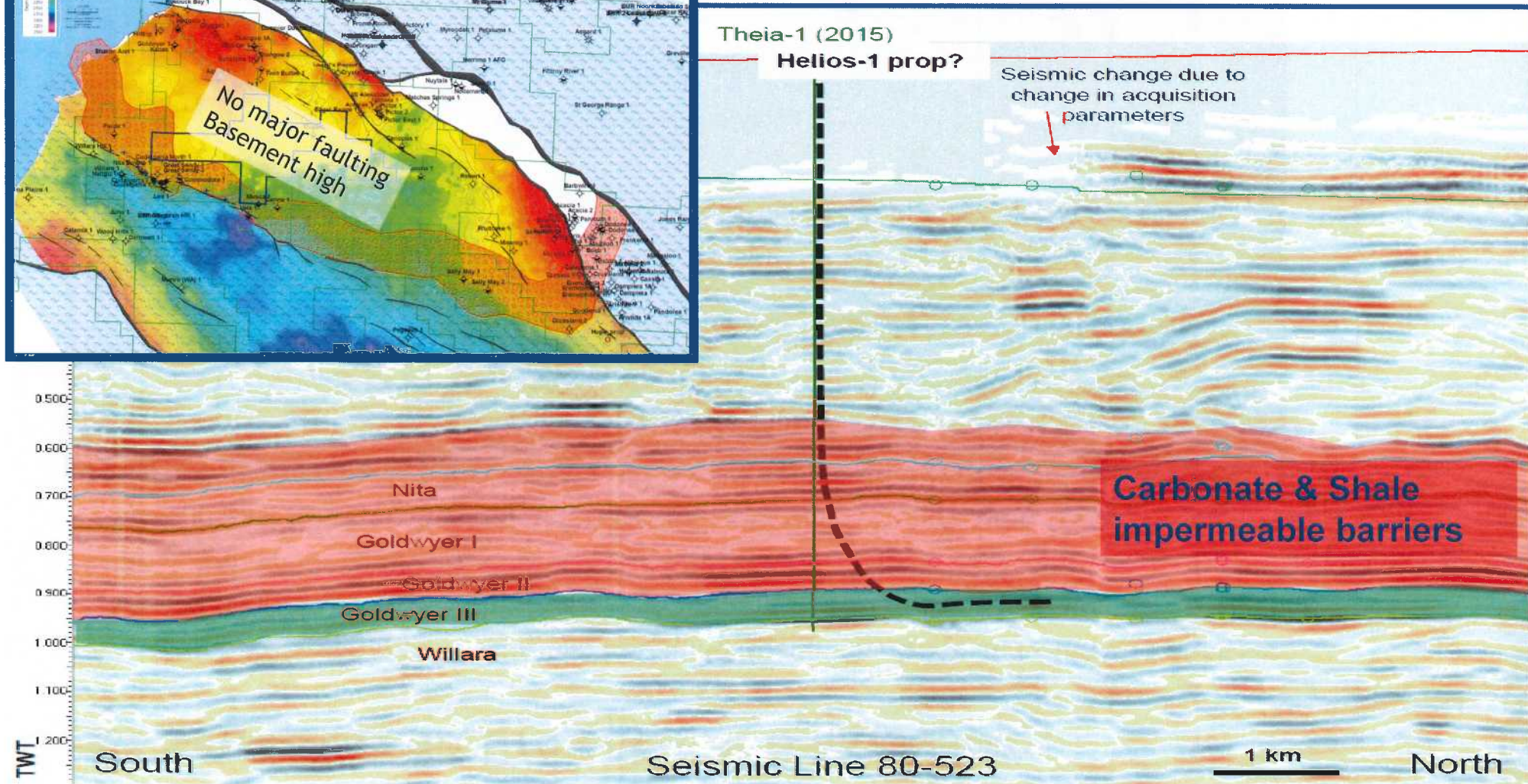
HFS fractures will not propagate through the natural carbonate barriers above and below the target Goldwyer III shale. Carbonates form geomechanical barriers assessed from Theia-1 well data in addition they are impermeable.



Prospective area located on basement high (platform) 20km to >100km from major faults

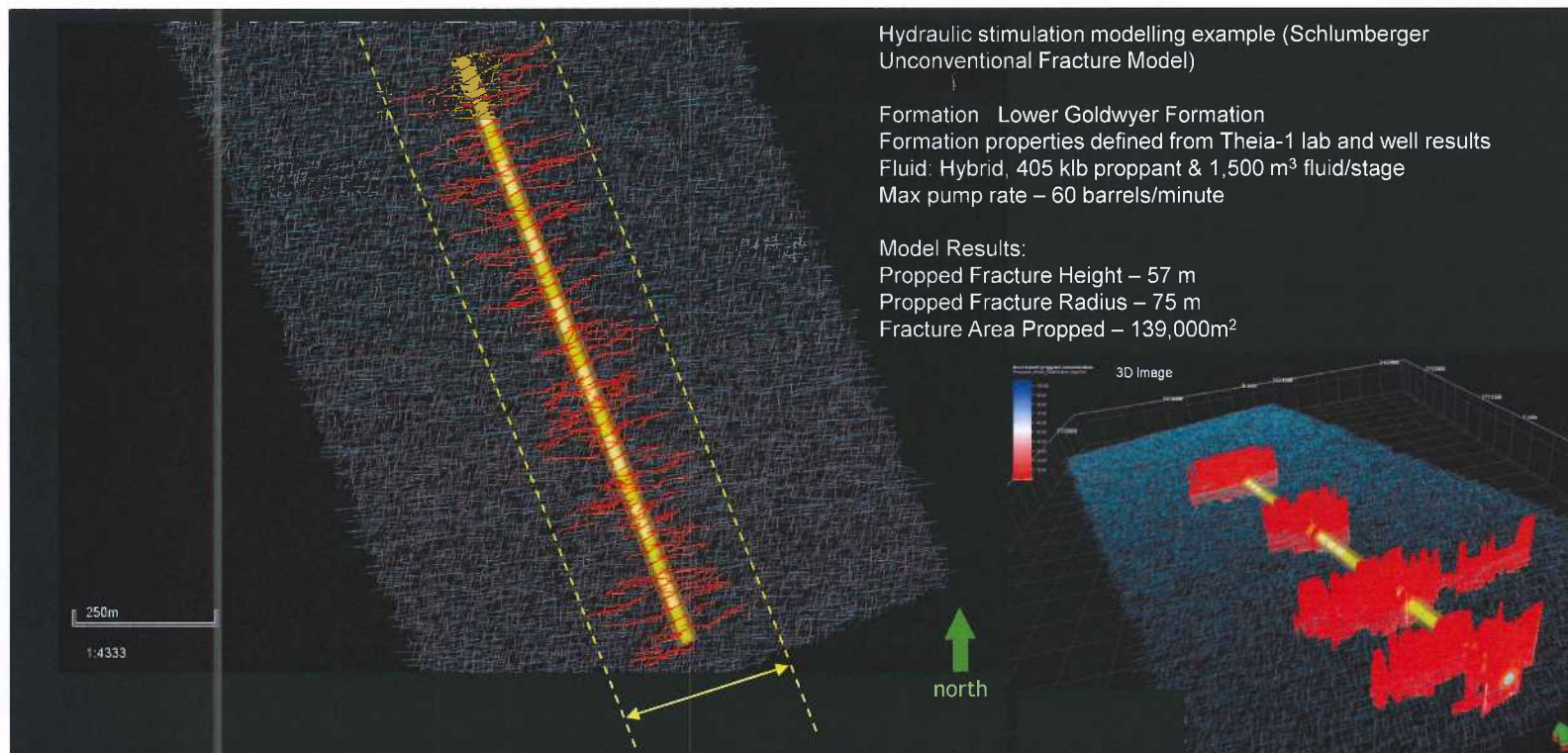


Seismic Line 80-523



Great Sandy Desert Project – HFS Modelling

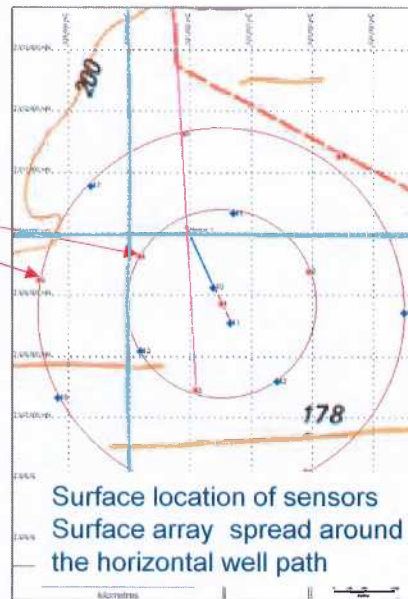
- Schlumberger completed hydraulic fracturing design using Theia-1 data and analysis
- Modelling incorporated parameters such as; horizontal landing point, fluid type selection, cluster spacing, stress interference and total stages/clusters per stage
- More than 13 models evaluated for area/height/length of stimulated zone



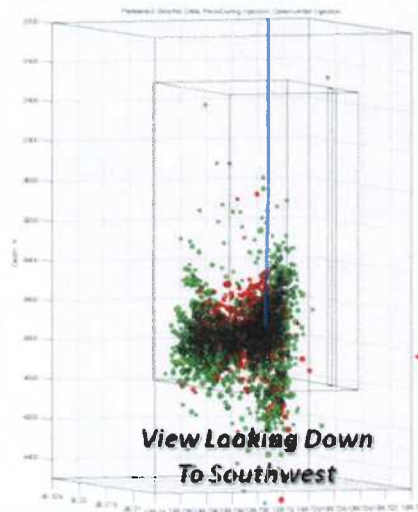
3D fracture imaging from micro-seismic monitoring data



2 Hz Oyo Geospace Seismometer



Surface location of sensors
Surface array spread around
the horizontal well path



View Looking Down
To Southwest

Example of HFS microseismic 3D
imaging of HFS fractures

HFS fractures can be detected and visualised with Micro-Seismic sensors

A site office contains the central recording facility for the real time monitoring of the HFS fractures. Several geoscientists analyse the data as it comes in and assess the real time propagation of the fractures. Micro seismic events resulting from the fracturing of the sub-surface rocks are recorded, analysed and imaged. This information is then fed back into the HFS main control office which can then be correlated against the real time fluid pumping rates and pump pressure data allowing for real time monitoring of HFS operations.

Example 3D image of the HFS induced fractures are produced from micro seismic recorded data.

Analysis of micro-seismic data and images can then be utilised for planning and optimisation of future hydraulic stimulations.

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Environmentally sustainable approach - leave no footprint

Site decommissioning and restoration

November 2015

Stored Topsoil

Final rehabilitation plan to restore
disturbed areas back to its original state

PHOTO

Theia-1 well pad (September 2015) well pad

Topsoil stockpile regrowth after one year

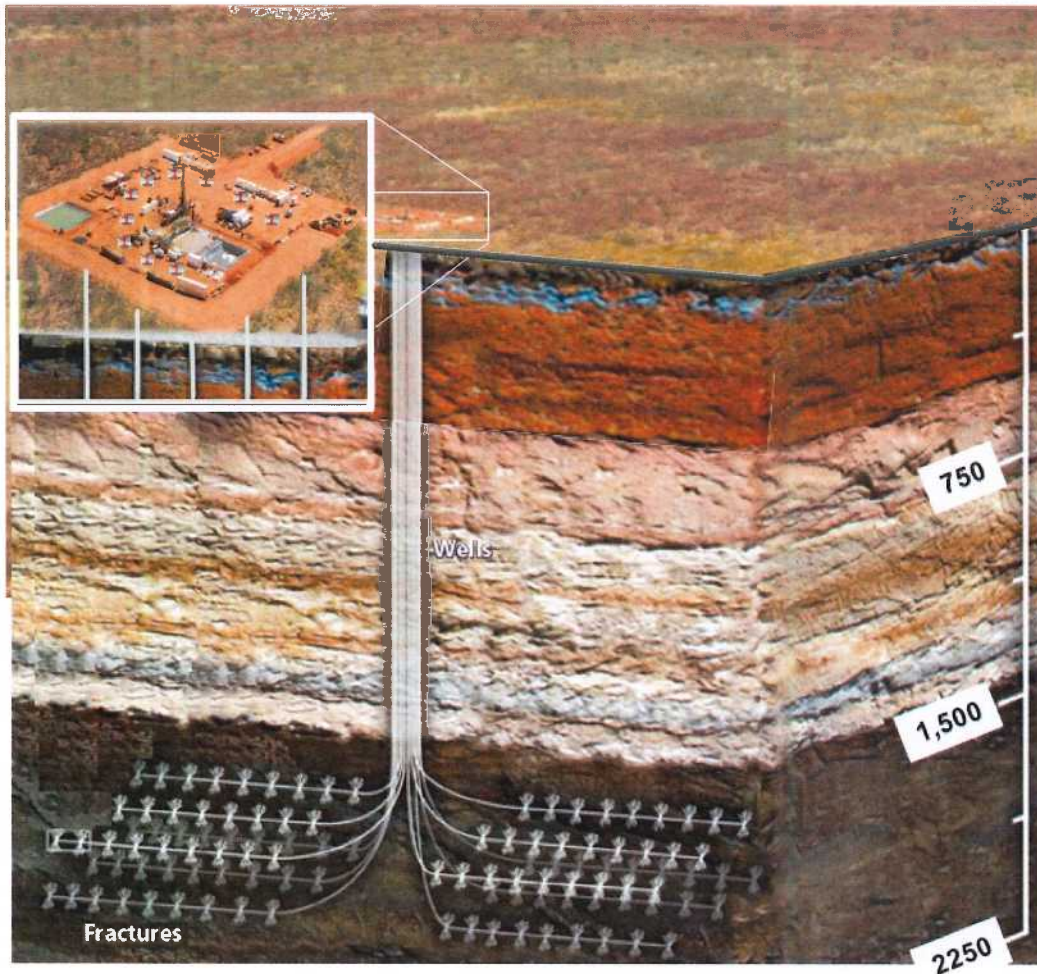
November 2016

2016 11 20

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Sustainable land use - conceptual layout

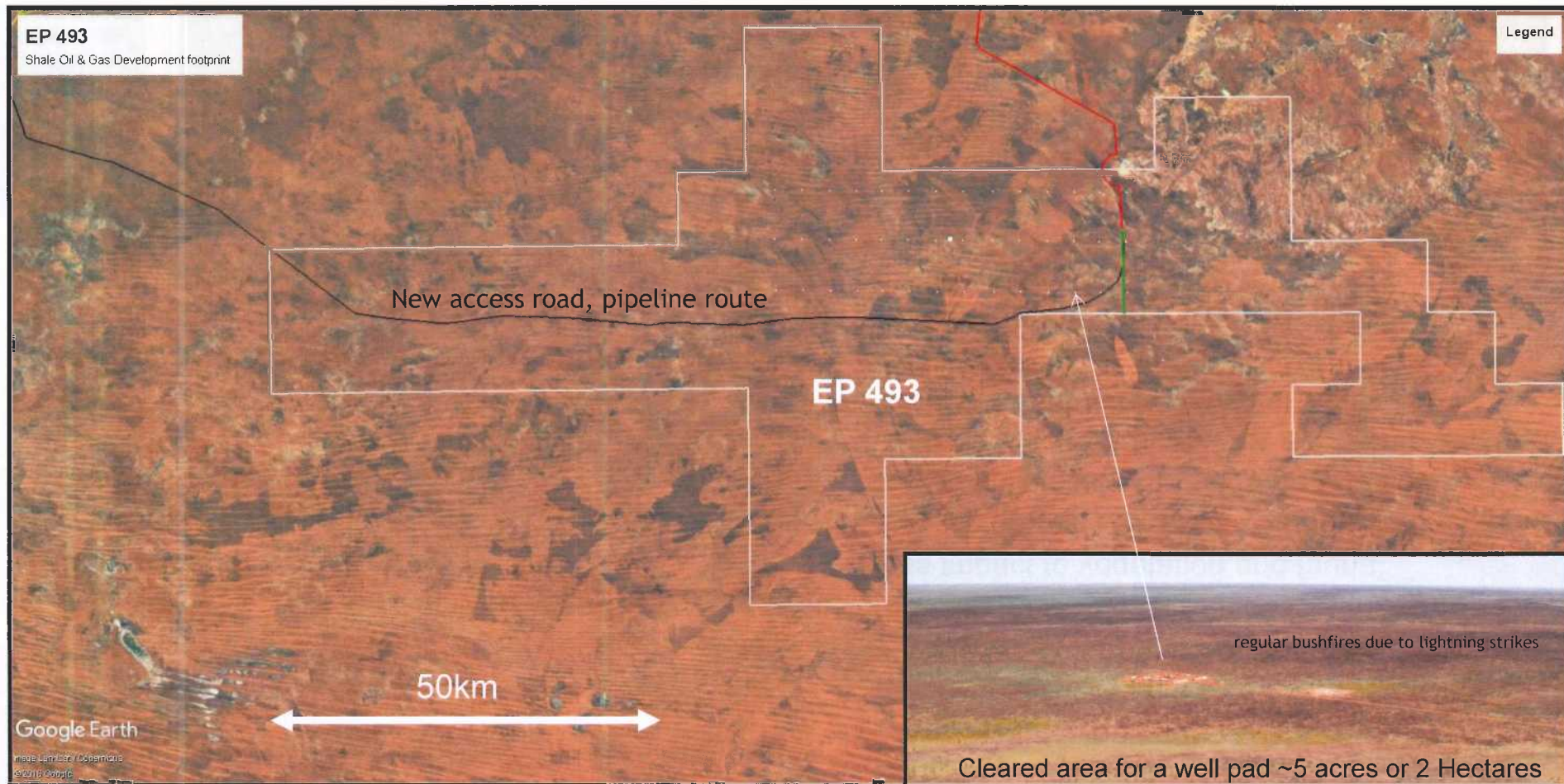


- horizontal drilling and multi wells per pad reduces environmental footprint
- 8 horizontal wells on a single 2ha well site substitutes 36 or more vertical wells
- reduced surface disturbance footprint by 36 times
- less impact to vegetation and fauna
- less disturbance for axillary infrastructure – access roads, pipelines, water storage facilities
- reduced water requirements through reduced well sites and productive re-use of water and wastewater
- better rehabilitation outcomes due to less disturbance



Example of a single well site 120m x120m (~1.44 ha)

Great Sandy Desert conceptual project development



Multiple horizontal wells from single pads reducing above ground footprint

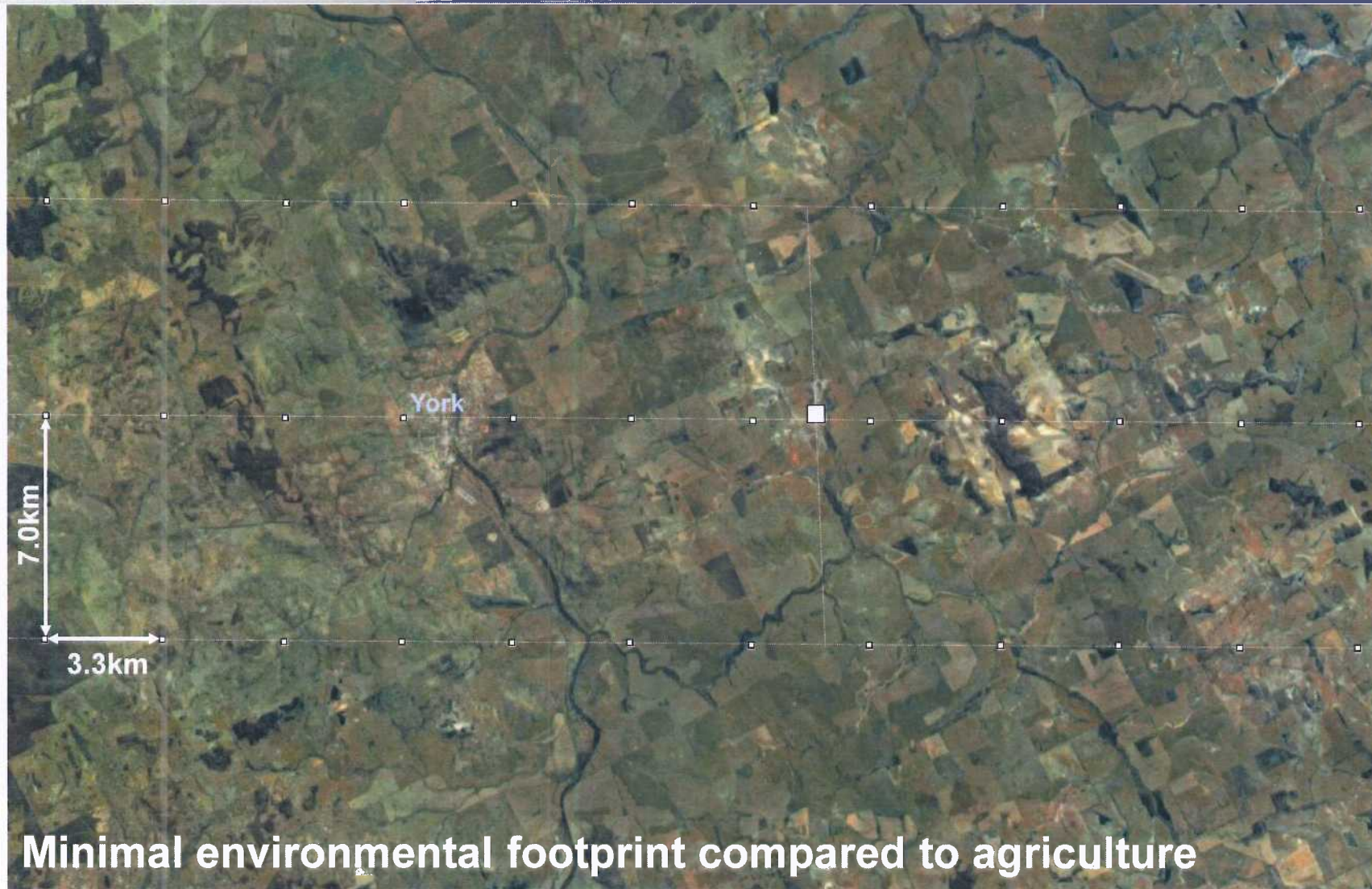
Development well pad spacing to scale on Perth metropolitan region

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EXPLORATION



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Development well pad spacing to scale on the Wheatbelt



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Community and social impact (Great Sandy Desert Project)

Region in and around EP 493

- no population, no private properties
- no declared conservation significant land, wetlands, national parks or reserves
- no public drinking water source areas and water bores and potable water supplies
- no groundwater users due to no population
- limited groundwater values (not potable)
- limited beneficial use of groundwater due to remote area on Unallocated Crown Land
- no social values such as recreational areas and tourist attractions
- little if any agricultural potential

Tight reservoir oil and gas projects co-exist in populated areas with other land users and industries all the time. In this case a valuable resource happens to be located in a completely undeveloped, remote & arid region of the state.

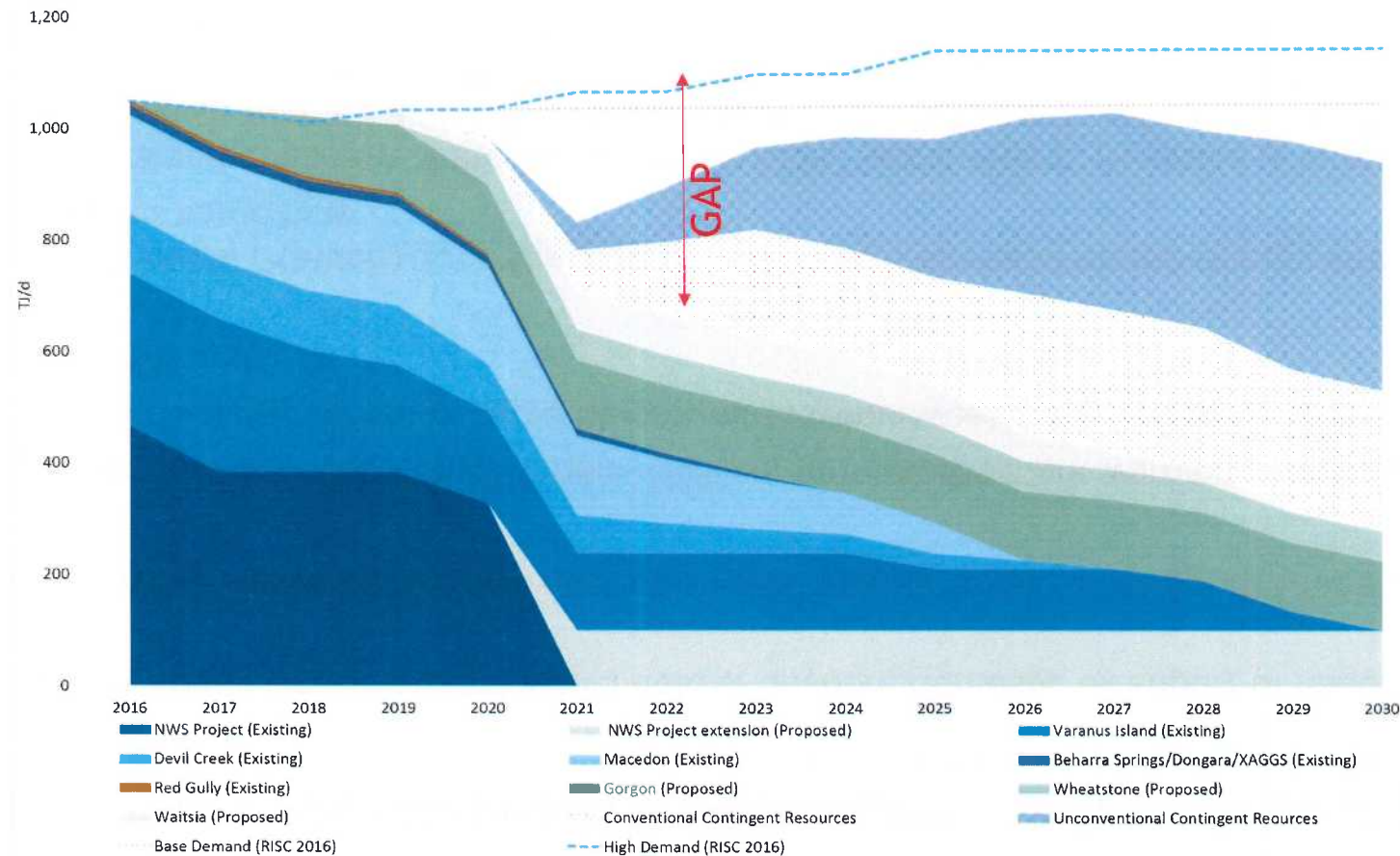
Benefits

- Finder have \$17Mil invested with plans to invest an additional \$35Mil into the Great Sandy Desert shale oil and gas project to prove its viability.
- 5000+ long-term direct and indirect jobs for indigenous and local communities and local businesses
- economic stimulus injected into regional communities such as Broome
- better understanding of the environment from environmental surveys and data collection
- understanding of groundwater aquifers and water quality

Predicted WA domestic gas supply shortage

WA domestic gas security of supply

The gap in the supply of gas needed to meet WA domestic demand in 2021 and beyond can potentially be filled through gas from the Great Sandy Desert project.



Significantly reduce Australia's dependency on foreign oil imports

The Great Sandy Desert project would deliver onshore domestic oil supply of national importance.

Defence White Paper 2016: Dependency on fuel imports 'a risk' amid South China Sea tensions

Jim Molan, former military chief turned NSW senator, issues stark warning over defence capabilities.

- Australia's defence forces could be grounded within weeks of an attack due to a desperate lack of fuel reserves.

Air Vice Marshal (Retired) John Blackburn has focused attention on the energy security shortfall for Australia for some time:

- As an island continent at the bottom of the Asia Pacific region, Australia is heavily dependent upon liquid energy imports and with a rapidly disappearing domestic refinery production capacity, these imports necessarily are with regard to refined end products as well.

Great Sandy Desert Goldwyer III shale oil is a high quality light crude oil 45° (**API gravity of Diesel Fuel is 40° to 45°**) which could be refined at minimal cost providing a NW Australian source of domestic transport fuel.

Shale oil and gas projects create a diverse range of **jobs** and need a **diversity of people** and supporting **businesses** to make them successful

Jobs

- Kitchen hands & cooks
- Logistics and supply chain managers
- HSE officers and managers
- Truck and bus drivers
- Mechanics
- Environmental specialists
- Indigenous Rangers
- Indigenous heritage inspectors
- Anthropologists
- Administrators

Service companies

- Environmental consultants
- Accommodation camp supplies
- Food and provisions
- Civil Engineering
- Well construction engineers

Jobs

- Flora & Fauna specialists
- Reservoir engineers
- Geologists
- Geophysicists
- Geochemists
- Chopper pilots
- Surveyors
- Petrophysicists
- Drilling crews
- HFS teams
- Electricians

Service companies

- Drilling
- Drilling services
- HFS services
- Seismic
- Proppant supply

Jobs

- Pipeline and facility construction crews
- Human resources personnel
- Water bore drilling teams
- Laboratory technicians
 - Water sampling
 - Core analysis
 - Waste analysis
- IT specialists
- Lawyers
- Accountants
- And the list goes on and on...

Service companies

- Tank storage manufacturing
- Pipeline/facilities construction
- HC processing and refineries
- Transportation
- Maintenance
- Health

Great Sandy Desert Project (EP 493) – Shale oil and gas

1. Background, location & shale play model
2. Well planning and WA state regulatory approvals
3. Groundwater usage and waste management
4. Well construction, well integrity
5. Below ground geological setting and HFS risk assessment
6. Well site remediation and site rehabilitation
7. Project development utilising current horizontal multi well pad drilling methods
8. Community and Social Impact
9. FINDER Concerns

Finder Concerns

- **Domestic oil and gas security.** The Great Sandy Desert project could fill the projected 2021 WA domestic gas supply shortage ensuring the energy crises seen in the East cost is not replicated in WA. Unnecessary delays are concerning as the lead time to develop a project and deliver domestic oil and gas is about 6 years.
- **Overregulation.** In Western Australia we are highly regulated and the concern is the outcome of this current inquiry and political process will result in further increases in regulation adding to the cost and further delay or stop projects from being developed. For example a standard onshore well in Canada is approved in less than a week, in WA the timeframe is 4 to 6 months.

Finder Exploration Contact Details

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