NORTHERN TERRITORY GOVERNMENT

DEPARTMENT OF PRIMARY INDUSTRY AND RESOURCES

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File Ref:

The Hon. Justice Rachel Pepper
Chair
Hydraulic Fracturing Taskforce
GPO Box 4396
DARWIN NT 0801

By email: fracking.inquiry@nt.gov.au

Dear Justice Pepper,

I refer to your letter of 27 April 2017 requesting information in respect to following areas:-

- Petroleum Resources;
- Petroleum Industrial Water Use; and
- Primary Industry Resources.

In response to your request the following information is provided for your consideration.

Petroleum Resource Information

Detailed information has been compiled for the panel in the folders labelled "NTGS Data" and "Energy Division Data". Furthermore, data with regard to planning, suitable land use and water resources data has been compiled in the folder labelled "Planning Data".

In place volumes of shale and tight gas were compiled by the Northern Territory Geological Survey as tabulated in Table 1 and Table 2 below.

Table 1: Shale gas in-place resource estimates

Basin / *prospect*				Reference
	Potentially in place			
McArthur Basin (Beetaloo Sub-basin)	**P90 Bscf**	**P50 Bscf**	**P10 Bscf**	
lower Kyalla Formation	31 470	52 260	86 970	RPS (2013)
middle Velkerri Formation	65 012	104 220	166 770	RPS (2013)
middle Velkerri Formation (entire B-shale pool)	434 000#	601 000#	841 000#	Origin (2017a)
middle Velkerri Formation (within Origin's tenure)	360 000#	496 000	692 000#	Origin (2017a) and Falcon (2017)
middle Velkerri Formation (within Pangaea's tenure)		113 000#		Alnes (2016)
middle Velkerri Formation (within Imperials's tenure)	383	1 192	3 086	Imperial Oil and Gas, ASX Release 10/09/2016
middle Velkerri Formation (basinwide)	118 000	202 000	293 000	Weatherford (2017)
McArthur Basin				
Barney Creek Formation (within Armour's tenure)	3 801	12 971	39 085	MBA (2012)
Barney Creek Fm (within Imperial's tenure)	3 304	8 699	20 172	Imperial Oil and Gas, ASX Release 10/09/2016
Wollogorang Formation (within Imperial's tenure)	1 384	1 185	2 371	Imperial Oil and Gas, ASX Release 10/09/2016
Amadeus Basin				
Horn Valley Siltstone	2 600	11 300	23 800	DSWPET (2011)

 # - Denotes commercial-in-confidence resource not in the public domain

Table 2: Basin-centred gas (tight gas) in-place resource estimates

Basin / *prospect*				Reference
	Potentially in place			
McArthur Basin (Beetaloo Sub-basin)	P90 Bscf	P50 Bscf	P10 Bscf	
Moroak Sst	1 360	8260	51 240	RPS (2013)
Bessie Creek Sandstone	35 220	62 310	107 030	RPS (2013)
Amadeus Basin	P90 PJ (Bscf)	Mean PJ (Bscf)	P10 PJ (Bscf)	
Stairway Sandstone	(1 100)	(5 100)	(10 500)	DSWPET (2011)
Pacoota Sandstone	2 545 (2 400)	10 392 (9 800)	20 891 (19 700)	DSWPET (2011)

Shale and tight prospective (technically recoverable) petroleum resource estimates in the Northern Territory were compiled and tabulated by the Energy Division and summarized in Table 3.

Table 3: NT Shale and Tight Recoverable Petroleum Resource Estimates (Open and Confidential Reports)

	Gas			Oil		
Basin Name	Prospective Resources (Bscf)*	Contingent Resources (Bscf)	Reserves (Bscf)	Prospective Resources (mmbbl)**	Contingent Resources (mmbbl)	Reserves (mmbbl)
Bonaparte	18	11	0	0	0	0
South Georgina Basin	0	0	0	26,420	0	0
McArthur	209,389	6,715	0	22,454	0	0
Amadeus	26,200	0	0	1061	0	0
Total	235,607	6,726	0	49,935	0	0

*Bscf: Billion standard cubic feet
**mmbbl: Million barrels

Recent exploration activity has been focussed in the Beetaloo Sub-Basin of the Greater McArthur Basin. Notwithstanding the development potential of other basins within the Northern Territory, the Beetaloo Sub-Basin currently presents the greatest likelihood for development in the near term. Two petroleum discoveries of petroleum were recently reported to the Department with details of recoverable quantities of petroleum from the prospective middle Velkerri Formation only within the Beetaloo Sub-basin.

In aggregate the best estimate of prospective (recoverable) quantities of petroleum in the Beetaloo Sub-Basin from the middle Velkerri shale only amount to 125 trillion cubic feet (Tcf) of gas with a range of 50 Tcf (90 percent confidence – low estimate) to 250 Tcf (10 percent confidence – high estimate). Considering that the discoveries and resulting prospective and contingent resource estimates were based on a limited number of observations (wells), resource classification rules as per the Petroleum Resource Management System (PRMS) developed by the Society of Petroleum Engineers (SPE) apply.

The discovery of gas and the estimates of technically recoverable gas using proven and available technology at the time of estimate, does not take into consideration whether or not the petroleum can be recovered economically. To reduce uncertainty about the technically recoverable petroleum resources and the commercial viability for development will require quite significant further exploration and appraisal including the use of hydraulic fracturing stimulation techniques. In the professional opinion of officers in the department a further two to three years of drilling and testing will be required to prove the commercial viability of the Beetaloo Sub-Basin. If proven viable, the preparation and implementation of major projects is likely to take five to ten years particularly if the development involves export of gas via a new purpose built liquefied natural gas (LNG) terminal (Figure 1).

Factors influencing the commerciality of the Beetaloo Sub-Basin will include:

- Long term international demand for gas
- Domestic gas demand and gas prices
- Recovery per well
- Cost and efficiency of drilling and stimulation of wells
- Access to water resources
- Access to land
- Availability of (skilled) labour and resources
- Access to capital
- Stable policies, fiscal climate and regulatory systems

Requested shape files of basin boundaries and geological and geochemical data are provided on a universal serial bus (USB) accompanying this letter.

Petroleum Industrial Water Use

As previously mentioned, exploration for shale and tight gas resources requires further understanding through appraisal to establish the extent to which technically recoverable resources can be commercially developed. Given recent discoveries, the industry is now entering the appraisal phase with any development to be six years away (Figure 1).

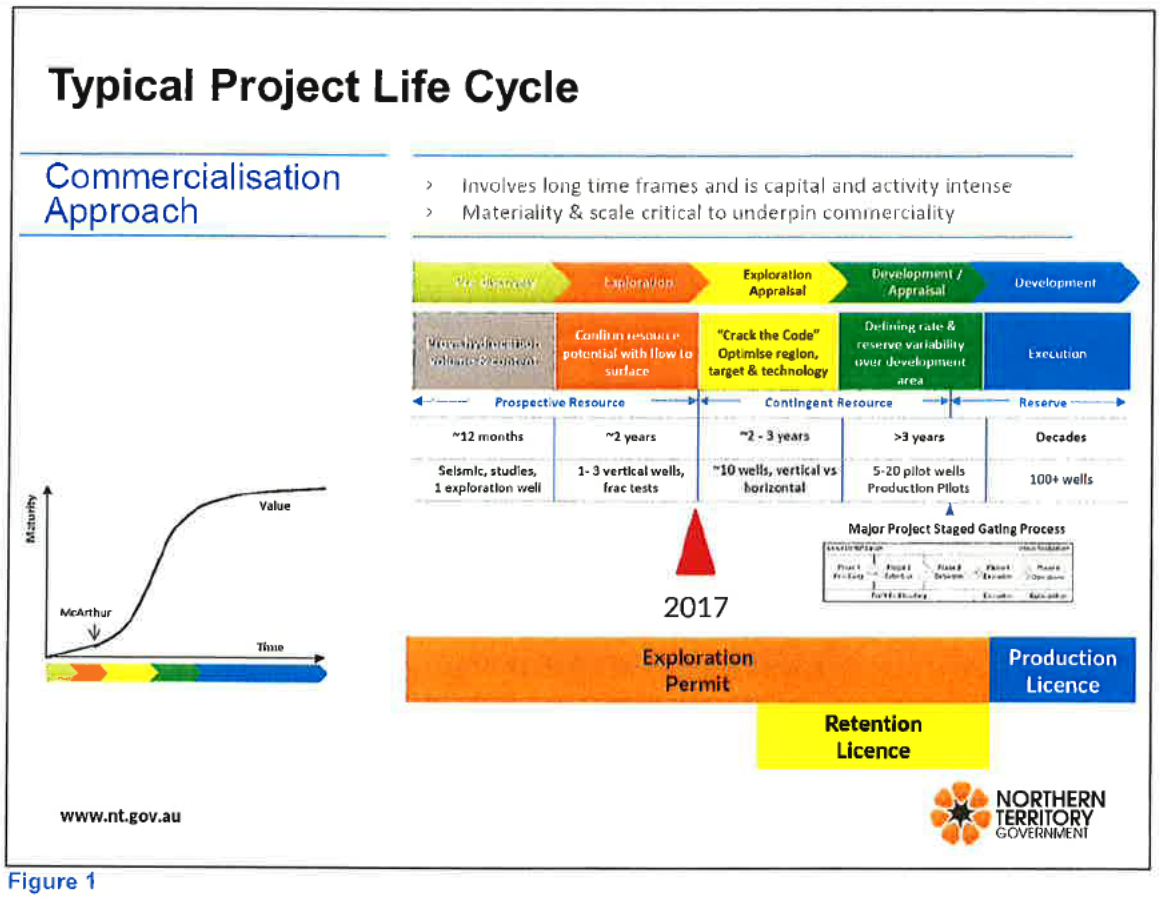

Figure 1

In order to provide the panel with some indicative scenarios the department offers the following highly speculative cases to be developed over 40 years (1 Tcf = one trillion cubic feet of gas = 1,000 billion cubic feet of gas):

- Case 1: 20 Tcf (low case)
- Case 2: 50 Tcf (best estimate)
- Case 3: 125 Tcf (high case)

Table 4 illustrates the number of wells required at 6 PJ, 8 PJ and 12 PJ ultimate recovery per well with development scenarios for each reference case. One peta joule (PJ) is roughly equal to 1 billion cubic feet (Bcf) of gas. One LNG train (~4.5 million tonnes per annum Mtpa) requires about 250 PJ gas per year. Steep production declines of shale wells require a steady drilling rate to maintain production.

Potential development scenarios will include potential gas supply to users in the Northern Territory such as the mining industry and/or other yet to be established industrial users, gas supply to the East coast via a yet to be built pipeline noting that capacity in the Northern Gas Pipeline is limited to about 90 TJ/d only and potential existing or new LNG export capacity in the Northern Territory.

Table 4: Well numbers and reference development scenarios

	Total number of wells			Number of wells per year			
Case	High (6 Bcf per well)	Best estimate (8 Bcf per well)	Low (12 Bcf per well)	High	Best	Low	Development
1	3,350	2,500	1,670	83	63	42	1 x LNG + NT + East Coast
2	**8,350**	**6,250**	**4,170**	**208**	**156**	**104**	**4 x LNG + NT + East Coast**
3	20,850	15,625	10,420	521	391	260	10 x LNG + NT + East Coast

Table 5 shows the number of well pads for the corresponding reference cases and surface clearing required for development assuming 15 wells per pad and a surface clearing area of 500 x 500 metre for each well pad. Well pads can be substantially (50-65%) reduced in size after drilling and workover activities are completed. The total surface area of the Beetaloo Sub-Basin is estimated to be 25,000 km^2. This figure was used to illustrate the percentage of land used for onshore gas development before partial rehabilitation during production.

Table 5: Well pads, clearing and percentage of land affected

	Number of well pads			Land clearing in km^2			Percentage of land use		
Case	High	Best	Low	High	Best	Low	High	Best	Low
1	222	167	111	56	42	28	0.2%	0.2%	0.1%
2	556	417	278	139	104	69	0.6%	0.4%	0.3%
3	1,389	1,042	694	347	260	174	1.4%	1.0%	0.7%

Table 6 shows total water usage assuming 25 mega litres (ML) per well and a 20% recycle rate of water used and annual water use for each scenario over 40 years. Recycle rates may vary and actual water usage may range between 20 to 30 ML. Amount of waste water generated is conservatively assumed to be 60% of water used. The Beetaloo Sub-Basin appears to bear some resemblance to the US Marcellus field where recycle rates of 85% have been achieved. Flowback water from the Amungee well was only about 30% due to operational constraints. It is expected that during full scale development higher flowback rates can be achieved and water re-use can be optimised.

A trend has been observed that longer horizontal laterals are being drilled with more intensive hydraulic fracturing which increases the amount of water used for hydraulic fracturing per well but yields higher recovery factors for shale gas. Water usage is given in giga litres (GL) where 1 GL equals 1,000 ML.

Waste water may be managed in a number of ways:

- Evaporation ponds;
- Beneficial use after treatment; and
- Reinjection into deep aquifers or reservoirs.

Table 6: Total and average annual water use

Case	Total water use in GL			Water use per year in GL			Waste water per year in GL		
	High	Best	Low	High	Best	Low	High	Best	Low
1	67	50	33	1.7	1.3	0.8	1.0	0.8	0.5
2	167	125	83	4.2	3.1	2.1	2.5	1.9	1.3
3	417	313	208	10.4	7.8	5.2	6.3	4.7	3.1

The Beetaloo Sub-Basin underlies the Cambrian Limestone Aquifer (CLA). The most recent exploration campaigns involving hydraulic fracturing have accessed fresh water resources held within the CLA. While other sources of water may be available, the use of water resources from the CLA will be the base case.

For the most recent information about water resources we refer the panel to the GHD report for the Department of Land resource Management titled 'Groundwater Overlying the Beetaloo Sub-Basin Explanatory Report', April 2016 and the Beetaloo Basin Hydrogeological (Baseline) Assessment by CloudGMS, February 2015. The GHD report (page 6) states that "The CLA contains a significant but largely undeveloped groundwater resource with the sustainable yield from the Georgina Basin estimated to be in the order of 100,000 ML/year (NALWTF, 2009). Existing groundwater use in the Beetaloo Basin is estimated at 6,000 ML/year."

The panel have requested estimates of volumes of waste water to be produced, likely economical recycle rates for waste water reuse, best estimates of likely discharges into the environment and a list of the likely chemicals and their individual and combined toxicity. The department respectfully refers the panel to industry for comment. The panel may also wish to refer to the slidepack provided by Joe Lima, Director Environmental Sustainability at Schlumberger.

Current practice requires that waste water from hydraulic fracturing activities is fully contained on site. The fluids may be held in double HDPE lined evaporation ponds. Evaporation may be aided with sprinklers or other devices to accelerate evaporation rates. Concentrated waste fluids must be collected and transported to a licenced waste treatment facility in accordance with the *Waste Management and Pollution Control Act*. Certificates of acceptance of waste fluids by the treatment facility must be provided to the Department.

Primary Industry Resources

Please find attached:-

- Summary/Overview of the value of the pastoral, agriculture/horticulture industries in the NT. The attached NT Pastoral Map – Districts shows the location of the pastoral districts referred to in the Summary/Overview. The Department notes that valuation of industry sectors in the NT is a matter of constant review. Industry associations consistently estimate value at higher levels than Departmental conservative estimates. Refer to NT Farmers Association 2015 publication of economic value as attached as an example. The Department does not have the power to inspect or audit the financial records of NT producers and therefore relies on estimates such as the "farm gate price" or "gross value of production";

- Identification of Potential Land For Long-term Sustainable Food Production – Soil and Water Suitability Assessment (2nd Edition)

This report identifies areas that have the potential for agribusiness (pastoral, horticulture and agriculture) based on the soil and water information currently available. Further detailed studies are required to determine viability of the areas. The report does not prioritise agriculture development areas based on land tenure, willingness of landholders to develop, investment readiness (ie: detailed resource and environmental studies have been conducted and business cases completed) or access to existing infrastructure.

- Study Areas – Land and Water Suitability Program 2014-2018 map

  The Study Areas – Land and Water Suitability Program 2014-2018 has been developed by the Department of Environment and Natural Resources, in consultation with other agencies (including this Department), and NT Farmers Association to determine which areas warrant further investigation.

  Generally speaking, the areas identified were based on:-

  - Existing soil and water data;
  - Market access opportunities;
  - Established infrastructure eg.: road access;
  - Climate; and
  - Development opportunities for pastoral properties to diversify.

The maps referenced in the Soil and Water Suitability Assessment and the Study Areas – Land and the Water Suitability Program 2014-2018 map is provide in ESRI shapefiles to GDA94 Datum, as requested by the Hydraulic Fracturing Inquiry. The link can also be accessed at:

https://ftp-dlrm.nt.gov.au/main.html?download&weblink=8edcfaf47ad773e782dbfff9d89e8743&realfilename=JohnD.zip

It should be noted that emerging technology and new market opportunities may allow pastoral properties to be developed and used for intensive agriculture purposes.

Future agricultural development may also depend on changes to government policy and legislative amendments.

There have been a number of land based aquaculture developments, with the most significant ones being Humpty Doo Barramundi and the proposed Project Sea Dragon (tiger prawn farm).

The approximate total foot print of Humpty Doo Barramundi's existing and proposed development could be approximately 585 ha. Project Sea Dragon proposes to develop 10,000 ha of ponds and associated infrastructure to farm Tiger Prawns. The total land mass of the Northern Territory is approximately 142.1M ha and as such Humpty Doo Barramundi and Project Sea Dragon development foot print represent approximately 0.000004117% and 0.00007037297% respectively of the Territory land area. Plans showing the location of Humpty Doo Barramundi and Project Sea Dragon are attached for your information.

Land based aquaculture developments have specific requirements eg.: close to salt water, remote locations for biosecurity protection. As such hydraulic fracturing is unlikely to impact these developments.

Please contact me with any further questions or requests.

Yours sincerely

Alister Trier
Chief Executive

30 May 2017

Incl.:

- Planning Data
- Primary Industry Data
- Northern Territory Geological Survey Data
- Energy Division Data