SCIENTIFIC INQUIRY INTO

HYDRAULIC FRACTURING

IN THE NORTHERN TERRITORY

Final Report

March 2018

frackinginquiry.nt.gov.au

SCIENTIFIC INQUIRY INTO

HYDRAULIC FRACTURING

IN THE NORTHERN TERRITORY

Chapters 1-3
Purpose, work and findings of the Inquiry

frackinginquiry.nt.gov.au

What we have done

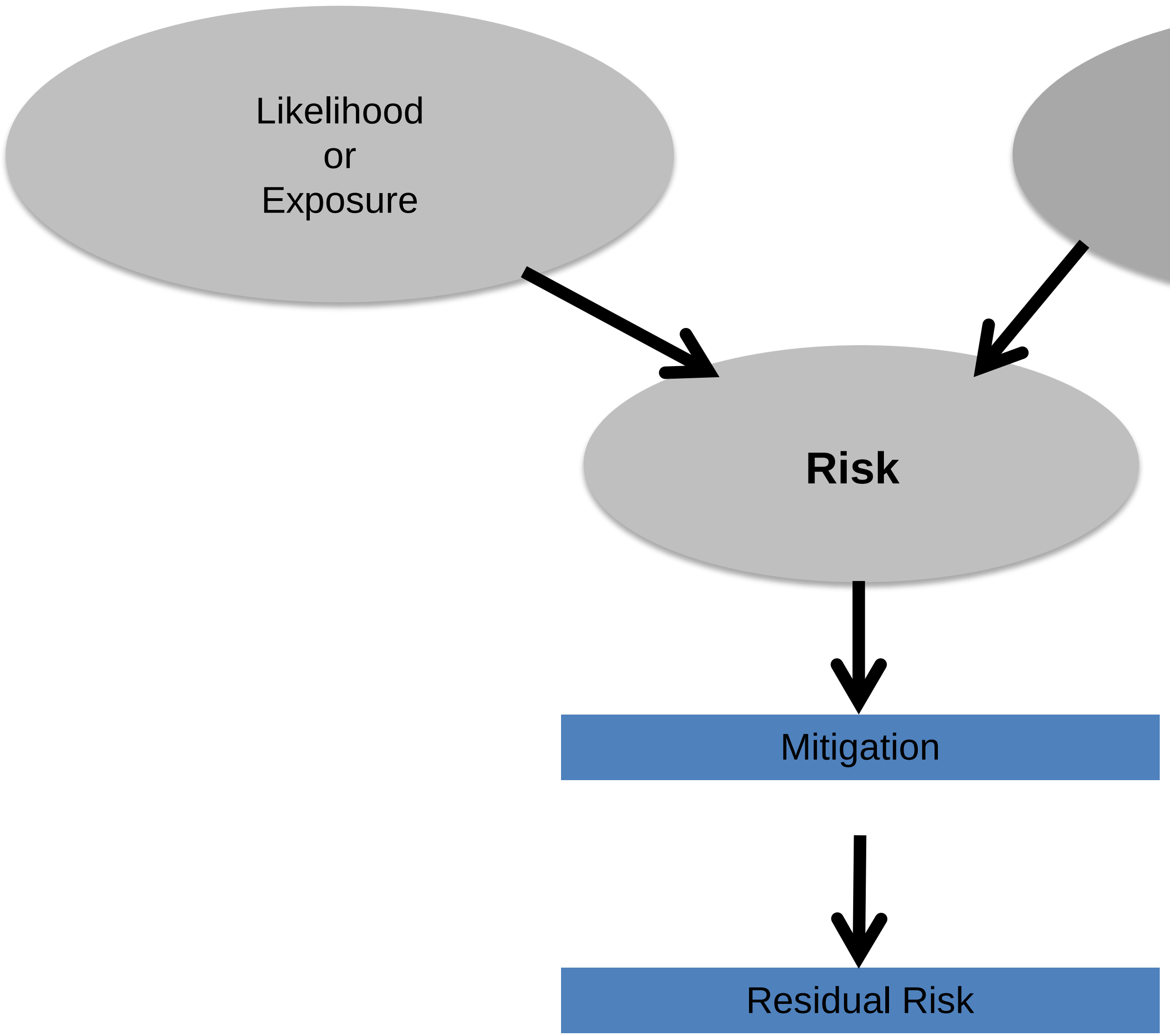
- We met 12 times
- We saw a frack at Moomba in South Australia
- We released a *Background and Issues Paper*
- We conducted 151 public hearings
- We held 52 community forums: 37 of these were in regional and remote areas, and 15 were held in urban centres
- We visited CSG gas fields in Queensland and spoke to people affected by CSG
- We consulted pastoralists and visited cattle stations
- We released an *Interim Report*
- We released the ACIL Allen and Coffey reports
- We visited Mereenie and Palm Valley gasfields
- We released the *Draft Final Report* in December 2017 including 120 draft recommendations
- We issued 31 community updates
- We received 1257 submissions
- We translated our publications into Aboriginal language
- We delivered the *Final Report* in March 2018 with 136 recommendations

SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 4
Evidence and Risk Assessment Methodology

frackinginquiry.nt.gov.au

Risk Assessment Methodology



Q: Actions that can minimise the risk (note application of the precautionary principle)?

Q: Is it acceptable (including by reference to the principles of ESD)?

Precautionary Principle

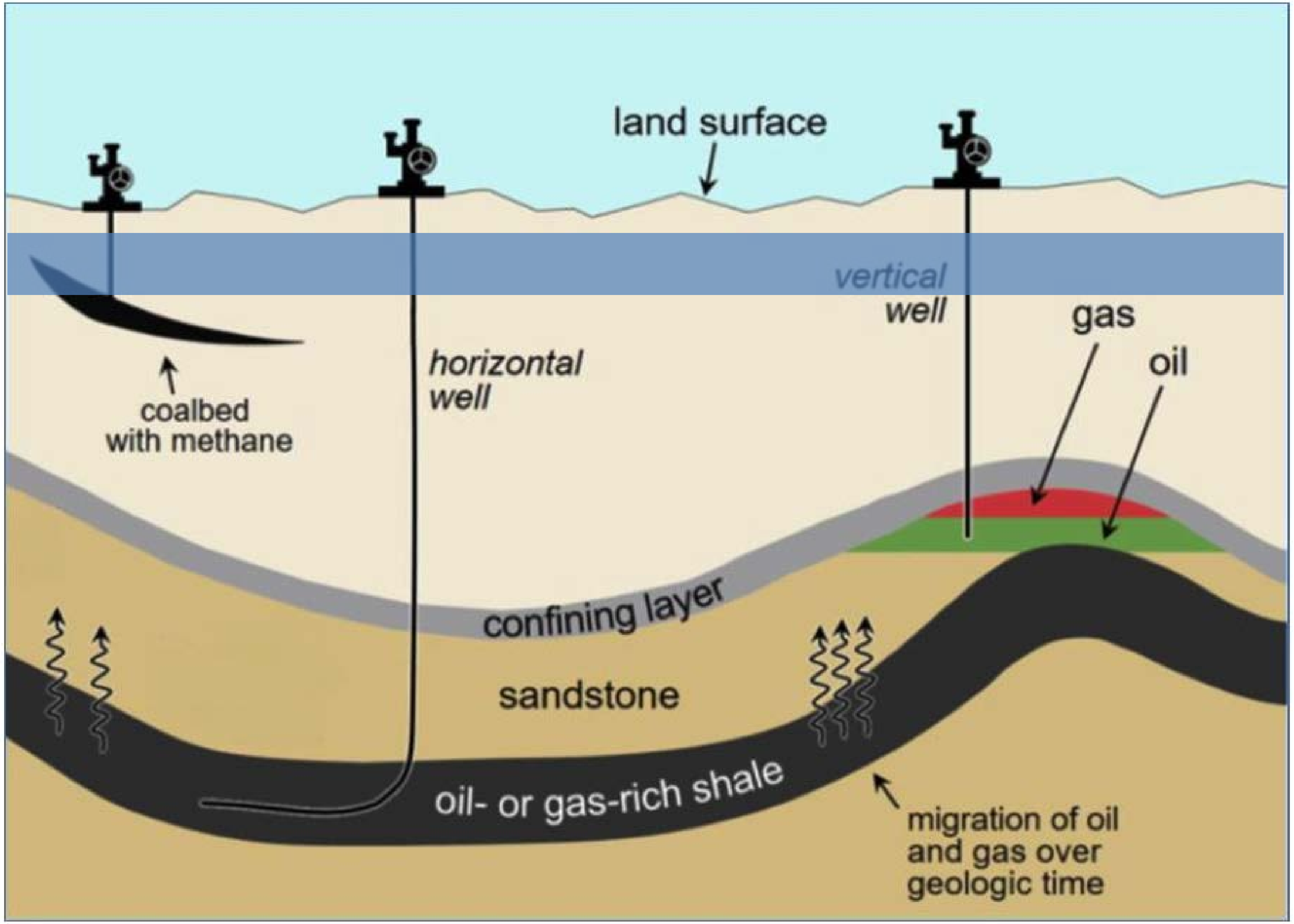
- When is the precautionary principle applied?
  - there is scientific evidence of potential threat of serious or irreversible environmental damage; and
  - uncertainty as to the nature and scope of the threat of environmental damage
- Common misunderstanding that any uncertainty in risk means that a development should be stopped until issues resolved
- Application of the principle actually means that the worst case should be assumed and that the maximum level of mitigation should be implemented until scientific evidence to the contrary is obtained
  - if potential mitigation measures are not sufficient then ‘unacceptable’

Chapter 5
Shale Gas Extraction and Development

Content of Chapter

- **Well Integrity**
- **Water Use**
- **Waste Water - Production and Management**
- Extraction of Gas
- Solid Waste
- Seismicity and Subsidence

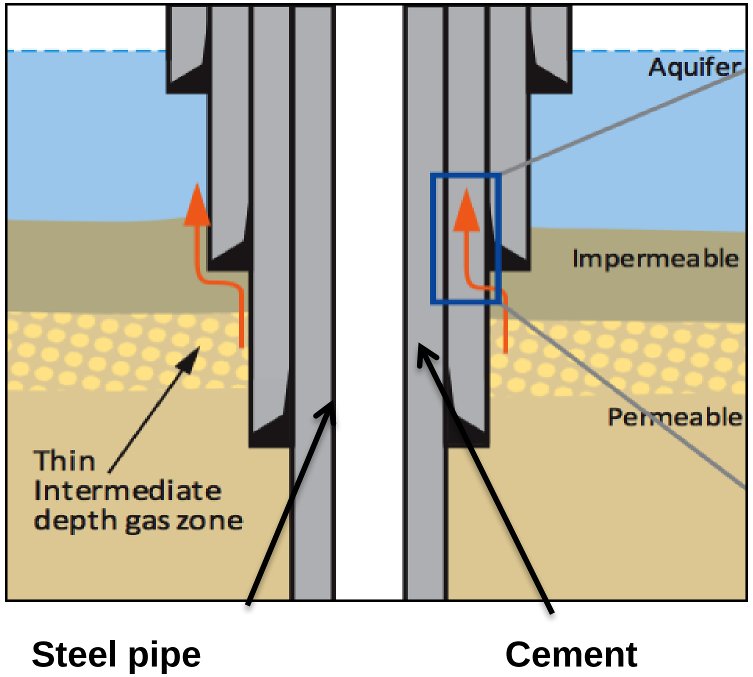
Sources of Onshore Gas

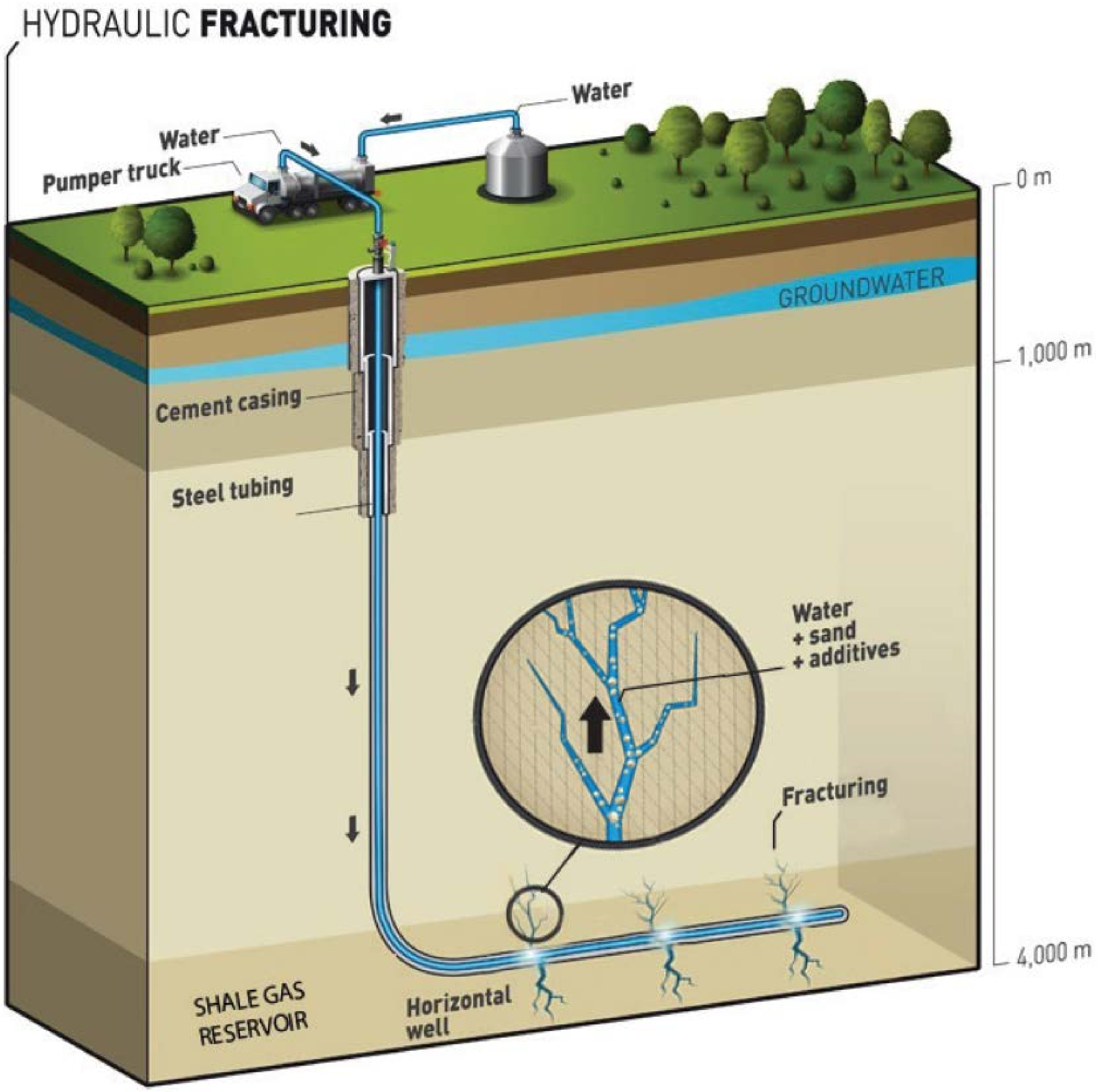


'Typical' surface aquifer zone

Well Life Cycle

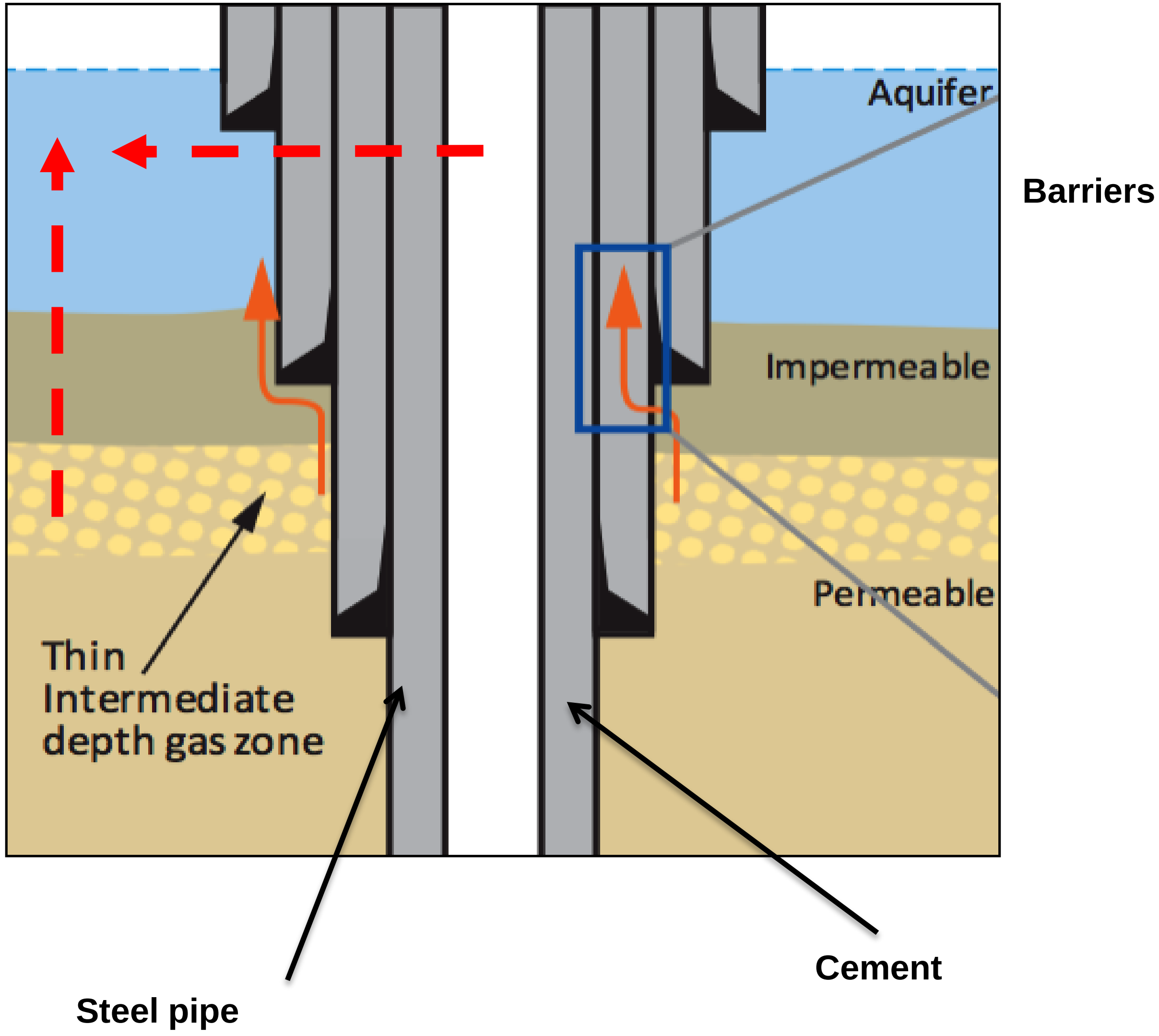
- Design phase (exploration - years)
- Construction/drilling phase (weeks)
- Hydraulic fracturing (weeks)
- Production (20-40 years)
- Decommissioning and abandonment





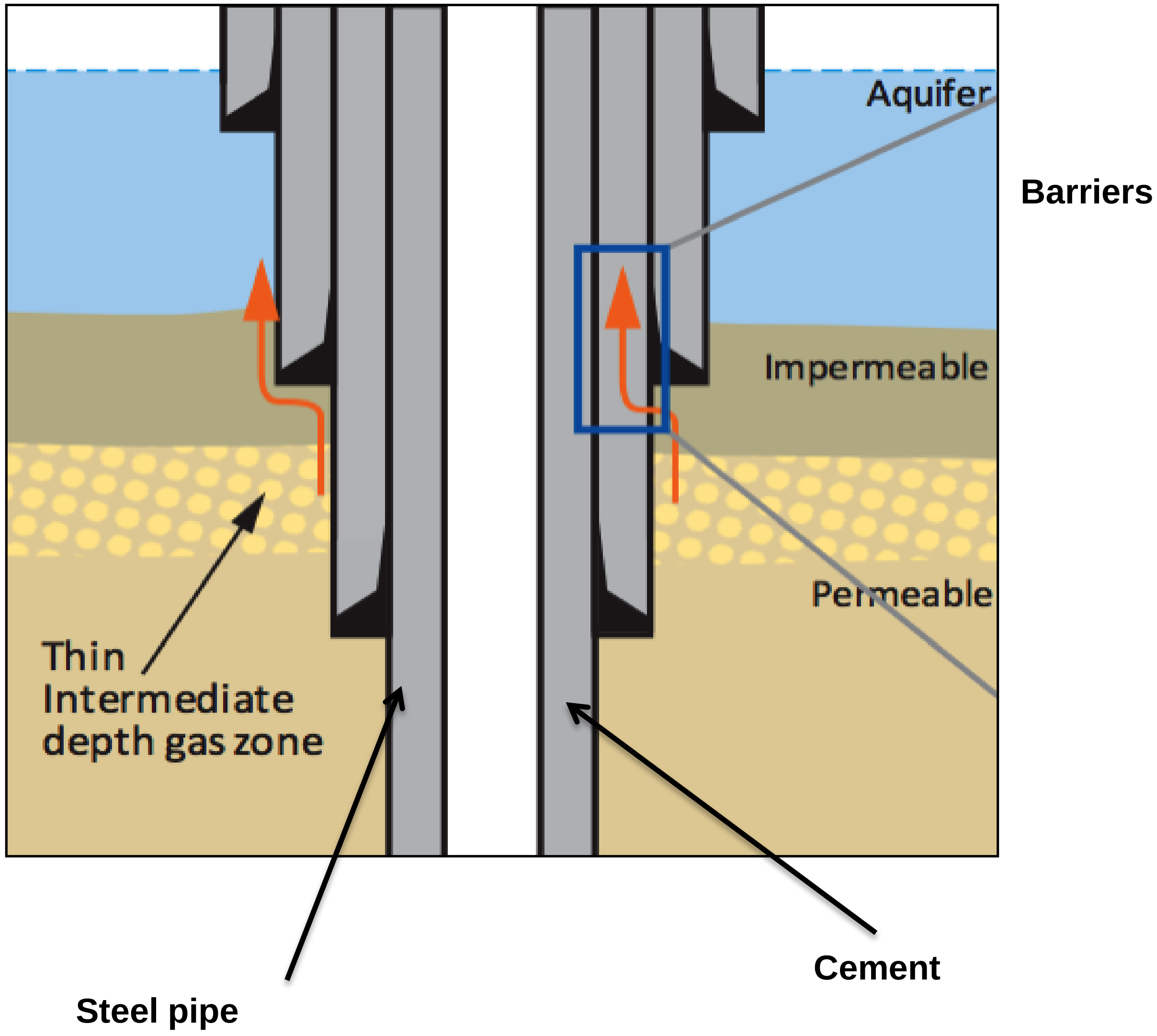
Well Integrity

- Crucial for safe operation and to ensure that groundwater is not contaminated
  - operations (hydraulic fracturing and production)
  - decommissioning at end of life
- Types of failure:
  - well barrier failure – one barrier fails but no loss of fluids
  - well integrity failure – all barriers fail and fluids can flow into and out of the well – may result in groundwater contamination
  - failures can be related to casing and/or cement



Well Integrity Review

- Commissioned CSIRO to conduct in-depth world-wide review
  - CSIRO review found that well integrity failure (all barriers fail) rates were typically less than 0.1% of wells
  - single barrier failure rates are higher (1-10%) historically but are rare for high quality constructed wells (Category 9 or equivalent)
  - single barrier failures do not result in release of gas or fluid to the environment



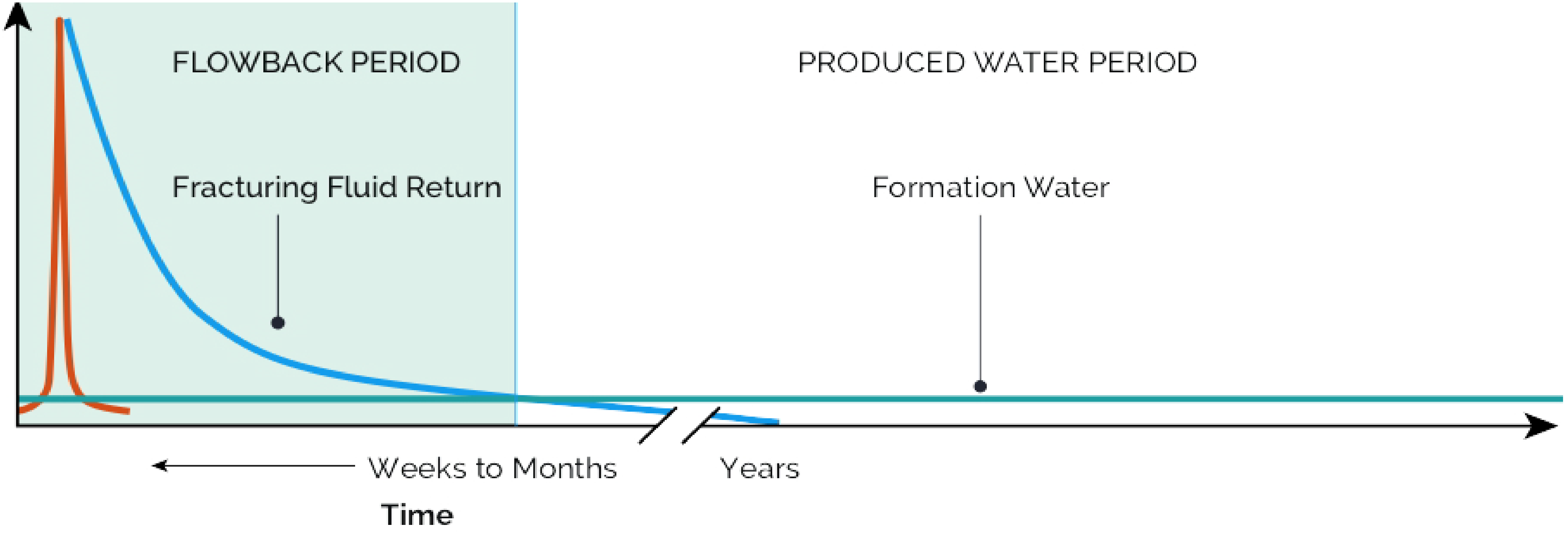
Wastewater Sources

Sources:

- **Flow back water:** return from hydraulic fracturing (weeks to months) – potentially able to be re-used for next fracking operation on multi-well pad
- **Produced water:** continues over the lifetime of the well

Flowback Water Composition:

- fracking chemicals
- chemicals from the shale layer



Recommendations

- That the Government develop and mandate an enforceable code of practice for well design and construction (***Rec 5.3***)
  - minimum requirements
  - all wells be at least Category 9 or equivalent
- That gas companies develop and implement a whole-of-life well integrity management system for each well (compliant with ISO 16530 – 1:2017) *(**Rec 5.4**)*
- That there be an enforceable code of practice for decommissioning of wells, with on-going monitoring after decommissioning *(**Rec 5.1*** and ***5.2**)*
- That a wastewater management framework be developed, including an auditable chain of custody that enables source-to-delivery tracking *(**Rec 5.5**)*

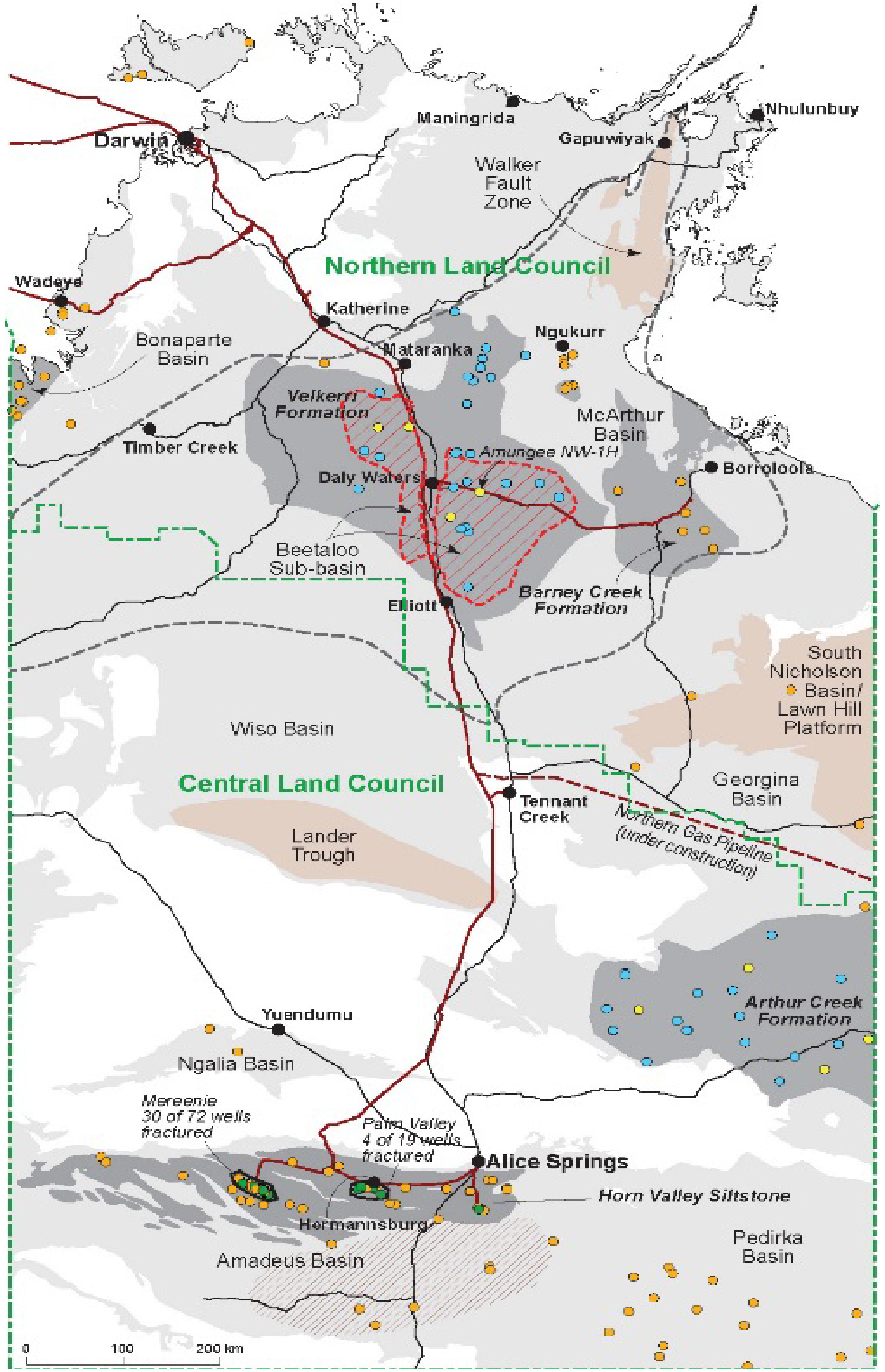
SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 6
Onshore Shale Gas in Australia and the NT

frackinginquiry.nt.gov.au

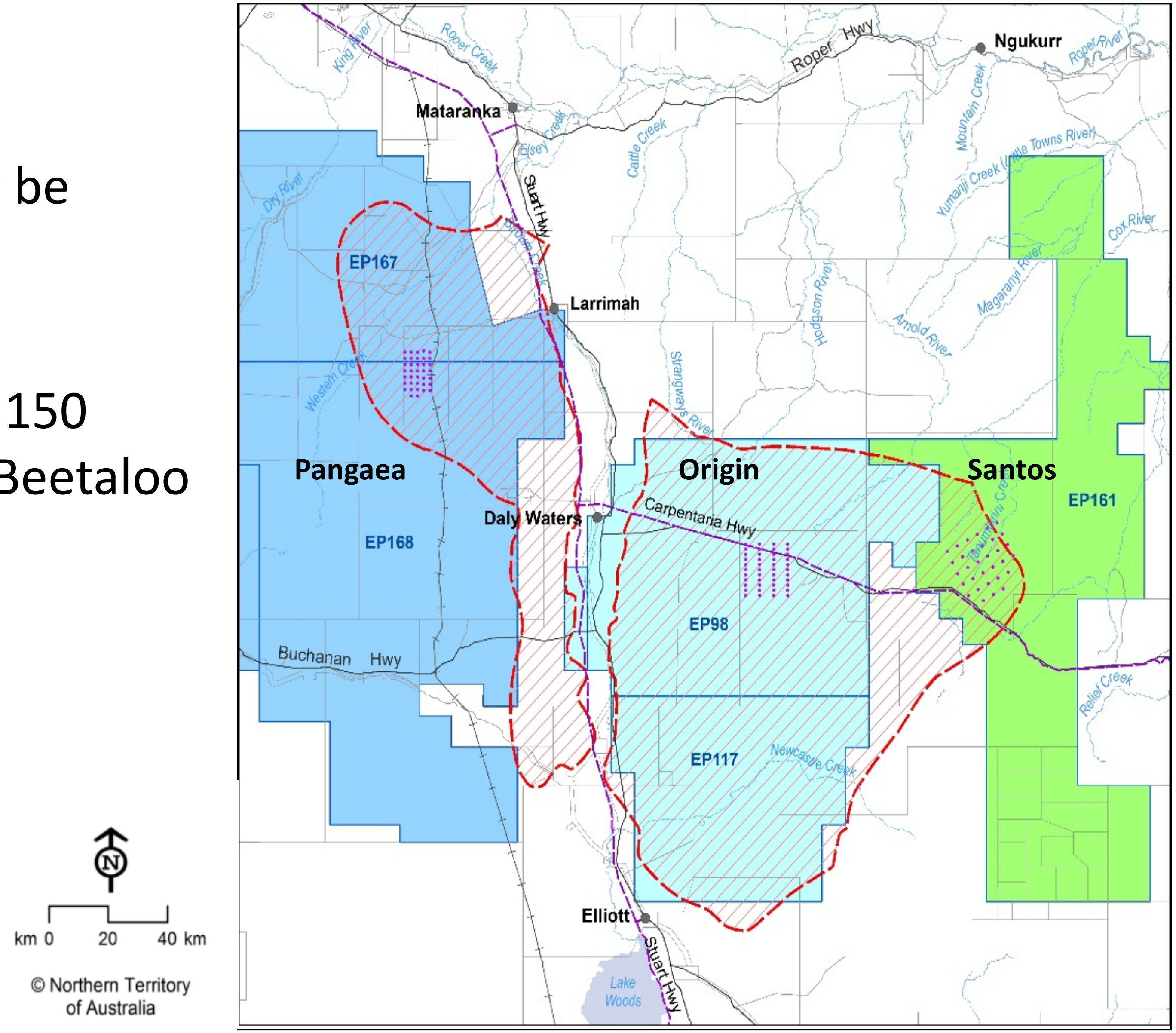
Where is the shale gas?

- There are six major basins
- Most of them are unexplored
- ~ 70% of the total shale gas is in the Beetaloo Sub-basin
- There has already been hydraulic fracturing of conventional wells (sandstone) already in the NT (e.g. Mereenie)
- Some gas plays in some basins may produce gas plus liquids
  - o the presence of liquids would not materially affect the panel's assessment of risks



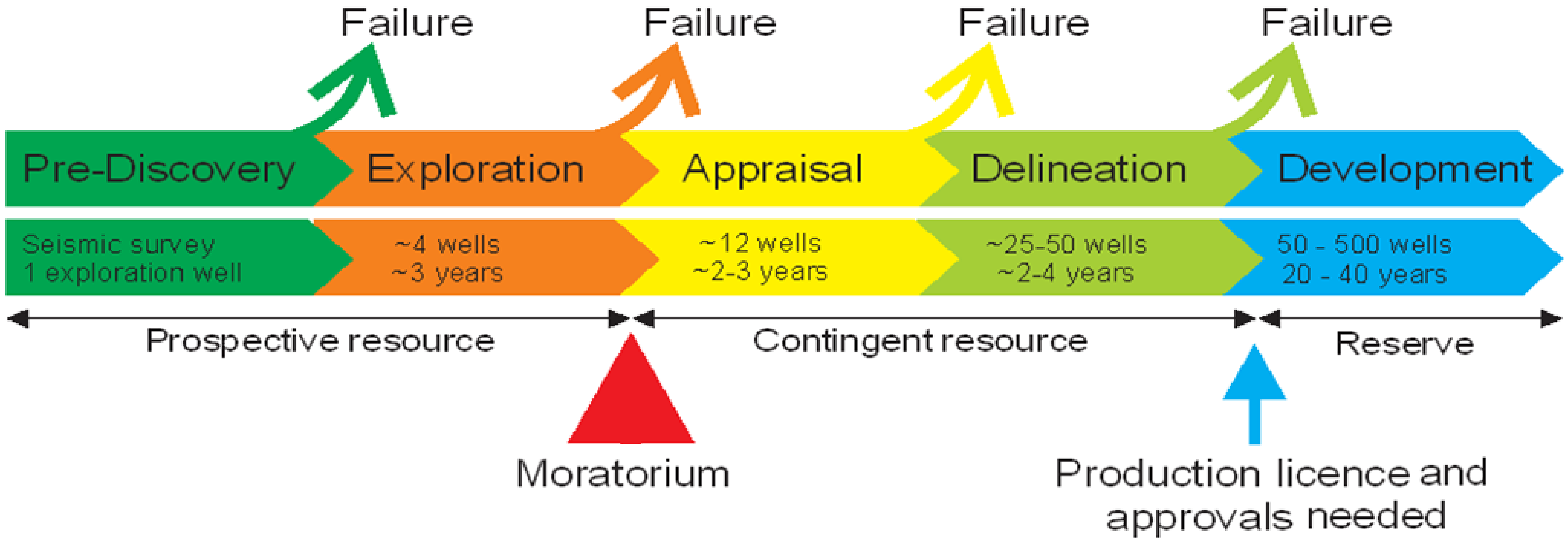
What might development look like?

- 1-2 onshore shale gas resources might be developed in next 5 - 10 years
- Beetaloo Sub-basin is likely to be first
- Industry estimates between 1,000 - 1,150 wells on 104 - 140 drilling pads in the Beetaloo



Development timeline

Possible timeline for the Beetaloo Sub-basin (time required for regulatory approval of each activity is not indicated)



Developed from DPIR and Origin development diagrams

Chapter 7
Water

Water

- Inquiry focused on ensuring acceptable protection of surface and groundwater resources:
  - water supply (quantity)
  - water quality (contamination)
  - aquatic ecosystems
- Assessed 20 water-related risks. Made 19 recommendations
- Four high priority issues:
  - unsustainable groundwater use
  - contamination of groundwater from leaky wells
  - contamination of groundwater by surface spills of fracking fluid chemicals (transit or storage) and wastewater
  - effects on surface or groundwater-dependent ecosystems

Water supply

- Shale gas industry likely to use groundwater
- Industry in Beetaloo Sub-basin likely to use 2,500-5,000 ML per year (1,000-2000 Olympic swimming pools)
- Significant unknowns:
  - need better information on groundwater (recharge, movement) – regional groundwater model
  - need better information on groundwater-dependent ecosystems, e.g. Mataranka springs
- Strategic Regional Environmental and Baseline Assessment (**SREBA**) (***Rec 7.5***, ***7.19*** and ***7.20***)

Water supply - recommendations

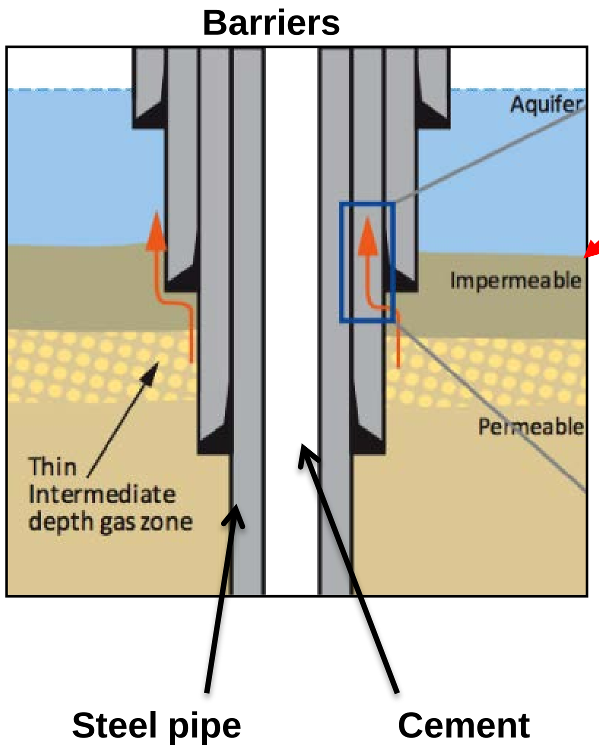
- Gas companies to become subject to the Water Act (need to obtain a licence and pay for water extracted) (***Rec 7.1*** and ***7.2***)
- Changes to water management (e.g. Water Allocation Plans) (***Rec 7.7***)
- No taking of surface waters (rivers, lakes, wetlands) (***Rec 7.6***)
- Restrictions on distance between gas company supply bores and domestic or pastoral water bores (***Rec 7.8*** and ***7.11***)
- Regulator to promote reuse of wastewater

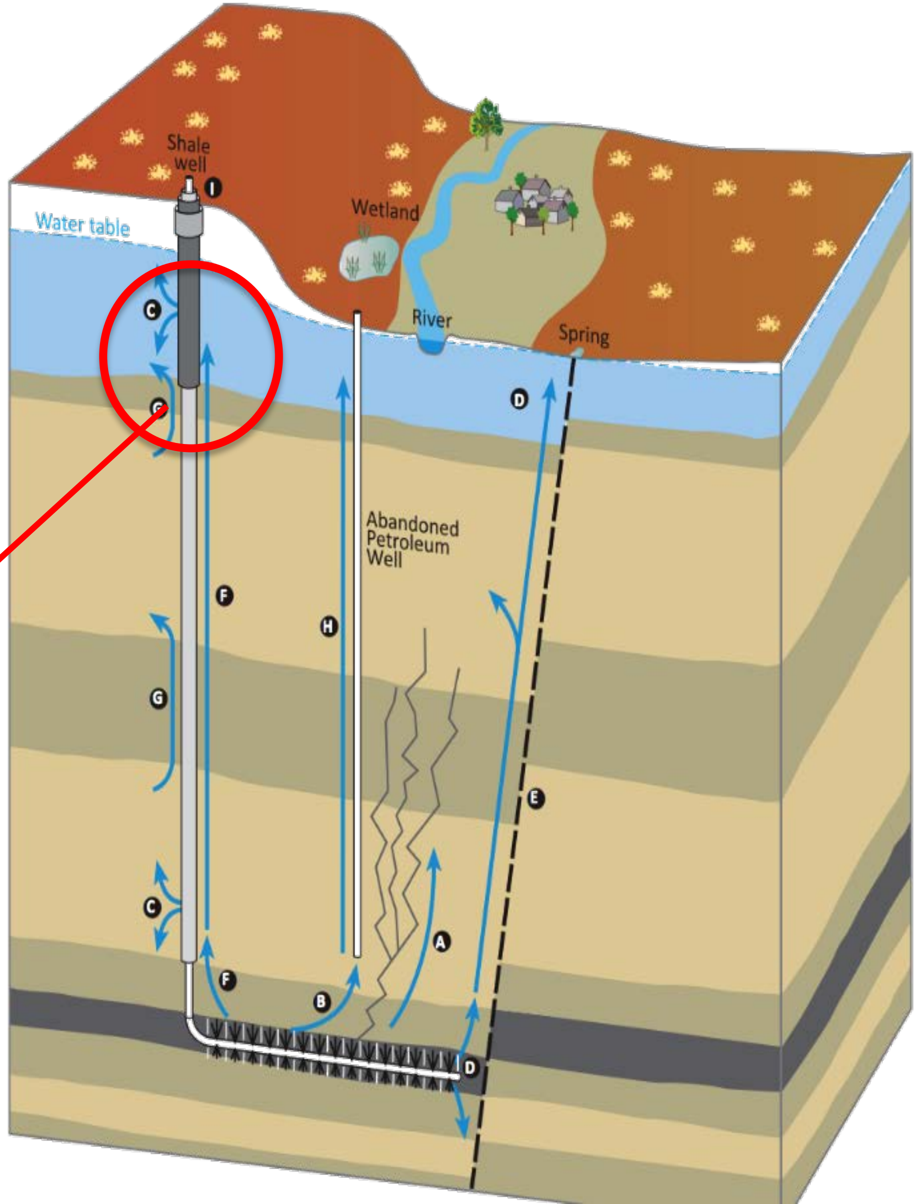
Water quality

- Key issue is to ensure that shale gas wastewater does not pollute surface or groundwater
- Need to minimise the risk of contamination from:
  - wastewater and chemicals (flowback and produced water)
  - methane – not toxic, but is a greenhouse gas
- Panel focused on three potential contamination pathways:
  - leaky wells (well integrity)
  - contamination via faults
  - surface spills

Risk of contamination by faulty wells

- Leaky wells
  - o Where it goes through the aquifer (multiple metal and cement barriers)
  - o Between outer cement layer and rock
- Assessed low risk
  - o Very large distance (2 - 4km) between fractured area and surface aquifers
  - o High construction standards – Category 9 or equivalent – independent regulator



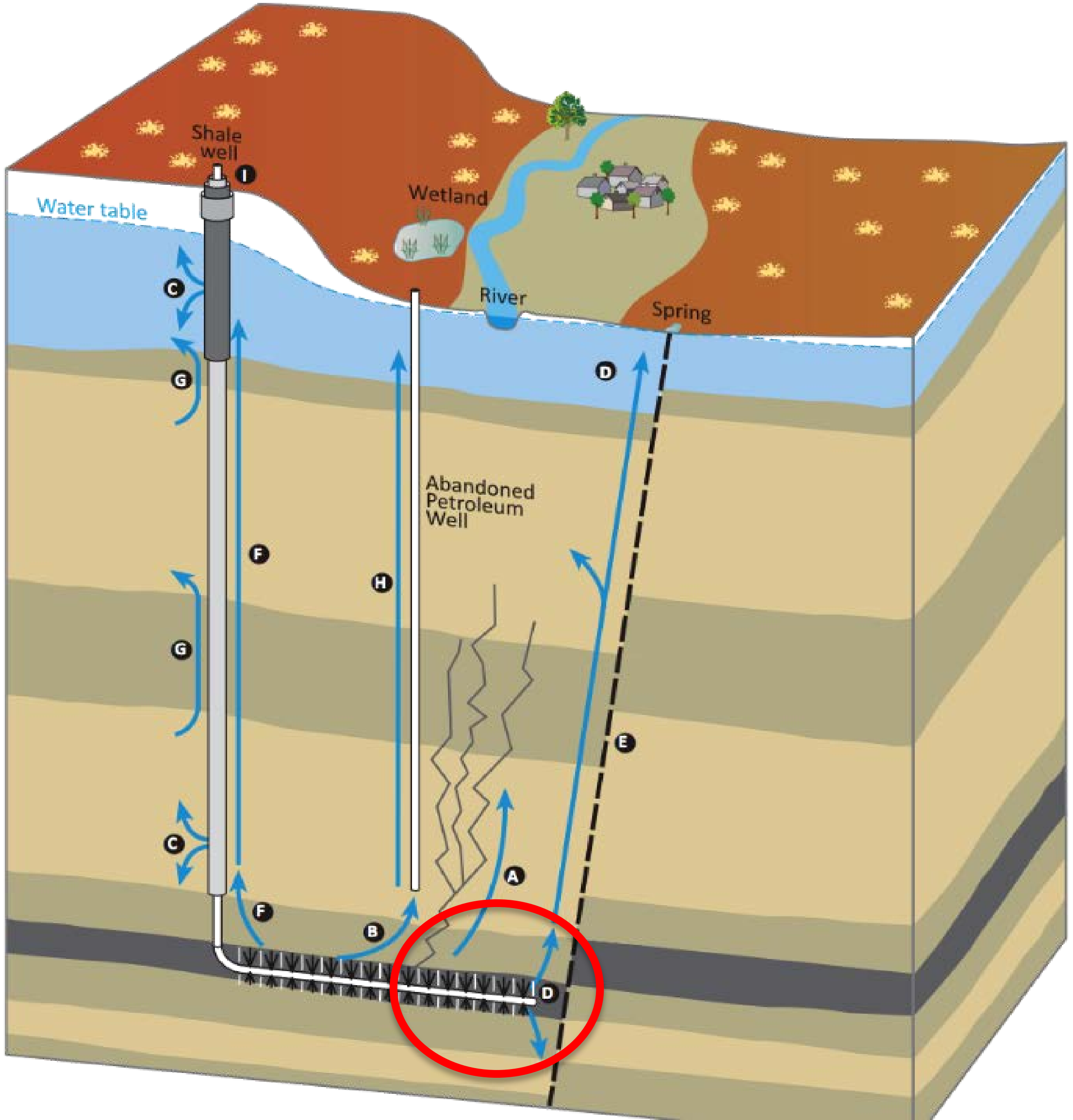


Recommendations

- Need better information on hydraulic fracturing chemicals used, and those from the shale formations in gases and liquids – make publically available (***Rec 7.10***)
- High construction standards (Category 9) for wells, with independent regulator certification (***Rec 7.11***)
- Periodic integrity testing through the life of the well (***Rec 7.11, 5.3*** and ***5.4***)
- On-going monitoring of groundwater and public reporting (***Rec 7.11***)

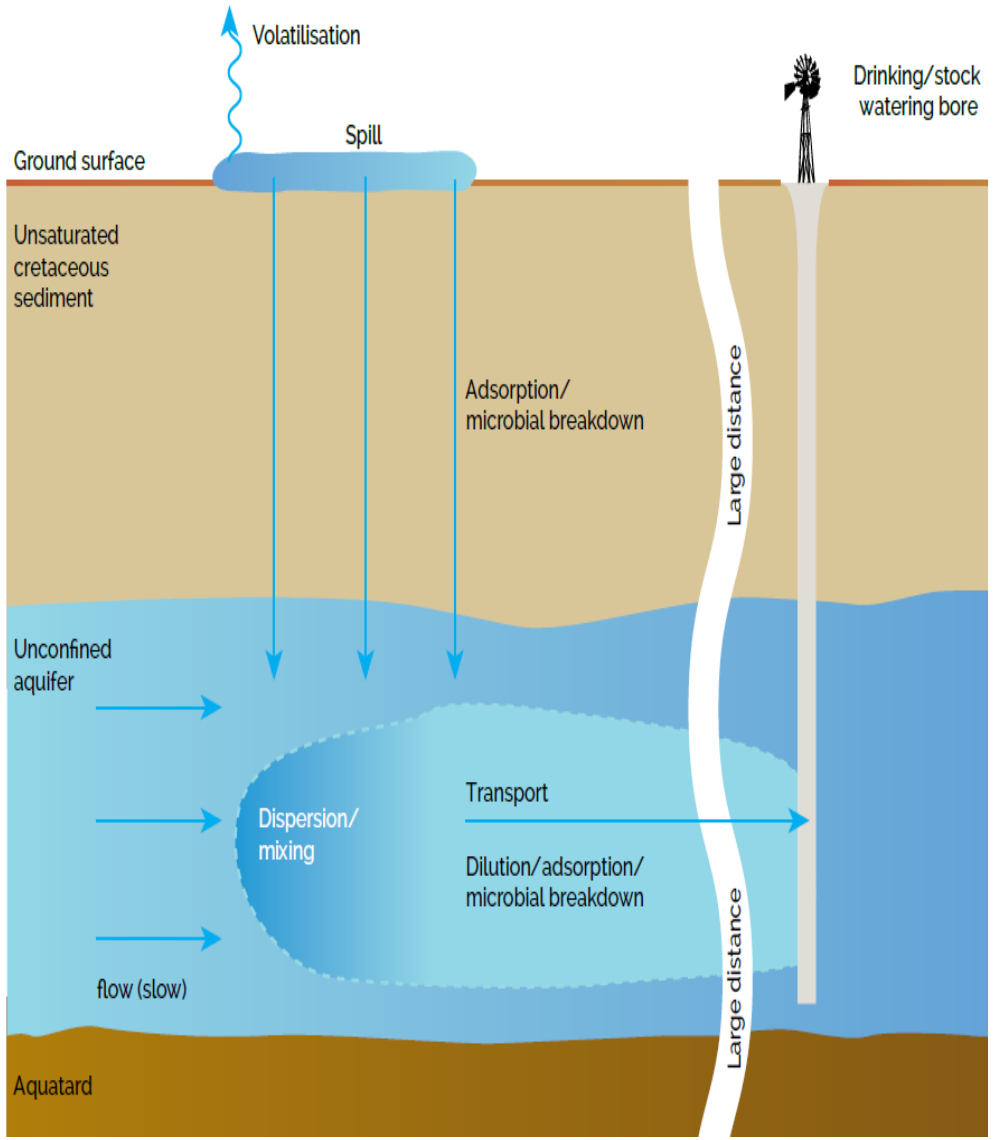
Risk of contamination through faults

- Possible connection between shale area and surface aquifer through a fault
- Assessed low risk
  - o very large distance (2-4 km) between fractured area and surface aquifers
  - o regulator to ensure wells are not drilled close to faults



Risk of contamination by surface spills

- Spills highly likely to occur, but small volumes
- Good management of wastewater is essential
- Two pathways for bore to be contaminated:
  - o passage through the soil/rock layer
  - o transport in aquifer to bore
- Risk assessed as low:
  - o passage through rock to aquifer unlikely (100-150m)
  - o if aquifer contaminated, passage very slow (approximately 1 m/y) and also dispersion



Surface spills - recommendations

- Enforceable wastewater and spill management plan for each well pad (***Rec 7.12***)
- Use of enclosed tanks to hold wastewater (not open ponds) (***Rec 7.12***)
- Treatment of well pad to prevent spills entering groundwater (***Rec 7.12***)
- Monitoring of groundwater with information publically available (***Rec 7.12***)

Other recommendations

- No reinjection of treated or untreated wastewater (***Rec 7.9***)
- No discharge of treated or untreated wastewater to surface waters (***Rec 7.17***)
- The Government to review wet season transport of chemicals and wastewater (***Rec 7.14***)
- Minimise impacts of infrastructure (roads, pipelines) on flow and quality of surface waters (***Rec 7.18***)

SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 8
Land

Land based risks of onshore shale gas development

The Panel assessed potential risks to:

- biodiversity and ecosystem health
- landscape amenity

The Panel determined that the following needs to be ensured:

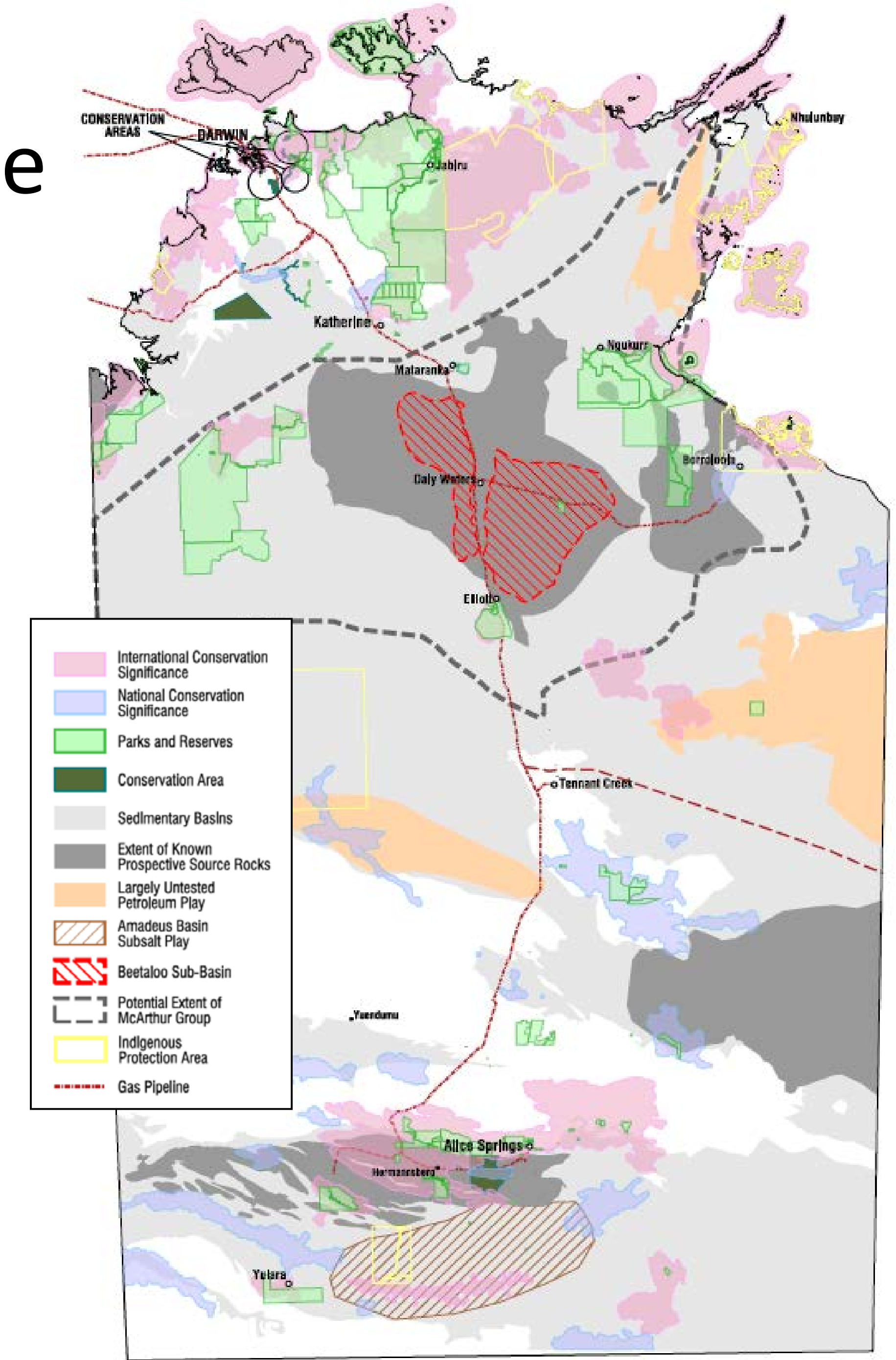
- no impact on terrestrial biodiversity values at regional scale
- maintenance of healthy terrestrial ecosystems
- shale gas infrastructure not highly visible
- heavy-vehicle traffic does not cause unacceptable impacts on amenity

No gas development in areas of particularly high conservation value

The Panel considered the current conservation framework, but also knowledge gaps which should inform future conservation priorities.

The Panel recommends:

- National parks and other conservation areas be legislated as ‘no go’ zones (***Rec 8.1*** and ***14.4)***
- Strategic regional biodiversity assessments (as part of SREBA) to inform requirements for further conservation (***Rec 8.5***)



Invasive species, especially weeds

- The Panel considered the risks posed by weeds, feral animals and invasive ants. Spread mechanisms and feasibility of control were considered
- Weeds recognised as posing highest risk
- To mitigate the impact of weeds the Panel recommended that:
  - baseline weeds assessments before exploration (***Rec 8.2***)
  - weed management plans (***Rec 8.4***)
  - dedicated weed management officers and ongoing monitoring (***Rec 8.2*** and ***Rec 8.3***)

Change to fire regimes

The Panel considered how fracking might affect fire regimes and current fire management programs in the NT

The Panel recommends ***(Rec 8.5)*** that:

- gas companies comply with statutory fire management plans
- baseline fire mapping
- control of ignitions
- ongoing monitoring and management

Changes to native vegetation

The Panel recommends the following measures to prevent unacceptable impacts to native vegetation:

- minimisation of vegetation clearing (***Recs 8.7*** and ***8.11***)
- avoidance of critical habitats such as rainforest and riparian zones (***Rec 8.10***)
- threatened species assessment (***Rec 8.6***)
- rehabilitation following operations (***Recs 8.8*** and ***8.11***)
- development and implementation of an environmental offset policy (***Rec 8.9***)

Roads and pipelines as ecological barriers

The Panel considered how roads and pipelines could act as ecological barriers.

The Panel recommends the following measures to minimise adverse impacts:

- minimise corridor widths (***Rec 8.11***)
- burial of pipelines (***Rec 8.11***)
- minimise erosion and changes to water flow paths (***Recs 8.12*** and ***8.13***)

Landscape amenity

Landscape transformation

- Recommendations made to protect landscapes include:
  - national parks as ‘no go’ zones (***Rec 8.1*** and ***14.4***)
  - well pads spaced by a minimum of 2km and infrastructure not visible from major public roads (***Rec 8.15***)

Landscape amenity

Heavy vehicle traffic

- Large volumes of heavy vehicle traffic are required for hydraulic fracturing
- Further assessment of this impact is required (***Rec 8.16***), but approaches to mitigate traffic impacts could include:
  - the use of railway
  - road upgrades

Chapter 9
Greenhouse Gas Emissions

Greenhouse Gas (GHG) Emissions

- Production and use* of shale gas emits:
  CO_2 (carbon dioxide) and CH_4 (methane – fugitive emissions)
- These are GHG that contribute to global warming
- Concern about the impact of global warming on:
  - climate change
  - sea level rise
  - hydrological systems (surface and ground water)
  - terrestrial, freshwater and marine species
  - human health: major increase in diseases and deaths
- Concern about the contribution of new NT shale gas field to global warming
- Leave gas in ground?

*Life Cycle = Upstream (extraction and processing) and Downstream (use: combustion of gas)

Global GHG – background

Historical: for last ~ 800,000 years, prior industrial, CO_2 < 280 ppm

Post industrial (150 years), most rapid change ever in CO_2

CO_2 +45% and CH_4 +157%

Intensity: CH_4 is a more intense GHG than CO_2, e.g. 36 times

Global Carbon Budget: To keep below 2^0C increase, must consume < 2,900 $GtCO_2$

Consumed 76%. Residual 24% = 700 $GtCO_2$. Current emissions 36 $GtCO_2$/year

Australia: 1% global emissions. **NT**: 2% Australian emissions

Australia's GHG emissions (in rank order): electricity generation, stationary energy, transport, agriculture, fugitive emissions and industrial processes and product use

Life-cycle emissions GHG - findings

Life Cycle GHG Emissions for Shale Gas (GHG are CO_2 and CH_4)			
Upstream (Production)		Downstream (Combustion – use)	Total (CO_2 - equivalent)
CO_2	CH_4		
5%	17%	78%	100%

Production PJ/y	% Australian GHG Emissions	% Global GHG Emissions	Risk
365 (~600+ wells)	4.5	0.05	Medium
1,240 (~4000+ wells)	7	0.07 (or 0.17)	Medium (or High)

Life-cycle emissions for shale gas are ~ ½ that of coal for electricity production

Methane mitigation - recommendations

Mitigation focus. Upstream fugitive methane emissions:

- about 3% of Australia's inventory fugitive methane emissions for 365 PJ/y NT shale gas production
- can be reduced by 23% if good practices and new technologies are used.

Mitigation. Implement the US EPA New Source Performance Standards (***Rec. 9.1***)

- Implement code of practice for baseline and ongoing monitoring (***Rec. 9.2)***
- Monitoring commenced at least one year prior to grant of any production approvals, where HF has already occurred (***Rec. 9.3***)
- Monitoring - responsibility of the regulator and funded by industry (undertaken by an independent third party) (***Rec. 9.4***)
- Monitoring results published online on a continuous basis in real time (***Rec. 9.5***)
- Once emission concentration limits are exceeded, 'make good' provisions are immediately implemented by industry (***Rec. 9.6***)

Decommissioned wells

- Evidence is mixed
- Decommissioned wells mostly have lower CH_4 emissions than abandoned wells with wellhead infrastructure left above the surface
- Implement decommissioned wells (wells that have been cut-off, sealed (plugged) and then buried under soil) (***Rec 5.1*** *and* ***5.2****)*
- Improve the integrity performance of decommissioned wells over 1,000+ years
- Fugitive methane emissions from 1,000 decommissioned wells:
  - 0.3% of Australia's inventory fugitive methane emissions, or
  - 0.005% of the global anthropogenic methane emissions from fossil fuels
  - risk is medium

Risk Assessments

- Methane

Mitigation	Risk
Before (and After)	Medium

Mitigation: reduce methane emissions by 23%. Meets acceptability criteria on emission levels
After mitigation, risk assessment remains medium

- GHG

Mitigation	Risk
Before*: 365 (1,240) PJ/y	Medium (High)
After	Low

*After mitigation CH_4 (***Rec 9.1*** to ***9.6***) and regulatory risk (***Rec. 9.7***), GHG risk is medium or high

Mitigation objective: risk must be low for acceptability. But how to achieve low GHG risk?

The Panel has formed the view that:

Methane mitigation measures will give lower emissions and meet the acceptability criterion.

The risk remains medium.

Life cycle GHG emissions (after mitigation of methane and regulatory risks) remain either medium or high.

This is unacceptable.

Life cycle GHG emissions must be reduced to a low risk to meet acceptability criterion.

GHG Mitigation Australian governments must seek to ensure that GHG emissions are fully offset and that there is no net increase in the life cycle GHG emissions emitted in Australia from NT shale gas production ***(Rec. 9.8)***

Outcome: If reduced methane emissions and GHG emissions are fully offset, then this is an acceptable outcome.

GHG Emissions in NT from Shale Gas Operations

	Upstream GHG Emissions (Emissions in the NT)	
	365* PJ/Y	1,240* PJ/y
Quantity of Emissions, Mt Co_2e/y	6	20
Emissions as a proportion of Total Australian Inventory**	1%	4%
Emissions as a proportion of Total NT Inventory***	46%	155%
Emissions as a proportion of NT Renewable Energy Policy (50%) GHG Savings	~ x 8	~ x 27

* This is 7.5% (365 PJ/y) & 26% (1,240 PJ/y) of Australia's estimated gas production in 2017/ 18
** Australian total GHG Inventory is 538 Mt Co_2e/y
*** NT total GHG Inventory is 12.7 Mt Co_2e/y
Proportional results are very approximate. Comparing "actual" with inventory estimates and inventory estimates are low compared to actual estimates

SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 10
Public Health

Two main approaches in the Final Report

- First, addressed potential risks posed by chemicals released from fracking fluids and flowback water to water, air and food
- Second, addressed risks to well-being and amenity (such as stress, nuisance etc)
  - issues identified along with possible measures to mitigate risk

Informed by:

- National Chemicals Risk Assessment (**NCRA**) guidance and other HHRA reports
- US/UK studies and reports of public health impacts
- Experience drawn from development of CSG industry in QLD and NSW
- Need for baseline assessments of health status in regions likely to have shale gas development*

  * An issue raised consistently in community consultations

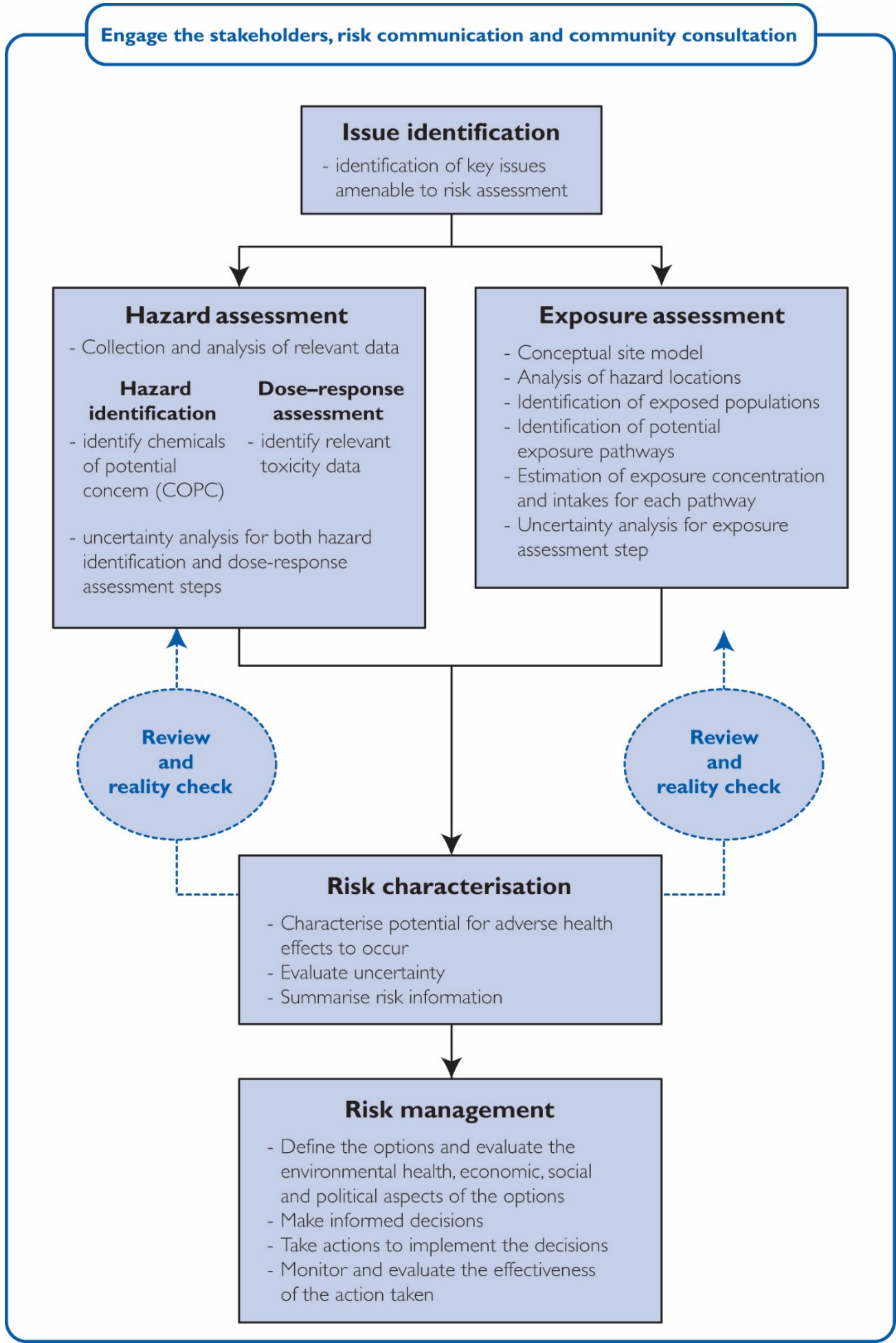
HHRA processes for released chemicals

- Identify chemicals of concern:
    - o in hydraulic fracturing fluids; in flowback water from deep rocks; in dusts and vapours

- Exposure pathways:
    - o are there people in the vicinity likely to be exposed to contaminated water, food, dusts, or airborne gases and vapours?
    - o What exposure pathways are most likely to result in significant human exposure*

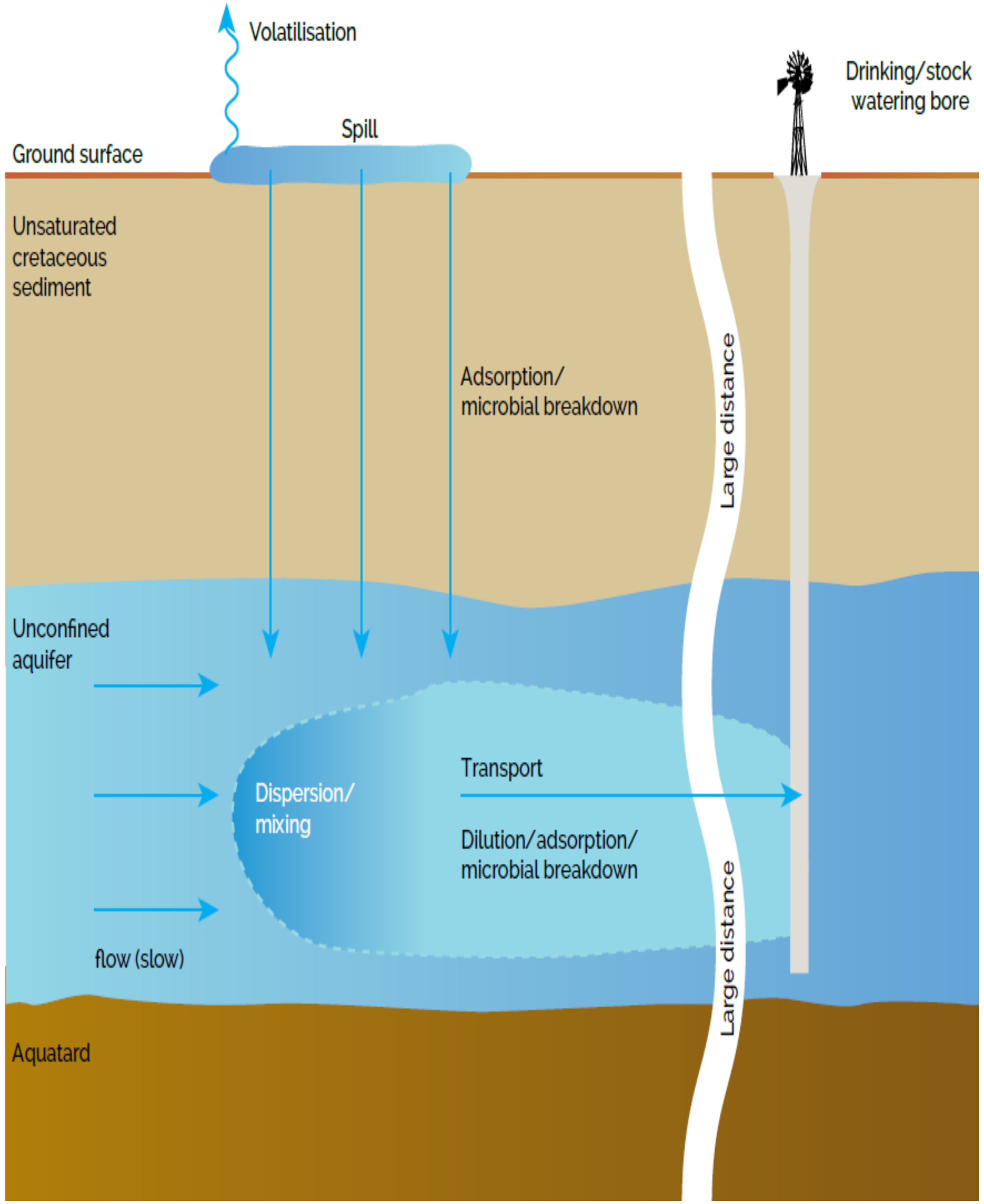
      * HHRA reports prepared so far have tended to discount exposure pathways deemed to be 'incomplete' – i.e no human exposures likely

- Will these chemical exposures be harmful?
    - o contrast predicted exposures with health-based guidance value



Assessment and mitigation of chemical risks

- Human Health Risk Assessments (**HHRA**) reports produced so far suggest health impacts likely to be negligible with adequate controls over well integrity, fluid and chemical storage and waste disposal (***Rec 7.10*** to ***7.14***)
- Panel recommends formal site, or regional-specific HHRA for all new developments (***Rec 10.1***)
  - methods based on enHealth and NCRA guidance
  - mandate as part of EIS requirements
  - including more information on chemicals used and emitted; and treatment/disposal of flowback and produced water (***Rec 7.10***)
  - to include risk estimates of off-site pathways even if considered to be 'incomplete'



Assessment and mitigation of chemical risks

- Off-site health risks more likely to be associated with airborne gases, vapours and dusts:
  - o distance from the emission site important*

    *U.S. experience and other reports (e.g. experience from CSG operations in QLD and NSW) suggest proximity to wells a significant factor in mitigating health risks; most instances of adverse health effects have been reported for people living within 60 – 1600m of gasfields in the US

  - o the Panel has recommended minimum set-back distances of 2km from dwellings and habitation (***Rec 10.2***)

- Risks associated with possible food contamination more difficult to assess, but possibly mitigated by chemical detoxification in animal and plant tissues or degradation after release to the environment

Assessed effects on well-being and amenity

- Stress associated with negotiating land access, impacts on property values
- Noise, dust, other nuisances and impacts of increased road traffic
- Impacts on Aboriginal culture
- Magnitude and health impacts of these risks likely to be dependent on the scale of exploratory/production phases of any gas fields
- SREBA an important tool to assess whether shale gas field developments have contributed to any increased health impacts (***Rec 15.1***)

SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 11
Aboriginal People and Their Culture

frackinginquiry.nt.gov.au

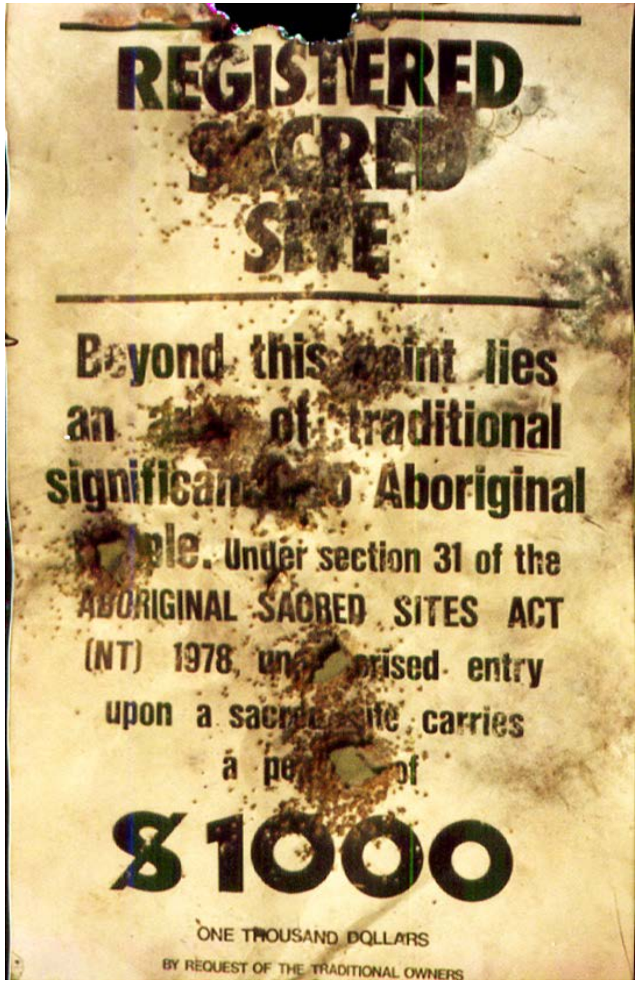
Aboriginal people and their culture

- Aboriginal people live and are the traditional owners of land where shale gas is likely to be located
- Aboriginal people must be able to maintain their culture so that their ownership rights continue
- If the landscape suffers, so will Aboriginal people
- The potential impacts (both good and bad) of any onshore shale gas industry on Aboriginal people and their communities must be fully explained before development starts
- A plan to manage these impacts must be put in place **before** development starts
- Aboriginal people must be involved in the design and implementation of this plan

Aboriginal people and their culture

Recommendations include:

- laws and systems to protect culturally significant places be strengthened (***Rec 11.5*** and ***11.3***)
- sacred sites legislation be amended to protect underground sites (***Rec 11.3***)
- gas companies be required to obtain Authority Certificates and lodge applications early in the assessment/approval process (***Rec 11.2***)
- that interpreters must be used at all consultations with Aboriginal people (***Rec 11.5***)
- that a comprehensive assessment of the cultural impact of any shale gas development must be completed prior to the grant of a production licence (***Rec 11.8***)
- that the Government consults and collaborates with Land Councils to ensure that reliable, accessible and accurate information about any shale gas developments is effectively communicated to Aboriginal people ***(Rec 11.6)***



Aboriginal people and their culture

- that gas companies must provide Aboriginal people with comprehensive information about proposed developments on all land (***Rec 11.6***)
- that the Government, gas companies, Land Councils and traditional owners must make exploration agreements publically available where appropriate (***Rec 11.7***)

Chapter 12
Social Impacts

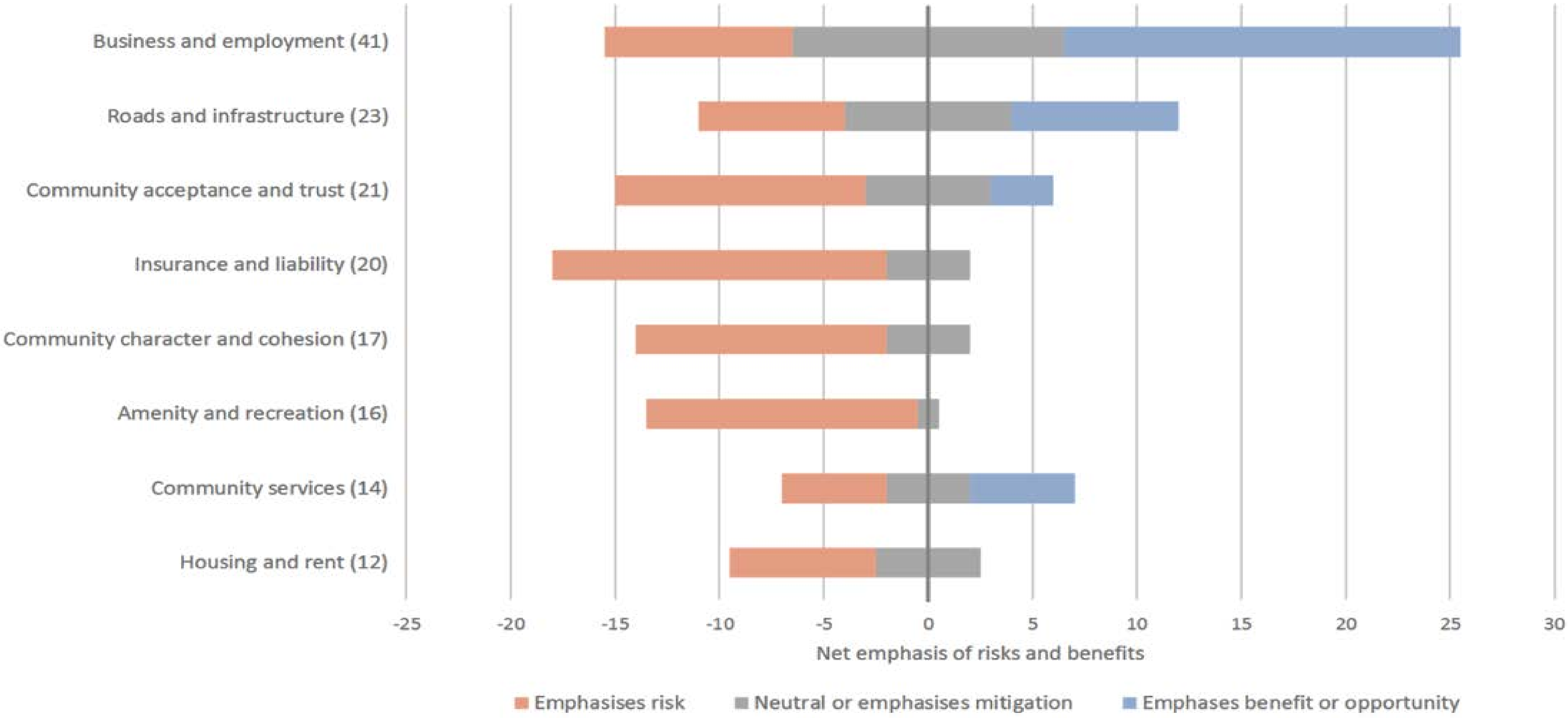
Definitions

- **Social impacts**: *“any change that arises from new developments and infrastructure projects, that positively or negatively influence the preferences, wellbeing, behaviour or perception of individuals, groups, social categories and society in general”* (Vanclay, 2003)
- **Cumulative impacts**: combined impacts arising from multiple projects occurring at one time
- **Social licence to operate (SLO)**: community acceptance or approval of a project, company or industry. Hard to earn but easily lost

Coffey – SIA Case Study

- Develop a **leading practice SIA framework** for the identification, assessment and management of the social impacts associated with the development of any onshore shale gas in the NT
- Apply that framework to the **Beetaloo Sub-basin** to identify the people, or groups of people, that are most likely to be affected by any development of shale gas resources in and around that region and, in consultation with those communities, to identify the impacts, risks and benefits, and the ways to avoid or manage (mitigate) those impacts and risks
- Discuss the concept an **SLO** and its application to the NT

Submissions emphasising risks and benefits



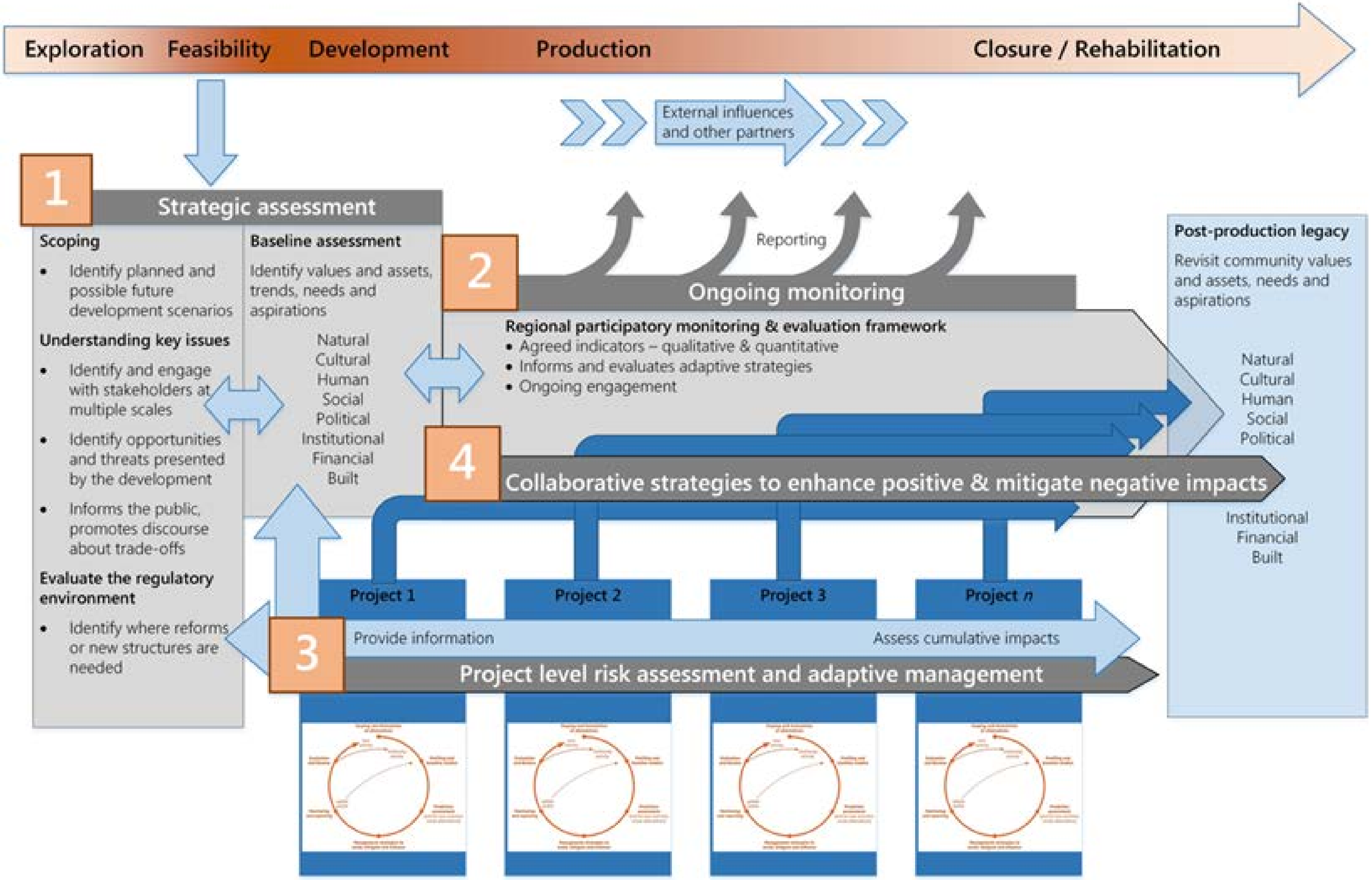
Essential elements of SIA

- Ensure that baseline data is collected on impacts identified and derived from the specific concerns of each local community
- Ensure participation of all affected stakeholders and associated groups
- Accommodate cumulative impacts that are likely to arise as a result of multiple projects occurring at the same time
- Reflexive - open and transparent

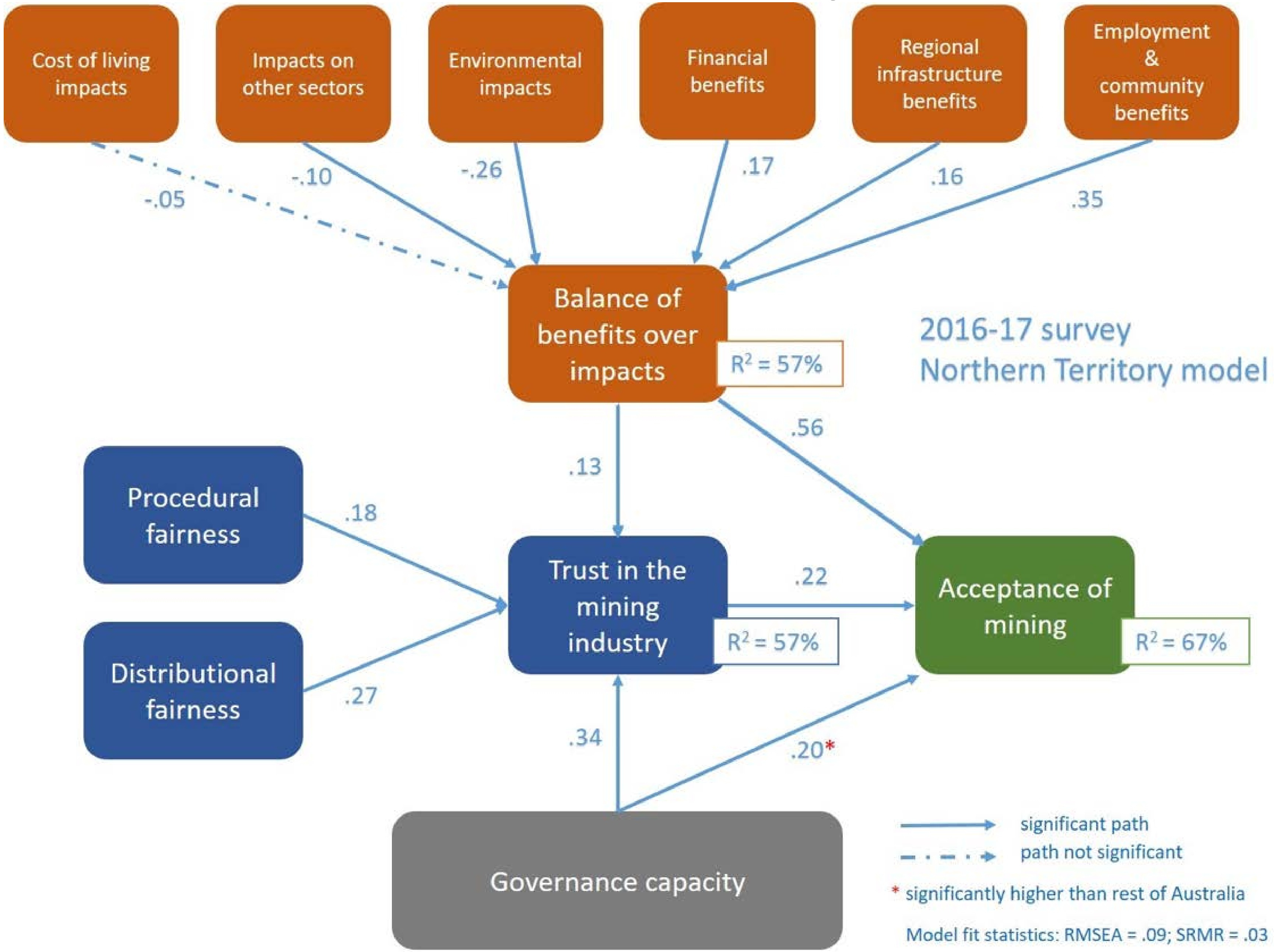
SIA framework must

- Identify and respond to impacts that occur across different stages of development
- Account for a lack in statistical social and economic data in remote and Aboriginal communities
- Be culturally sensitive
- Identify strategies to maximise benefits and minimise disturbances that are aligned with the needs and aspirations of affected stakeholders

Industry life cycle

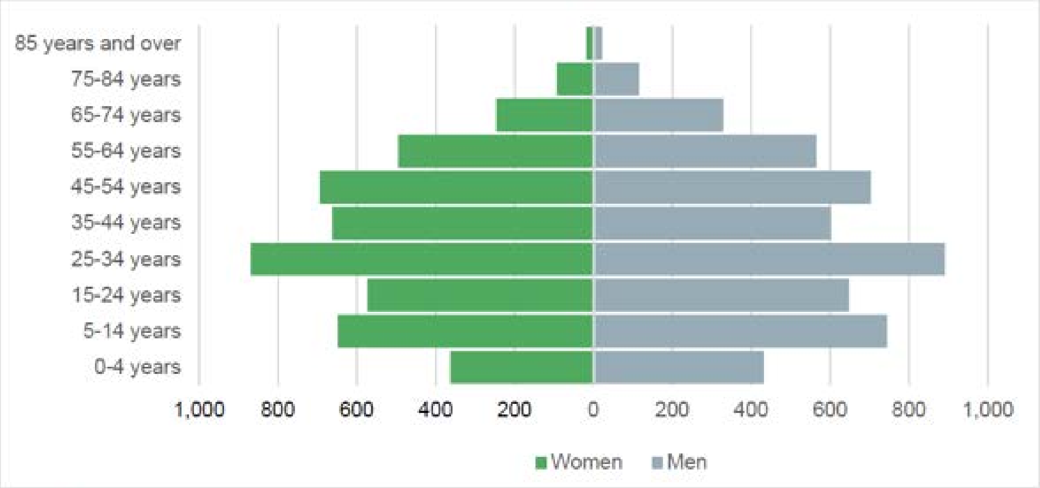


Social licence to operate



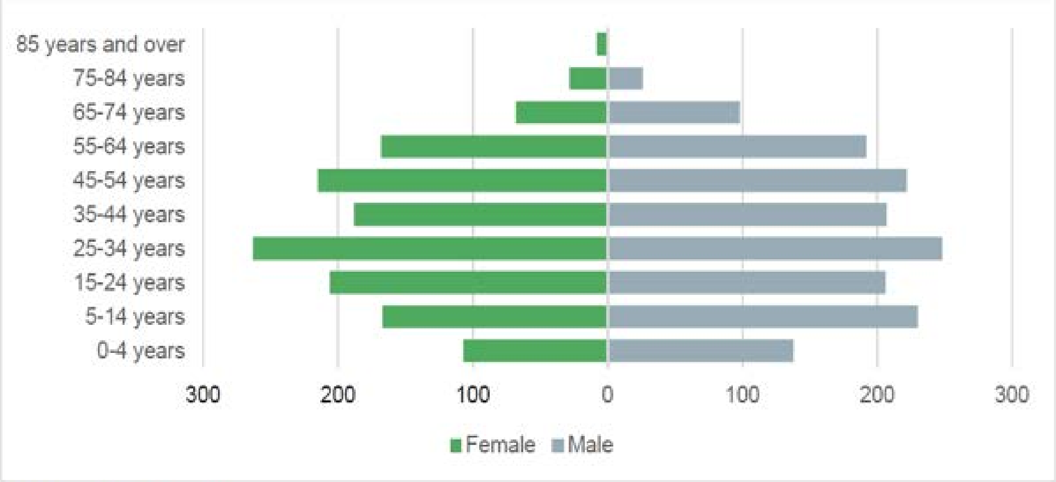
Likely affected communities

- **Urban** – Katherine (town) and Tennant Creek
- **Rural North** - Barunga, Beswick, Mataranka, Jilkminggan, Minyerri and Ngukurr
- **Rural Central** - Larrimah, Daly Waters, Dunmarra, Newcastle Waters and Elliott
- **Rural East** - Borroloola and Robinson River



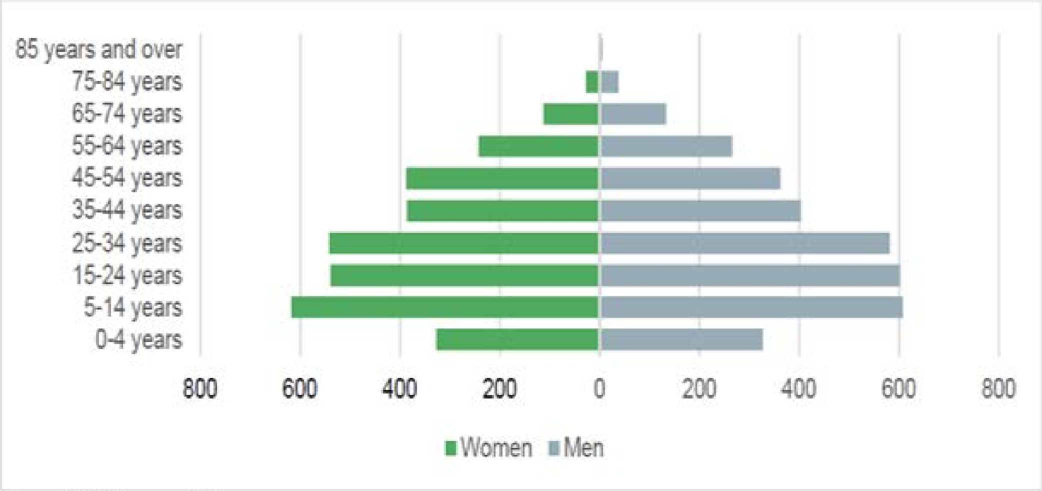
Source: ABS Census, 2016

Figure A5.2 Age-sex pyramid of Katherine town



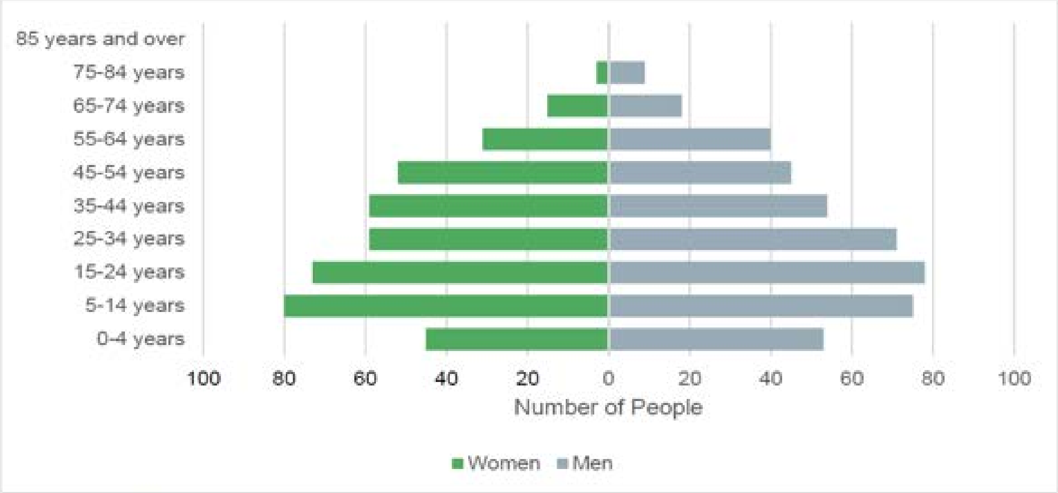
Source: ABS Census, 2016

Figure A5.9 Age-sex pyramid for Tennant Creek



Source: ABS Census, 2016

Figure A5.16 Age-sex pyramid of Roper Gulf region



Source: ABS Census, 2016

Figure A5.25 Combined age–sex pyramid for Borroloola

Potential impacts – affected communities

- Increased risk of road accidents from construction and operations traffic
- Increased levels of anxiety for Sub-basin residents
- The potential for higher wages to affect local businesses
- Heightened divisions in Aboriginal communities driven by perceived inequity in the receipt of royalties
- On-going conflict between supporters and opponents of unconventional gas development
- Heightened perceptions of cultural loss
- The potential for reduced investment in pastoral and horticultural operations

Potential opportunities – affected communities

- Increased employment, training and a broadening of the skills base of the local workforce
- Training and employment opportunities for Aboriginal communities in the area
- Flow-on benefits - if the workers saw Katherine or Tennant Creek as a desirable place to live it could lead to modest population increase
- Through local procurement of inputs to diversify the economic base of regional support towns
- Development of regional support facilities through worker accommodation and upgrades to airstrips which could be used for tourism
- Regional environmental monitoring through participation by natural resource management groups and Aboriginal ranger groups

Key recommendations

That a strategic SIA, separate from an EIS, must be conducted for any onshore shale gas development prior to any production approvals being granted (***Rec 12.1****)*

That this strategic SIA must be conducted holistically to anticipate any expected impacts on infrastructure and services and to mitigate potential negative impacts. The SIA must be funded by the gas industry (***Rec 12.2*** and ***12.3***)

That early engagement and communication of the findings of the strategic SIA be systematically undertaken with all potentially affected communities and with all levels of government and potentially affected stake-holders, including Land Councils, to ensure that unintended consequences are limited, and that shared understanding of roles and responsibilities, including financial responsibilities, can be developed. ***(Rec 12.4***)

SCIENTIFIC INQUIRY INTO

HYDRAULIC FRACTURING

IN THE NORTHERN TERRITORY

Chapter 13
Economic Impacts

frackinginquiry.nt.gov.au

The Potential Economic Impacts of Shale Gas Development in the Northern Territory

Final Report Briefing

March 2018

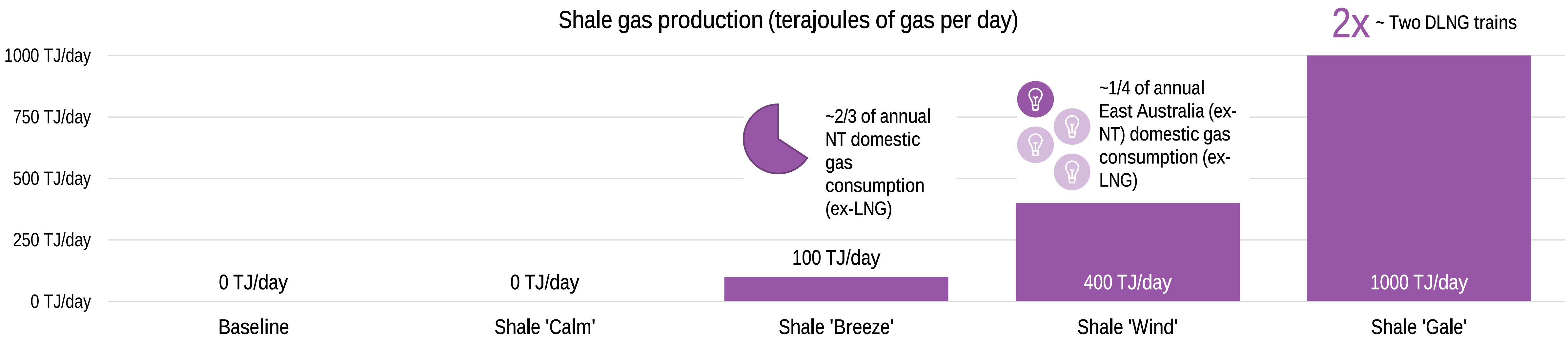
ACIL ALLEN CONSULTING

ACIL Allen's scope of works

- **ACIL Allen Consulting was appointed by the Inquiry to assess the actual and potential direct and indirect economic benefits, risks and impacts of fracking on the Northern Territory under the current regulatory regime.**
- ACIL Allen's report is <u>not</u> a commercial assessment of a potential shale gas industry, but an assessment of the economy-wide implications of a potential shale gas industry in the Northern Territory
- ACIL Allen took a **deliberately conservative approach** to this engagement, given the increased uncertainty on account of limited information
- The biggest challenge in this engagement was a complete **dearth of information** regarding the quantity, quality and properties of shale gas in the Northern Territory.
- To compensate, ACIL Allen built a new development from scratch, assuming that the volume of gas in situ was not a constraint, but that the **size of the market was the constraint**

- ACIL Allen proposed **five** scenarios:
  - Baseline (unchanged)
  - SHALE CALM: moratorium is lifted, but only exploration and appraisal activity occurs
  - SHALE BREEZE: the moratorium is lifted, exploration and appraisal activity occurs, and a small scale (100TJ/day) development results
  - SHALE WIND: as above, but with a moderate scale (400TJ/day) development results
  - SHALE GALE: as above, and a relatively large scale (1000TJ/day) development
- Our methodology involved:
  - Structured **stakeholder consultation** in the Northern Territory, across government, industry, representative groups and NGOs
  - A series of **economic and financial modelling**, including gas market modelling, development of a project development cash flow model and economic impact assessment (EIA) modelling
  - Discussion of key **economic policy issues**, arising from stakeholder consultation, an expansive review of literature, and practical examples of mining/petroleum industry development across Australia and the world

The five scenarios



Baseline
- The hydraulic fracturing moratorium remains in place
- The Northern Territory economy grows, without a shale gas industry
- There is a future off shore gas development, which is used to backfill the Darwin LNG plant
- This is the scenario used to compare others against

Shale 'Calm'
- The hydraulic fracturing moratorium is lifted, and exploration activity occurs, but there is a failure to commercialise
- The NT receives some short term economic benefits from exploration, but this is small and temporary

Shale 'Breeze'
- The hydraulic fracturing moratorium is lifted, exploration activity occurs, and a small scale development is commercialised
- Target production is 100 TJ/day
- Gas flows to NGP, and some gas to domestic NT market

Shale 'Wind'
- The hydraulic fracturing moratorium is lifted, exploration activity occurs, and a medium scale development is commercialised
- Target production is 400 TJ/day
- Gas flows to expanded NGP, and is used for domestic Australian gas market (displaces some higher cost CSG projects in Queensland)

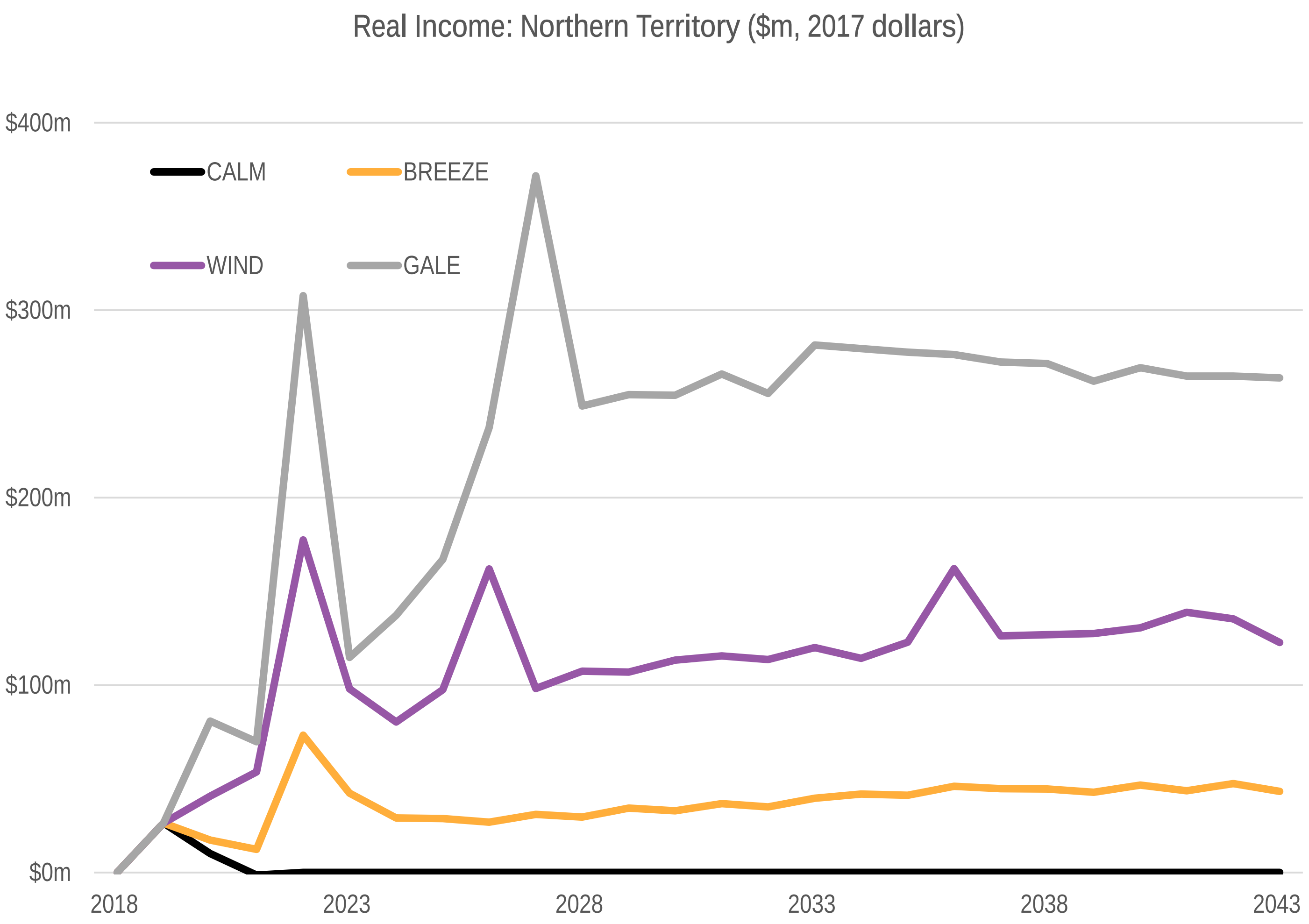
Shale 'Gale'
- The hydraulic fracturing moratorium is lifted, exploration activity occurs, and a large scale development is commercialised, pipeline expansions required
- Target production is 1000 TJ/day
- Gas flows to DLNG, East Coast LNG, and domestic market
- Off shore gas development is displaced, meaning economic benefit is smaller than otherwise

Critical assumptions

Item	BREEZE Scenario	WIND Scenario	GALE Scenario
Target gas production	100 TJ/day (~36.5 PJ/year)	400 TJ/day (~146 PJ/year)	1000 TJ/day (~365 PJ/year)
Peak wells in production (year in brackets)	98 (2042)	257 (2042)	645 (2043)
Total pads required to develop	13	34	87
Total area of disturbance* (including new major transmission pipelines)	67.7km^2 (4.9km^2 = pads, roads, gathering pipes & camps)	231.7km^2 (10.9km^2 = pads, roads, gathering pipes & camps)	475.9km^2 (26.3km^2 = pads, roads, gathering pipes & camps)
Average water consumption (per annum over 25 years)	0.17 GL	0.45 GL	1.13 GL
Total capital spend (2018 dollars)	$1.97 billion	$4.33 billion	$9.83 billion
Gas economics	Relatively weak but plausible (8 BCF per well)	Low end of industry expectations (10 BCF per well)	Strong, but still conservative (12 BCF per well)

- All developments proceed on the same **time horizon**:
  - Exploration/appraisal begins in 2018, runs for two years
  - Development begins in 2020, production in 2022
  - Five year "ramp up" to 2026, and plateau thereafter
  - Modelling ends in 2043 – a 25 year period
- **Gas developments are "dry"**, and contain no liquid hydrocarbon content. This is a significant limiting assumption, as "wet" shales improve project economics. Shale gas industry participants are confident there are liquids in prospective shales.
- Assumed **industry learning factors**, which improve development economics (lower costs) over time. This is in line with international experience and industry expectations
- An assumed **duplication of the NGP**, rather than an NT-Moomba interconnector, to get gas to the East Coast market. This was a simplifying assumption.
- No explicit **price for water**. The NT does not have a pricing regime for mining use. There is a notional extraction cost included in the model, but this is small.

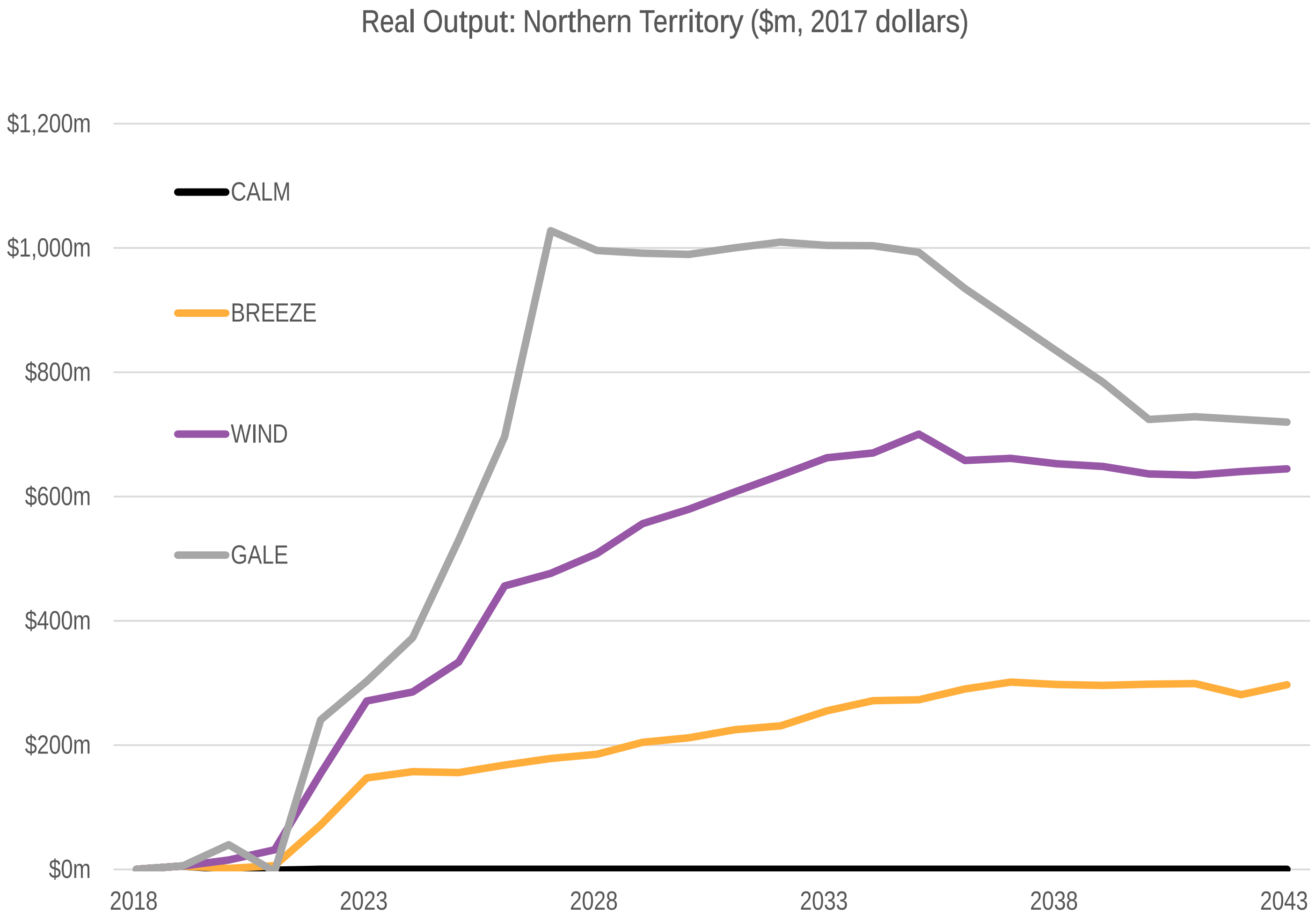
Economic Impacts: Income



- Real income is a measure of the welfare of residents in an economy through their ability to purchase goods and services and accumulate wealth.
- These results represent the incremental growth in real income over and above the baseline growth profile for NT.
- ACIL Allen projects a shale gas industry development could result in a net real income increase of between $937.2m (BREEZE), $2.8b (WIND) and $5.8b (GALE) for the Northern Territory over the modelling period.
- On an annual basis, this equates to $36m pa (BREEZE), $108.4m pa (WIND) and $222.2m pa (GALE).
- This equates to an “income boost” of between $149 and $903 per capita over the 25 year modelling period (or $6 to $36 pa).
- The rest of Australia also sees a lift in real income, due to the impact of lower gas prices and increased Commonwealth taxes associated with the development.

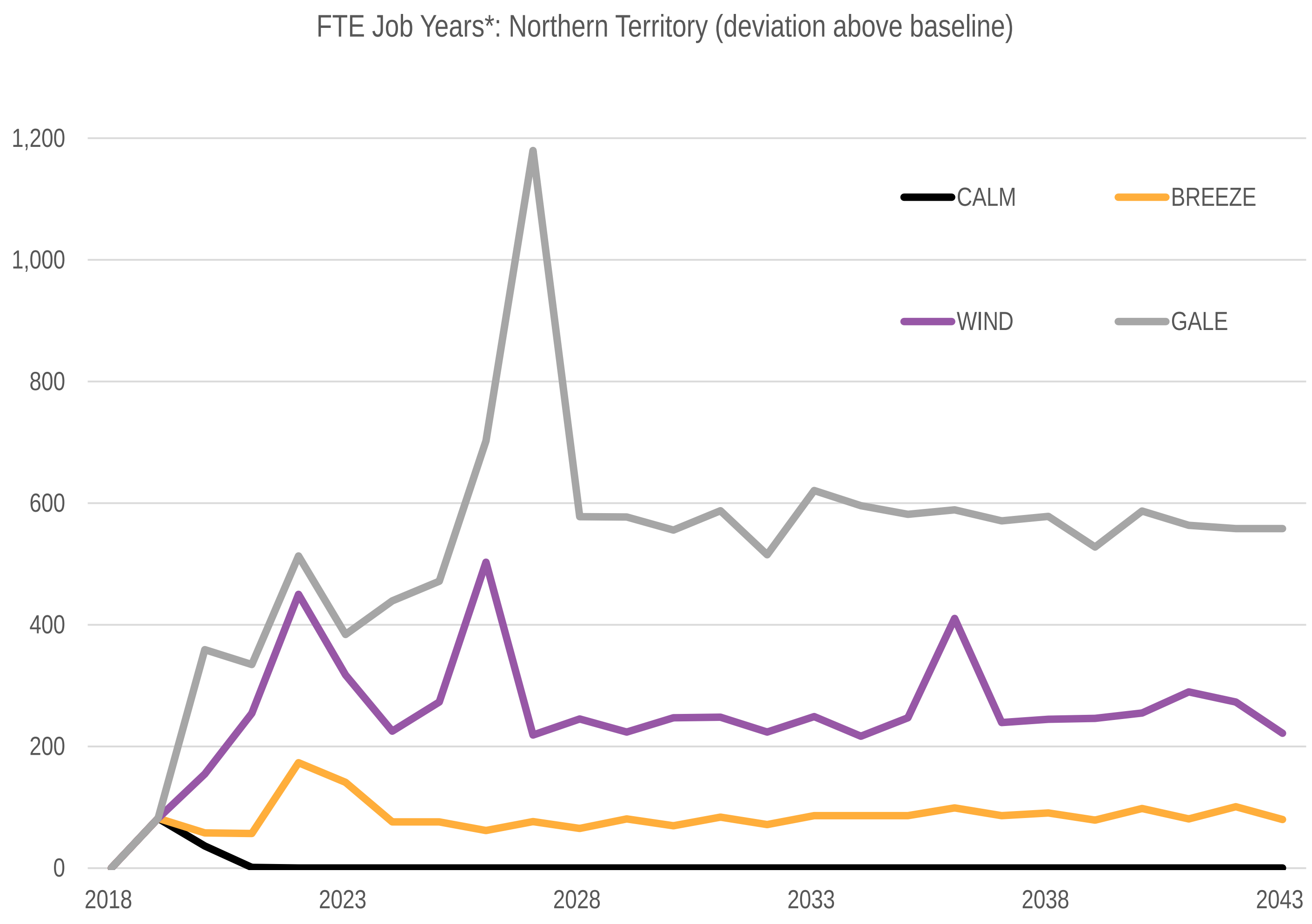
*job year concept explained on next slide

Economic Impacts: Output



- Real output is a measure of the size of an economy. At a national level, it is referred to as GDP, and at a Territory level it is Gross Territory Product.
- These results represent the incremental growth in real output over and above the baseline growth profile for NT.
- The increase in real output to the Northern Territory ranges from $5.1b in the BREEZE scenario ($196.5m pa), $12.1b in the WIND scenario ($466.4m pa), to $17.5b ($674.4m pa) in the GALE scenario.
- In annual average terms, this is the equivalent of an additional 0.8% of GTP under the BREEZE scenario, 1.9% under the WIND scenario and 2.9% under the GALE scenario in 2018.
- The slide in real output during the 2030s under the GALE scenario reflects the impact from the relatively lower cost shale gas displacing the need for a new offshore development to support the DLNG under the “baseline” scenario.

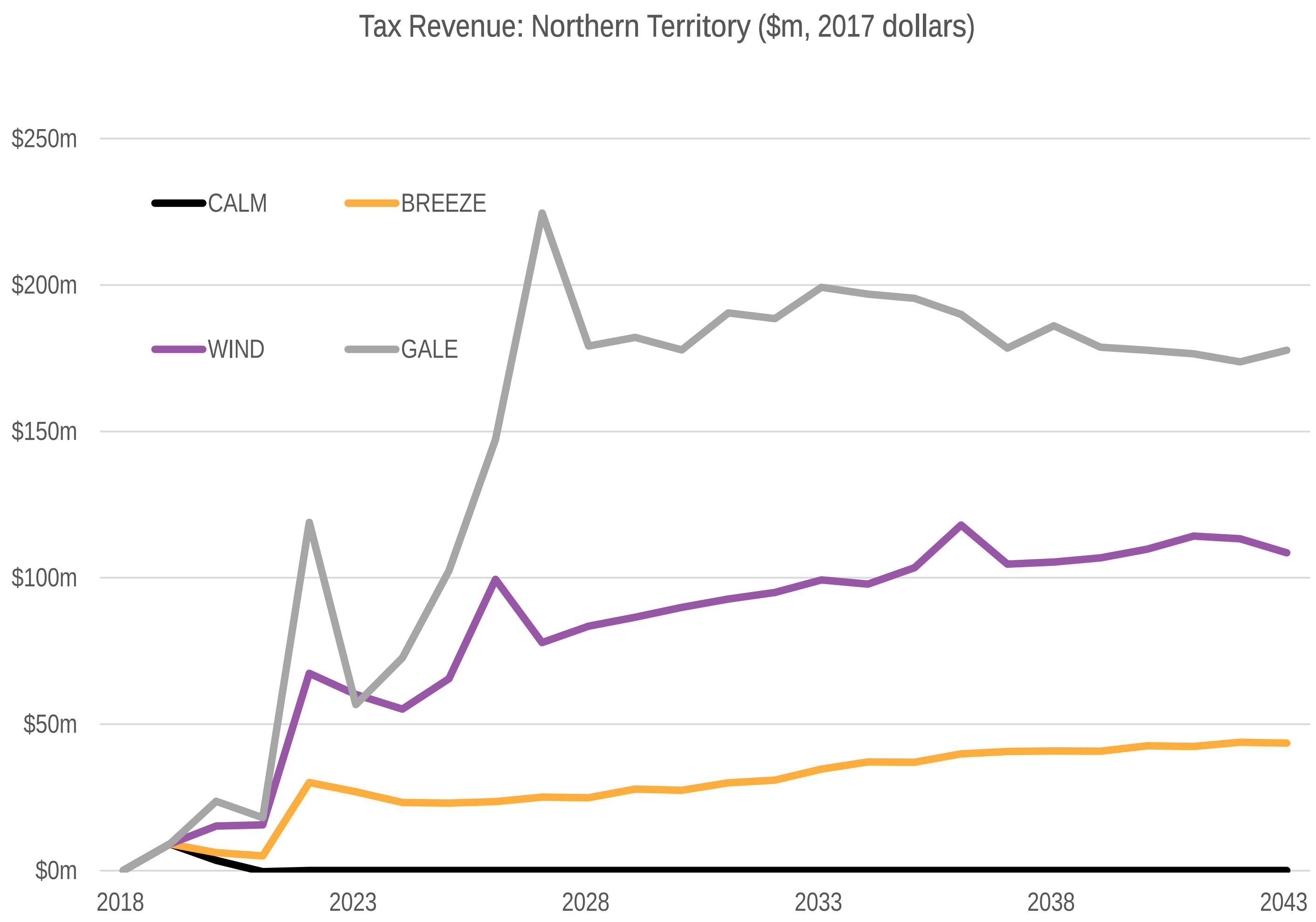
Economic Impacts: Employment



- Employment impacts are measured in terms of Full Time Equivalent (FTE) job years.
- These results represent the incremental growth in real employment over and above the baseline growth profile for NT.
- Under the BREEZE scenario, it is estimated that 2,154 FTE job years will be created, which equates to 82 FTEs in additional employment in the NT on average each year.
- Under the WIND scenario, it is estimated that 6,559 FTE job years will be created, which equates to 252 FTEs in additional employment in the NT on average each year.
- Under the GALE scenario, it is estimated that 13,611 FTE job years will be created, which equates to 524 FTEs in additional employment in the NT on average each year.

*job year concept explained on next slide

Economic Impacts: Taxation



- Taxation impacts are modelled for key heads of taxation and a State/Territory and Commonwealth level.
- A primary channel of economic impact that is likely to be felt in the NT is the increase to Territory Government revenue.
- Under the BREEZE scenario, it is estimated that a successful shale gas industry development could generate $757m over the study period, or $29.1m pa.
- Under the WIND scenario, it is estimated that an additional $2.1b in NT Government taxes would be generated over the 25 year modelling period, or $80.6m pa.
- Under the GALE scenario, it is estimated that an additional $3.7b in additional NT Government taxes would be generated over the 25 year modelling period, or $143.2m pa.
  - The Gale case is equal to an additional 8% of NT Government own source revenue.
  - Part of this is likely to be "taken away" through the GST distribution process. NT Treasury should request this be assessed by the Grants Commission.
- ACIL Allen estimates the Commonwealth Government could expect to raise between $1.3b (BREEZE) and $1.75b (GALE) in income and profits based taxation over the forecast period, or $50.2m and $210.4m pa.
  - This is primarily the results of lower domestic gas prices leading to increased company profitability, and therefore more company tax.

*job year concept explained on next slide

Modelling results: APPEA report comparison

	APPEA/Deloitte		Scientific Inquiry/ACIL Allen		
Case name	"Success"	"Aspirational"	"BREEZE"	"WIND"	"GALE"
Development modelling approach	Deloitte took the price of LNG, subtracted cost of processing and transmission pipeline, and used that to determine its target gas price. From there, it scaled CAPEX & OPEX estimates from a starting position that would allow all gas to be sold assuming a their market price, and had a different breakeven price for three market demand tranches (NT, East Coast and LNG). Deloitte assumed no market constraints.		ACIL Allen began by sizing its developments based on market tolerance, using *GasMark*. From there, ACIL Allen build its developments from the ground up using data to build a single average type curve, a well scheduling model, development cost assumptions by key components, and pipeline assumptions combining current pipeline capacity and new pipelines. ACIL Allen did not assume gas would be used to facilitate any new LNG development, and instead assumed in its base case that an offshore development would be required to backfill the DLNG facility.		
Economic impact assessment modelling approach	In-house CGE model		In-house CGE model		
Volume of gas (peak PJ/annum)	586 PJ/annum in 2040	910 PJ/annum in 2040	36.9 PJ/annum (2041)	108.3 PJ/annum (2042)	365 PJ/annum in 2043
Incremental LNG?	Yes, 100% incremental LNG. Two additional LNG trains to be built, with capital costs included in the economic impact assessment.		No LNG in these scenarios.		No incremental LNG in this scenario. It is assumed the onshore development displaces an offshore development.
CAPEX per well	$6.2m - $9.75m		$19.1m on average (including learnings)	$16.3m on average (including learnings)	$12.7m on average (including learnings)
OPEX per GJ	$0.53 - $0.89/GJ		$1.77/GJ on average (including learnings)	$1.59/GJ on average (including learnings)	$1.46/GJ on average (including learnings)
Wellhead cost per GJ (maximum case)	$1.90 - $2.67/GJ		$6.07/GJ on average	$5.03/GJ on average	$4.01/GJ on average
GTP impact (deviation from baseline in final year of study)	+$5.1bn (2040)	+$7.5bn (2040)	+$0.30bn (2043)	+$0.64bn (2043)	+$0.72bn (2043)
FTE impact (deviation from baseline in final year of study)	+4,195 FTE (2040)	+6,321 FTE (2040)	+80.1 FTE (2043)	+221.5 FTE (2043)	+558.1 FTE (2043)

Key policy issues

- ACIL Allen Consulting has considered the six policy areas as they relate to three key outcomes for the Northern Territory in the event of shale gas industry development.
  - Measures to **capture** the benefits
  - Measures to **distribute** the benefits
  - Measures to **manage** downside risks
- Managing an increase to NT Government Revenue
  - Royalties
  - Horizontal fiscal equalisation
  - Wealth funds (many options)
  - Royalties for Regions
- Managing an increased demand for labour
  - Coordination role with training providers and industry
  - Local content policies
- Maximising local expenditure
  - Information flows between projects and suppliers
  - Addressing information asymmetries
  - Indigenous participation
- Industry co-existence
  - Water pricing
  - Land allocation and competition
  - Allocation of permits
- Addressing infrastructure constraints
  - Supporting common use infrastructure
  - Infrastructure planning
  - Project prioritisation and long term planning
  - Role of the private sector
- Approaches to industry regulation
  - Regulator capacity and capability
  - “Pay your way” regulation

Summary – key messages

- ACIL Allen's assessment is subject to **higher than usual uncertainty**, as there is limited information regarding the commercial potential of a shale gas industry in the Northern Territory.
- On the basis of the **conservative assumptions** adopted, there are economic benefits for the Northern Territory in permitting the development of a shale gas industry.
- The potential **economic benefits scale with the size of the industry**, ranging from about $36 million per annum (BREEZE case) to $108 million per annum (WIND case) to $222 million per annum (GALE case).
- A shale gas industry is estimated to raise between $29.1 million (BREEZE) to $81 million (WIND) to $143 million (GALE) per an num in NT Government taxes and royalties.
  - In the GALE case, this represents an increase in the NT Government's own-source revenue of 8%.
- The primary <u>economic</u> policy challenge is **capturing and distributing benefits**. Key policy considerations should include:
  - promotion of local industry participation (both labour and purchases),
  - ensuring industry pays for additional resources required for regulation and water, and
  - further examination of the costs and benefits of a "royalties for regions" fund or wealth accumulation fund given these were front of mind for many stakeholders (and do exist in other States)

Key recommendations

- That the Government ensure that the regions impacted by the industry benefit from any royalties received (***Rec 13.1***)
- That early planning is important to make sure that any employment opportunities for local people, including Aboriginal people, are maximised (***Rec 13.2*** to ***13.5***)
- That the Government works with key stakeholders to facilitate local supply and service opportunities, including keeping benefits on country (***Rec 13.6*** to ***13.9***)
- That the Government works with key stakeholders to devise and implement local procurement targets (***Rec 13.10***)
- That any adverse impacts on other industries (including other industries that use groundwater) must be identified and mitigated early in the development process (***Rec 13.11***)
- That the Government works with all levels of government and key stakeholders to identify and manage infrastructure needs (***Rec 13.12***)

Chapter 14
Regulatory Reform

Lack of confidence in the regulator

- There is widespread lack of confidence in the regulator (DPIR), including in relation to:
  - resourcing
  - capacity
  - independence
  - its ability and/or willingness to carry out effective compliance and enforcement
- Implementation of a full cost recovery system where fees paid by the gas industry cover the costs of regulating the industry (***Rec 14.1***)

Making land available for onshore shale gas exploration

Current system for releasing land for onshore shale gas exploration

Minister for Resources decides which land to release

May take into account land release policy (not required to)

→

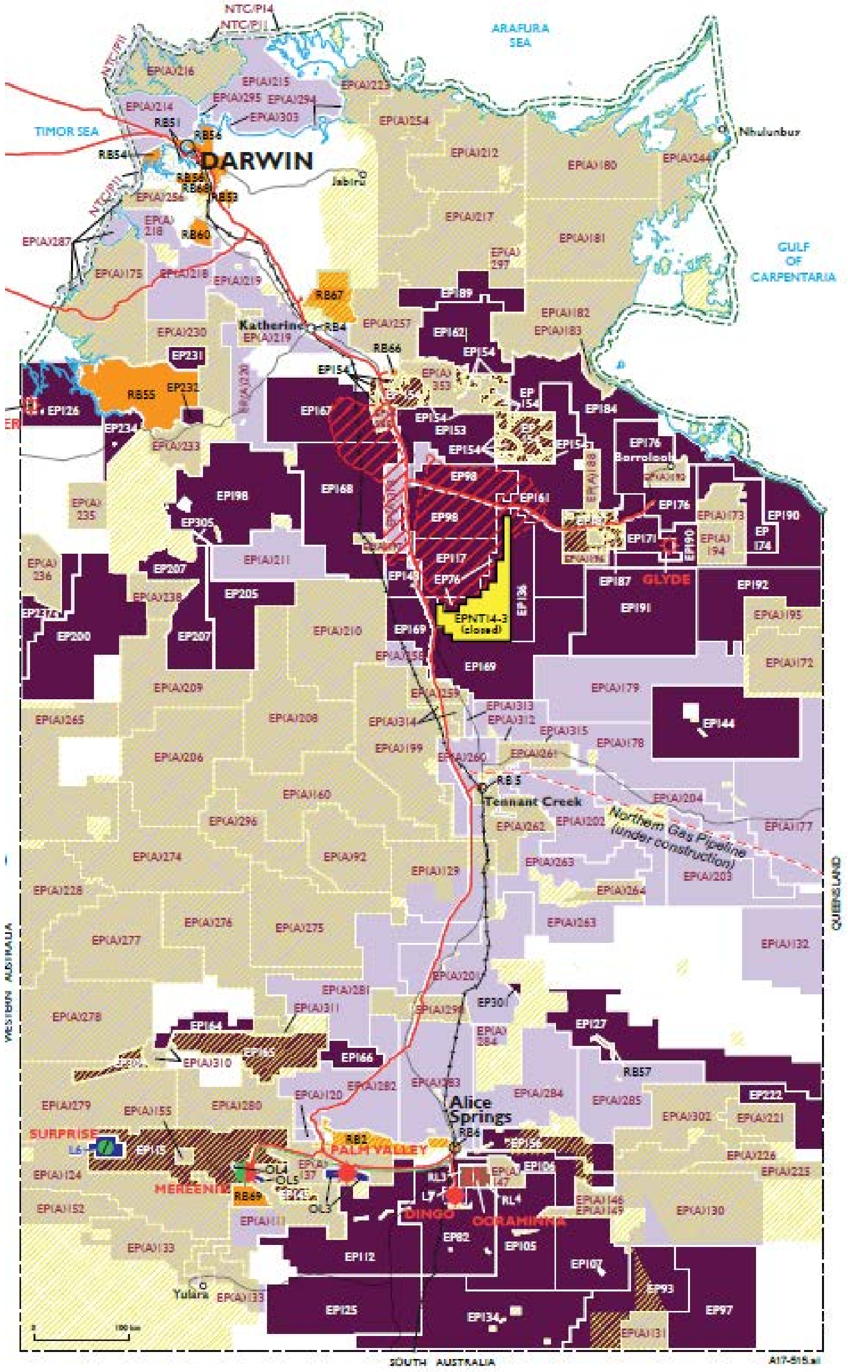
Minister for Resources publishes a notice inviting applications in relation to that land

Petroleum Act, s 16

→

Companies apply for exploration permits in relation to that land

Petroleum Act, s 16



Making land available for onshore shale gas exploration

- The decision about which land to make available for shale gas exploration must be more transparent, consultative and accountable
- The community must be given an opportunity to comment on any land release (***Rec 14.2***)
- The Minister must be made to consider whether any onshore shale gas industry can co-exist with other current and future land uses (***Rec 14.2***)
- Certain land should be ‘no go’ zones and **never** be available for exploration (***Rec 14.4***). For example:
    - areas of high tourism value
    - residential areas
    - national parks
    - conservation reserves
    - areas of high ecological significance
    - areas of cultural significance, including sacred sites
    - Indigenous Protected Areas
- The Government should consider mechanisms to retrospectively apply ***Rec 14.4*** to granted exploration permits (***Rec 14.5***)

Pastoral land

- The current regime does not adequately balance the rights and interests of gas companies and pastoralists or facilitate the making of appropriate and fair agreements between them. This can lead to imbalance
- The Panel has not recommended a veto, **but** has recommended that there be mandated statutory land access agreement in place before gas companies can obtain access to pastoral land. Currently there is no such requirement (***Rec 14.6***)
- In addition to any terms negotiated between the pastoralist and the gas company, the statutory land access agreement must contain standard minimum protections for pastoralists (***Rec 14.7***). For example, a requirement to notify the pastoralist of all spills, make good provisions in respect of water, indemnities and no confidentiality
- The Government must implement a mandatory minimum compensation scheme for pastoralists (***Rec 14.8***)
- Breach of the land access agreement should be a breach of the approval to carry out the activity on the land (***Rec 14.6***)

Improved decision-making

- The Panel has made recommendations to increase the transparency and accountability of decision-making processes, and the quality of the decision-making in relation to the granting of permits, EMPs**,** and other decisions under the *Petroleum Act*. Recommendations include:
  - a requirement to apply the principles of ESD, including the precautionary principle to all onshore shale gas decision-making (***Rec 14.11***)
  - a requirement that a gas company is a ‘fit and proper person’ to be granted an exploration permit or hold a production licence having regard to, for example, its history of compliance with environmental regulation both domestically and overseas (including related companies) (***Rec 14.12*** and ***14.20***)
  - mandatory publication of reasons for decisions (***Rec 14.2*** and ***14.12***)
  - providing opportunities for public comment, including on draft EMPs (***Rec 14.9*** and ***14.15***)
  - allowing the public the opportunity to challenge decisions in court or in a tribunal by way of judicial and merits review (including ‘open standing’ provisions)(***Rec 14.23, 14.24*** and ***14.25***)
  - requirement to consider cumulative impacts of production, for instance through ‘area-based’ regulation (***Rec 14.21*** and ***14.22***)

Mitigating ‘exploration creep’

- The community and various stakeholders expressed concern about ‘exploration creep’
  - a large numbers of exploration wells being constructed, drilled and hydraulically fractured under an exploration approval, rather than a production approval, prior to the completion of a SREBA and prior to the implementation of many of the Panel’s recommendations
- The Panel has recommended amending the Petroleum Environment Regulations to explicitly require the Minister for Resources, when considering whether or not to approve an EMP for an exploration approval, to consider the cumulative effects of onshore shale gas activities in the region (***Rec 14.19***). This includes the number of exploration wells being proposed

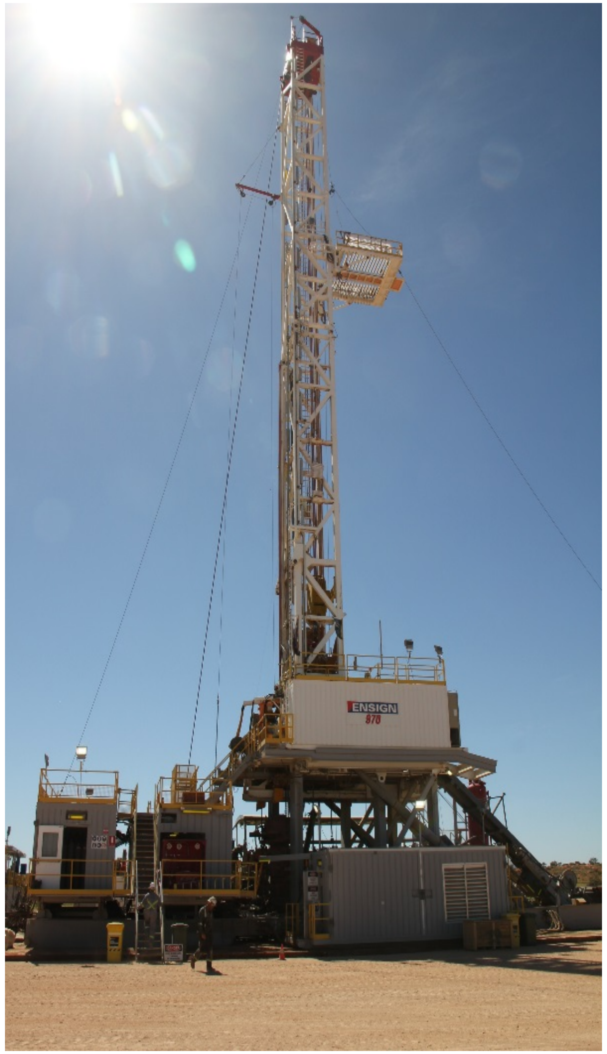
Improved financial assurances

- The present system of bonds and securities for rehabilitation is inadequate and opaque
- The Panel has recommended that world leading practice financial assurance regimes be implemented that include:
  - environmental rehabilitation bonds that accurately reflect the cost of rehabilitation and that are calculated transparently (***Rec 14.13***)
  - a non-refundable 'orphan well' levy to ensure that funds are available for the long term monitoring of wells and, if required, their management and rehabilitation (***Rec 14.14***)
  - chain of responsibility provisions to hold related parties of a gas company accountable if the company has not complied with its environmental obligations ***(Rec 14.30)***

Photo of Central Petroleum's Mereenie Oil and Gas Field taken in August 2017

Objective-based regulation, prescriptive regulation and enforceable codes of practice

- The Panel has recommended that any objective-based regulatory framework be supported by clear, prescriptive and **enforceable** codes of practice in relation to all exploration and production activities, including but not limited to, land clearing, seismic surveys, well construction, drilling, hydraulic fracturing and well decommissioning and abandonment (***Rec 14.18***)
- The *Schedule of Onshore Exploration and Production Requirements* is not enforceable. It must be repealed and replaced by secondary legislation to regulate land clearing, seismic surveys, well construction, drilling, hydraulic fracturing, and well decommissioning and abandonment prior to the grant of any production licence (***Rec 14.17***)



Compliance and enforcement

- The laws are currently weak in respect of compliance and enforcement and must be strengthened (***Rec 14.29*** and ***14.30***)
- Fines and other sanctions (jail of company directors and revocation of permits and licences) must be increased so that non-compliance does not become a mere cost of doing business (***Rec 14.33***)
- The Government must implement a transparent compliance system where non-compliance is made publically available and the public is aware of what activities are and are not permitted by gas companies (***Rec 14.26***)
- Civil enforcement actions ought to be permitted by the public where there is non-compliance by a gas company (***Rec 14.31***)
- There should be a reversal of the onus of proof so that gas companies must prove that they did not cause any environmental harm by their actions (***Rec 14.32****)*

Reform of the regulator

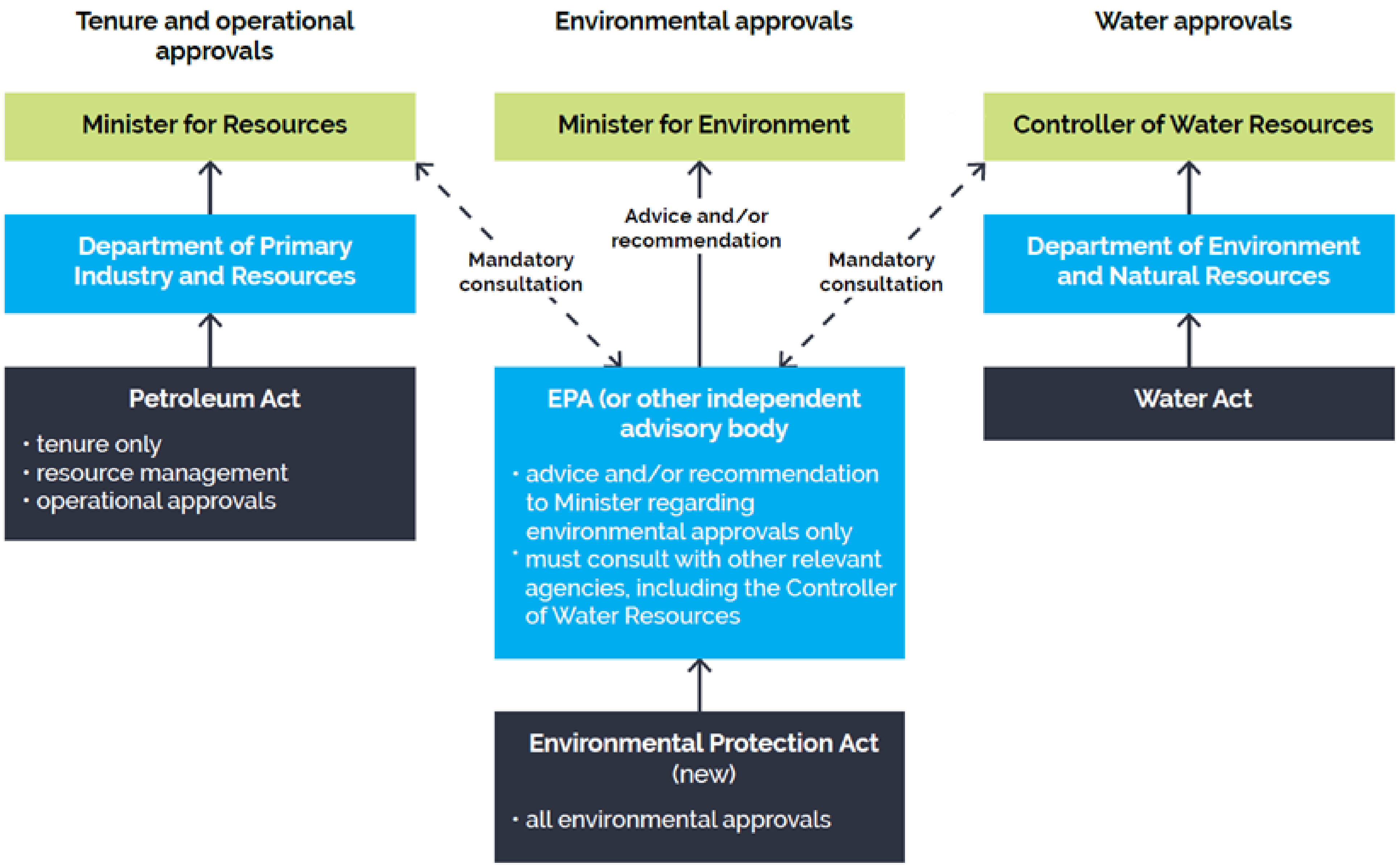
- There must be a clear separation between the agency with responsibility for regulating (compliance and enforcement) of any onshore shale gas industry and the agency responsible for promoting that industry (***Rec 14.34***)

- There are two options for a new regulator (***Rec 14.35***):

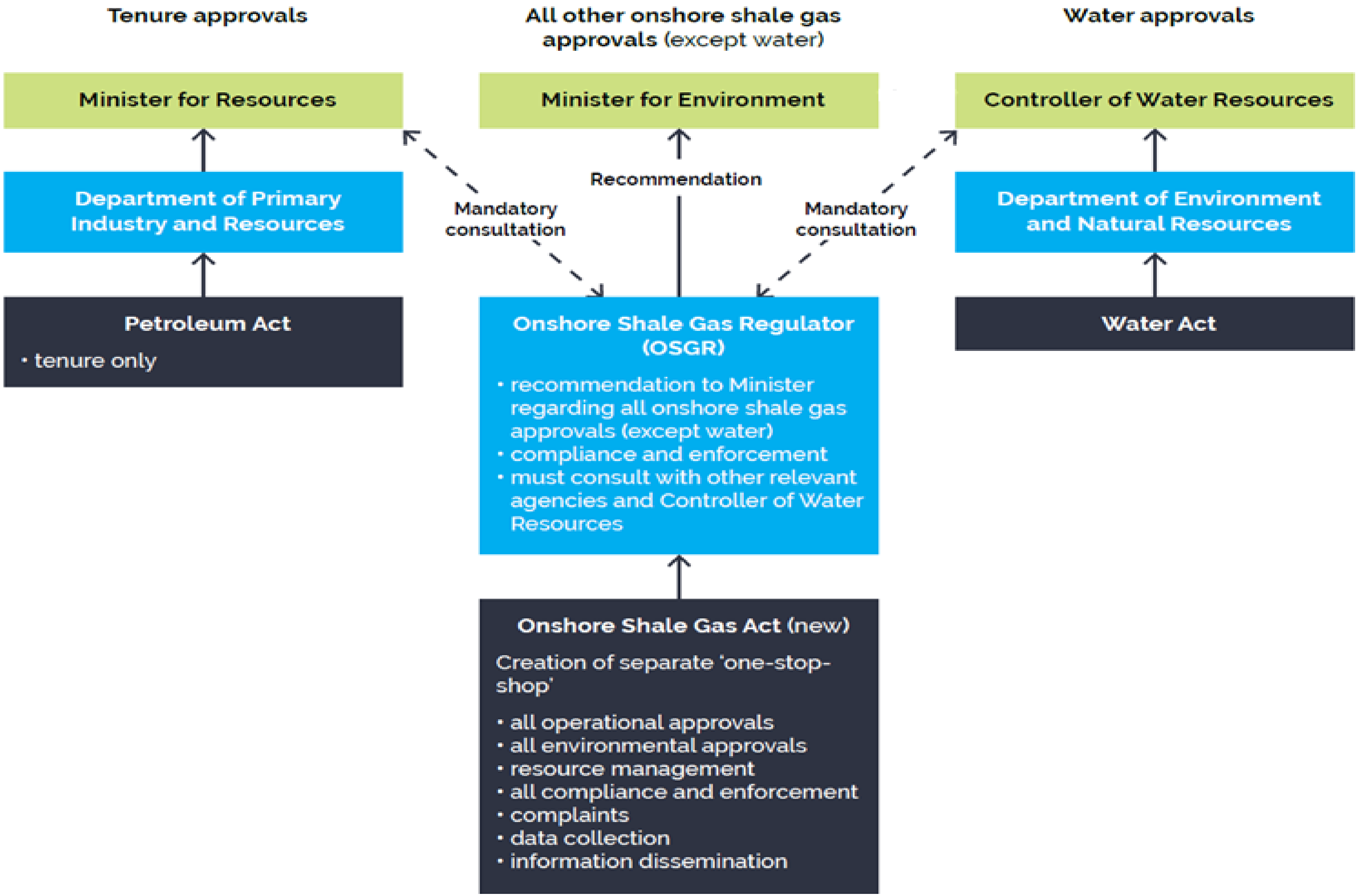
  - **Option 1:** separate environmental approvals for onshore shale gas activities under a new EP Act

  - **Option 2:** establish a new independent Onshore Shale Gas Regulator (the OSGR)

Option 1 – separate environmental approvals for onshore shale gas activities



Option 2 – establishment of a new Onshore Shale Gas Regulator (the OSGR)



Chapter 15
Strategic Regional Environmental and Baseline Assessment (SREBA)

Strategic Regional Environmental and Baseline Assessment (SREBA)

- **Two components:**
  - baseline information to assess post-development impacts
  - new knowledge to inform regional planning

- **Baseline**: lack of critical baseline data to be able to assess/quantify the post development impacts
- Examples of **baseline information** needed:
  - surface and groundwater quality
  - methane concentrations (air and water)
  - human health survey
  - social and cultural
  - weeds, fire, threatened species, feral pests

Strategic Regional Environmental and Baseline Assessment

New knowledge needed to inform land use planning:

- groundwater behaviour (recharge rates, flows, groundwater model, sustainable extraction yields)
- aquatic and terrestrial biodiversity assessment
- human health risk assessment
- social impact assessment

Strategic Regional Environmental and Baseline Assessment

- A SREBA can be undertaken during exploration (***Rec 15.1***)
- It must be completed and findings implemented prior to commercial production (***Rec 15.3***)
- The Beetaloo Sub-basin should be the first priority for a SREBA

SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

Chapter 16
Implementation

frackinginquiry.nt.gov.au

Implementing the recommendations

- If the moratorium is lifted, the Government must implement **all** of the recommendations in the *Final Report* (***Rec 16.1***)
- Timing of the implementation of the recommendations:
  - certain recommendations must be implemented prior to the granting of **any further exploration approvals** (see **Table 16.1**)
  - all other recommendations must be implemented prior to the granting of **any further production approvals**
- An implementation framework must be developed within three months from any lifting of the moratorium (***Rec 16.2***)
  - the framework should identify when, how and by whom the recommendations will be implemented
- An Implementation Unit should be established immediately within the Department of Chief Minister to coordinate the development of the implementation framework (***Rec 16.3***)