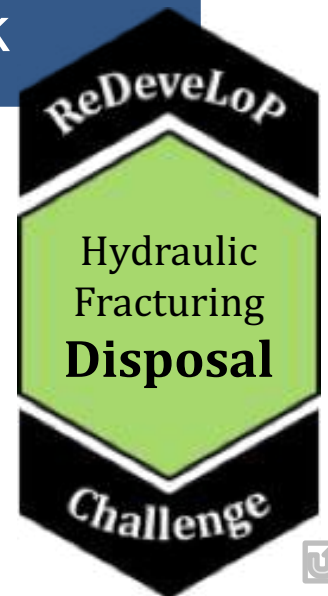


Risks and Mitigations for Hydraulic Fracturing Wastewater Disposal Operations in Western Canada

Mauricio Reyes Canales, Rabia Ladha,
Melissa MacDonald, & Wayne S. Park



The ReDeveLoP Challenge
Calgary, Alberta
May 27 – 31, 2019

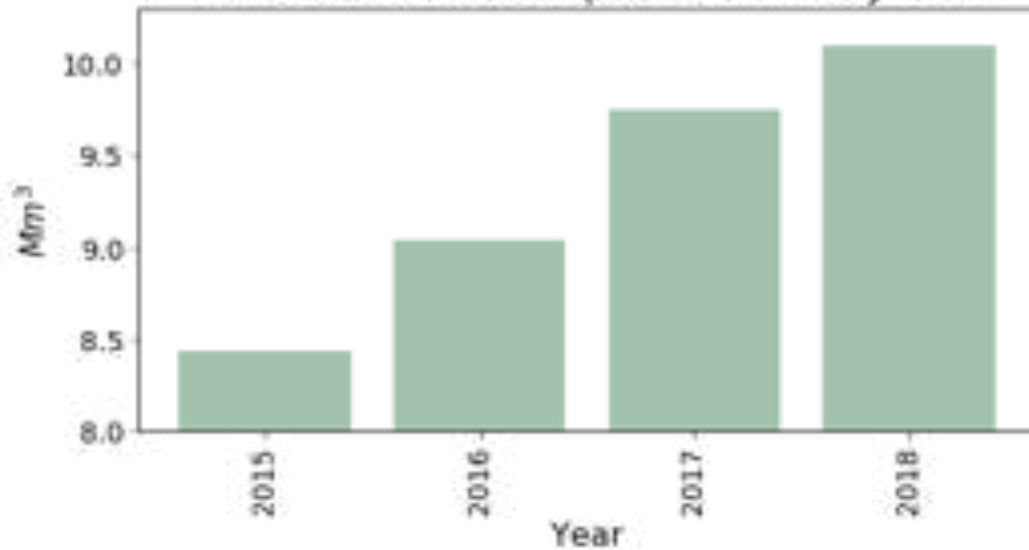


*What are the **risks** of wastewater disposal in hydraulic fracturing?*

*How can these **risks** be mitigated?*

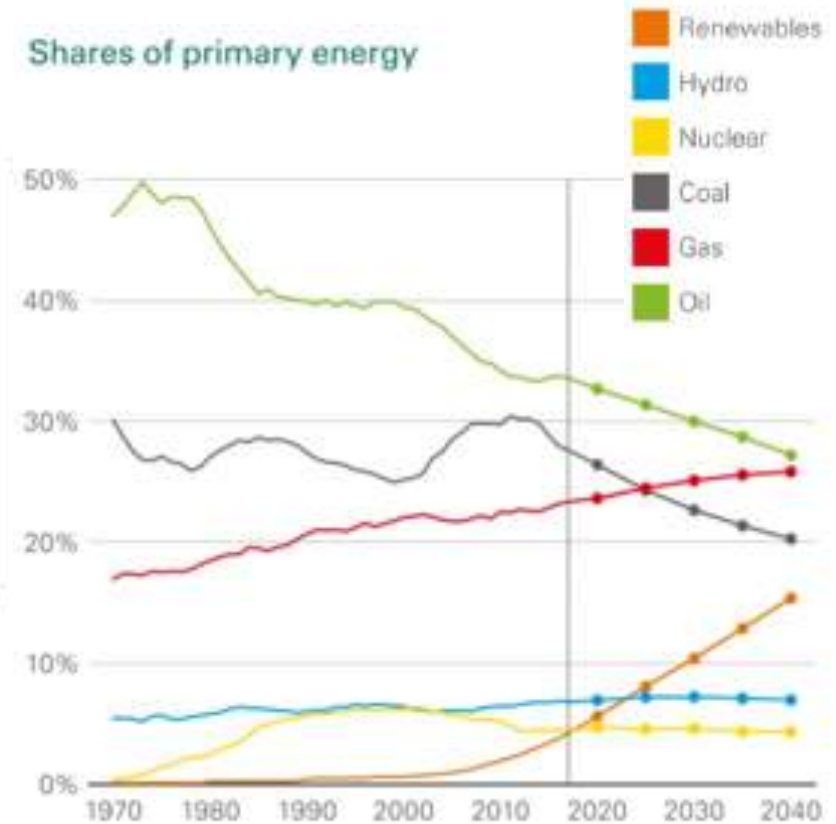
Why is this relevant?

2015-2018 Waste Disposal Volume by Year



From Petrinex database.

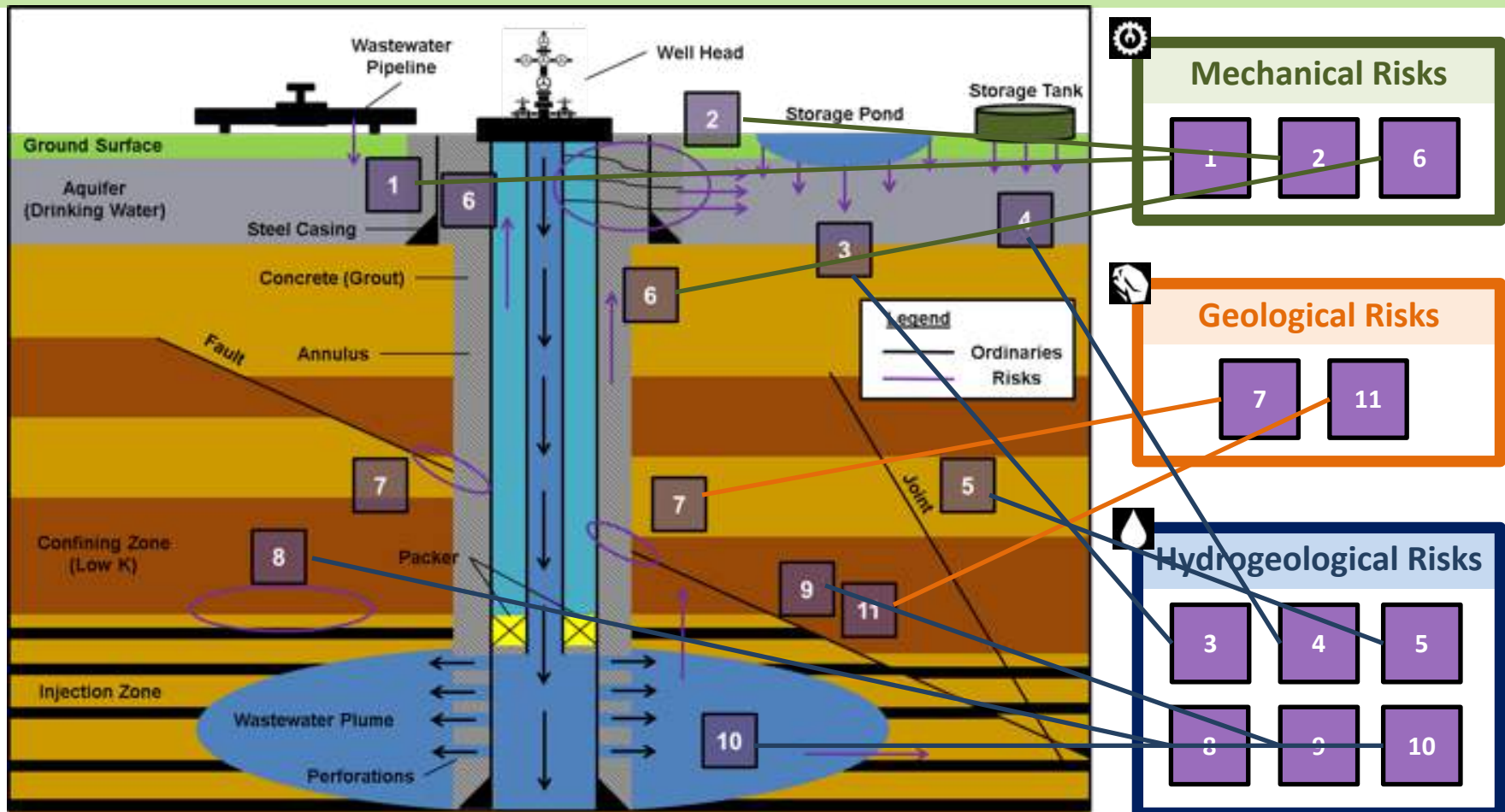
Shares of primary energy



From BP Energy Outlook 2019.



Sources of Risk for Disposal Activities



MANAGEMENT = Very Low x High



Risk Management Strategies



Canada's oil and gas industry **ranks highly** on many performance dimensions, including **corporate governance, transparency, environmental stringency, and innovation.**

Canada ranked the **second most responsible oil producer** in the world.

- *Financial Post, June 12, 2018* -

Hydroge

3

4

[Directive 05] and mitigation incorporating materials, *inspection* of leakage detection devices

5

8

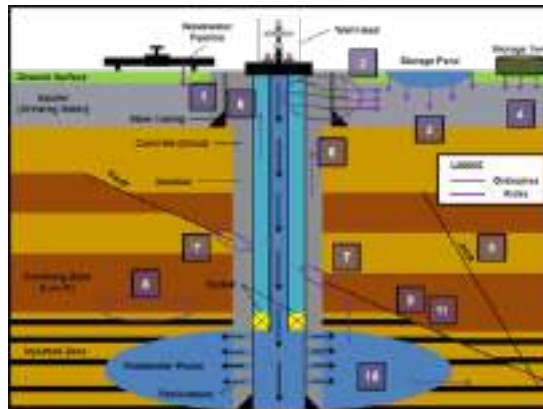
9

10

Disposal injection occurs kilometers away from the potable groundwater resources.

#Uncertainty

appropriate action to report and repair the failures



develop comprehensive management programs and systems

2

6

[Directives 013 & 051] Any well integrity failures should *be reported and immediately repaired*



Dispose or Recycle? Decision Parameters

Economics



Distance



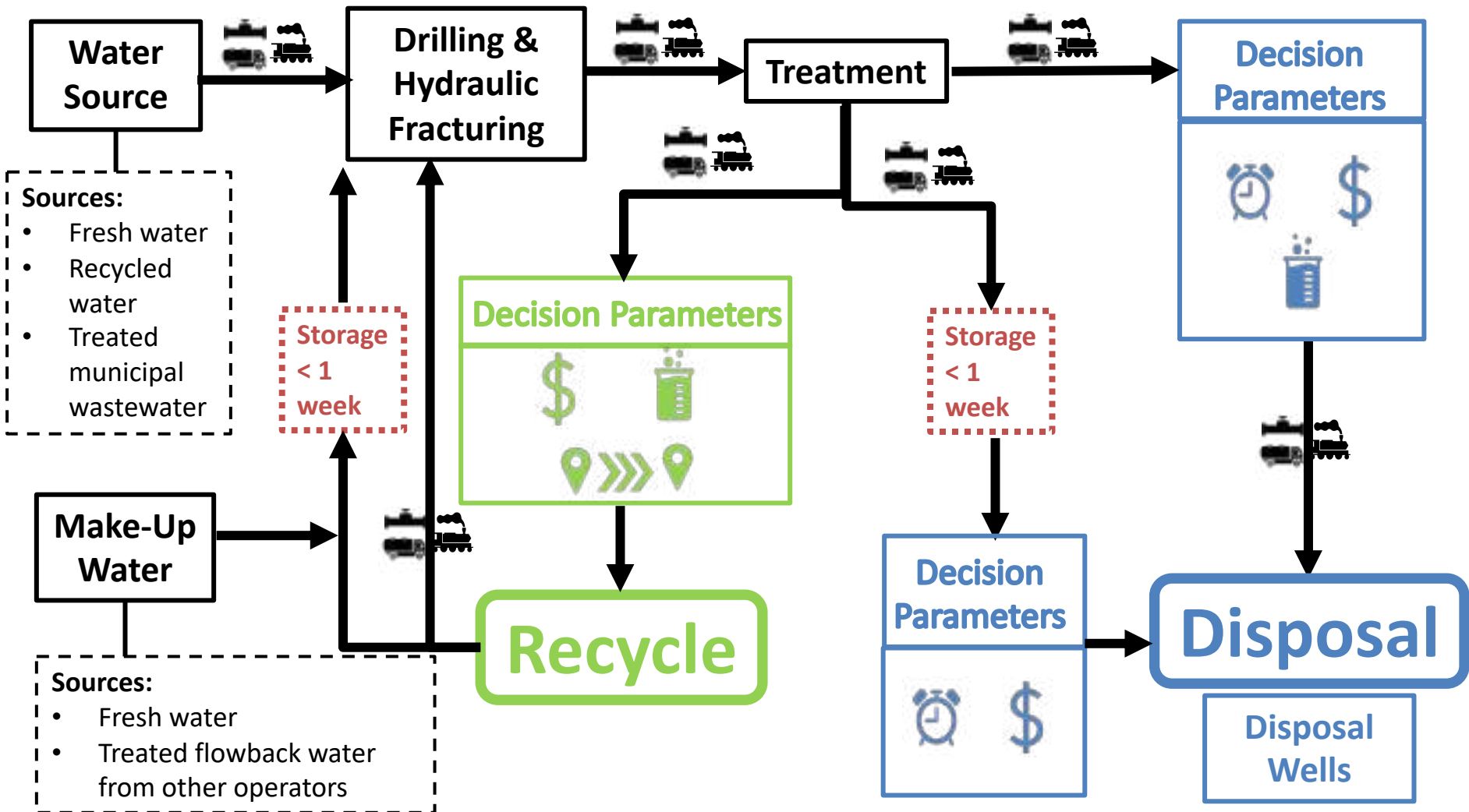
Time



Chemistry



Hydraulic Fracturing Water Cycle



Recycling Flowback Water

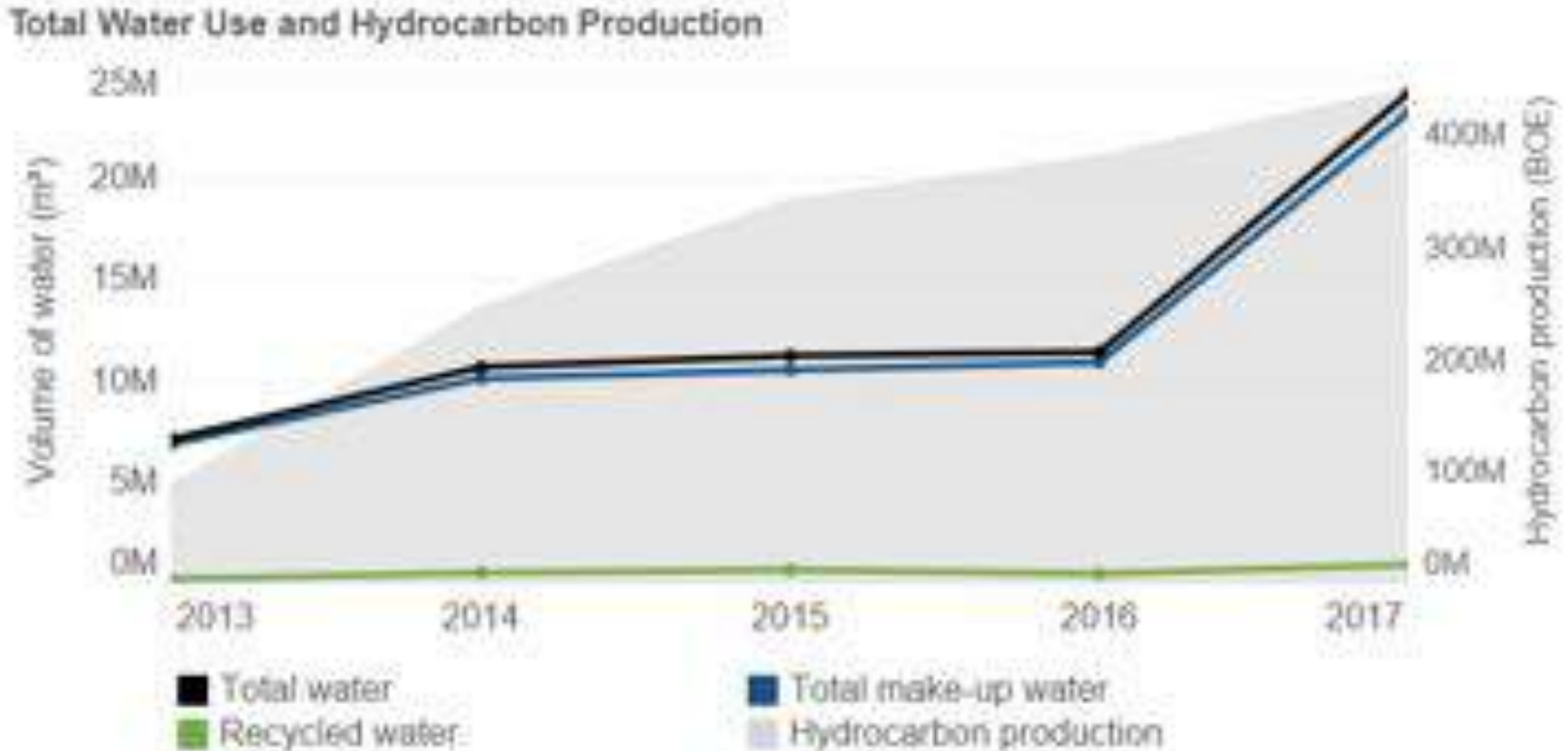
Why recycle?

Reduce the
amount of fresh
water used

Reduce the
amount of
disposal water

Methods used to recycle flowback water:
Blending, Filtration, Evaporation, Electrodialysis,
Gravimetric separation, Electrocoagulation.

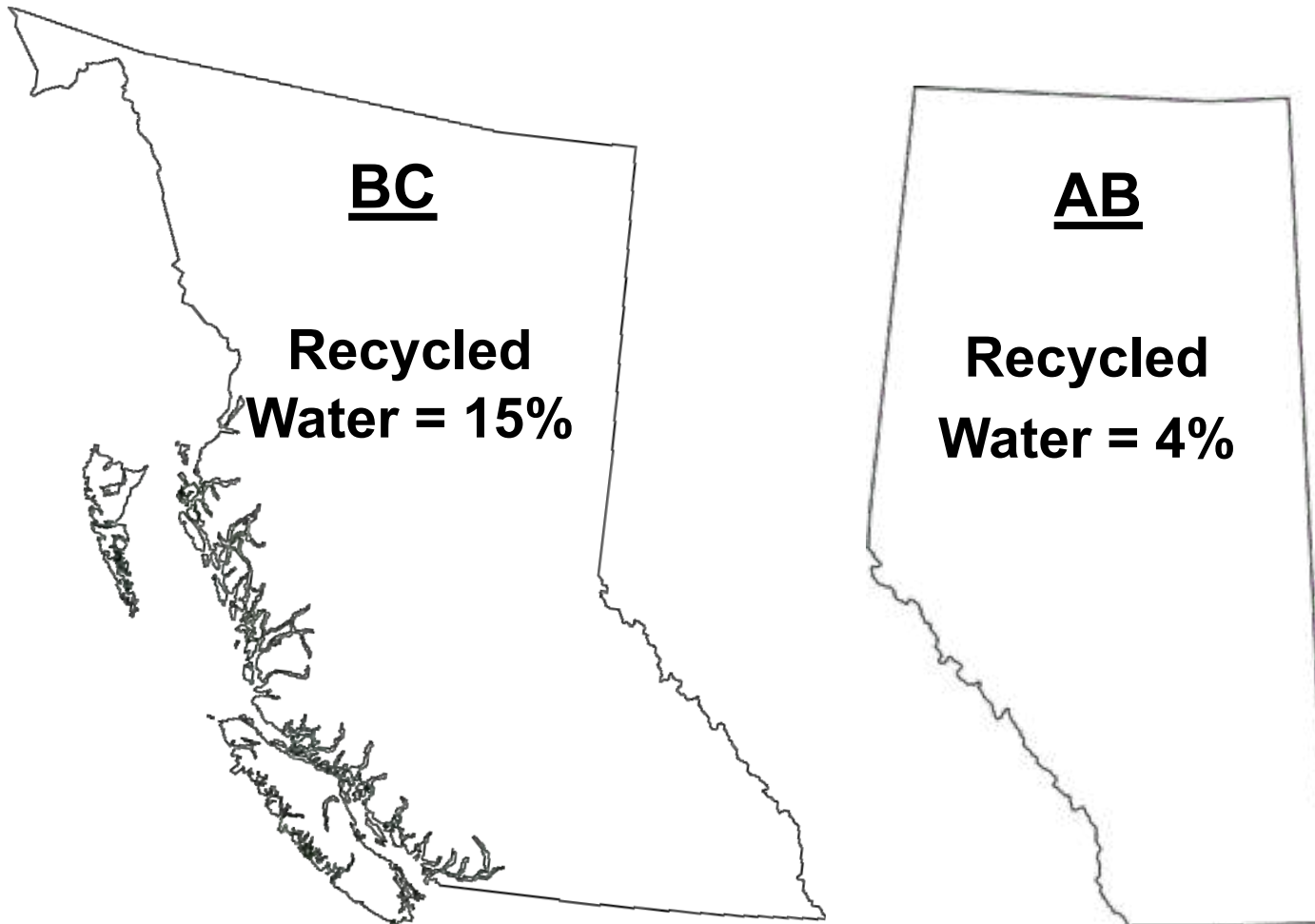
Current Water Recycling Practices in AB



From Hydraulic Fracturing water use report, AER.



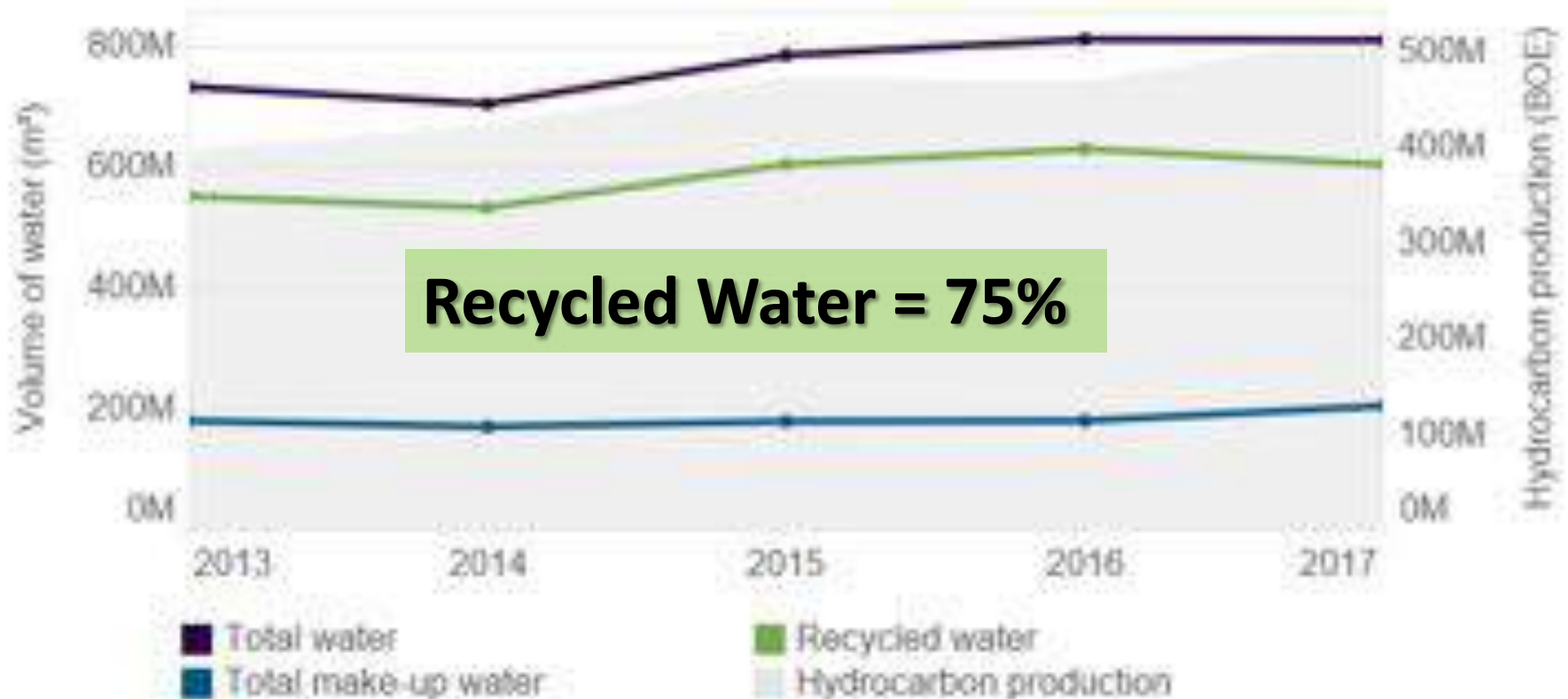
Comparison of AB and BC Water Recycling Practices



From BC Oil and gas commission water use report (2015) and Hydraulic Fracturing water use report, AER (2017)

Comparison to In-Situ Oil Sands in AB

Total Water Use and Hydrocarbon Production



From oil sands mining and in-situ water use report, AER.



Why is There More Recycling in the Oil Sands?

Maturity of
oil sands
development

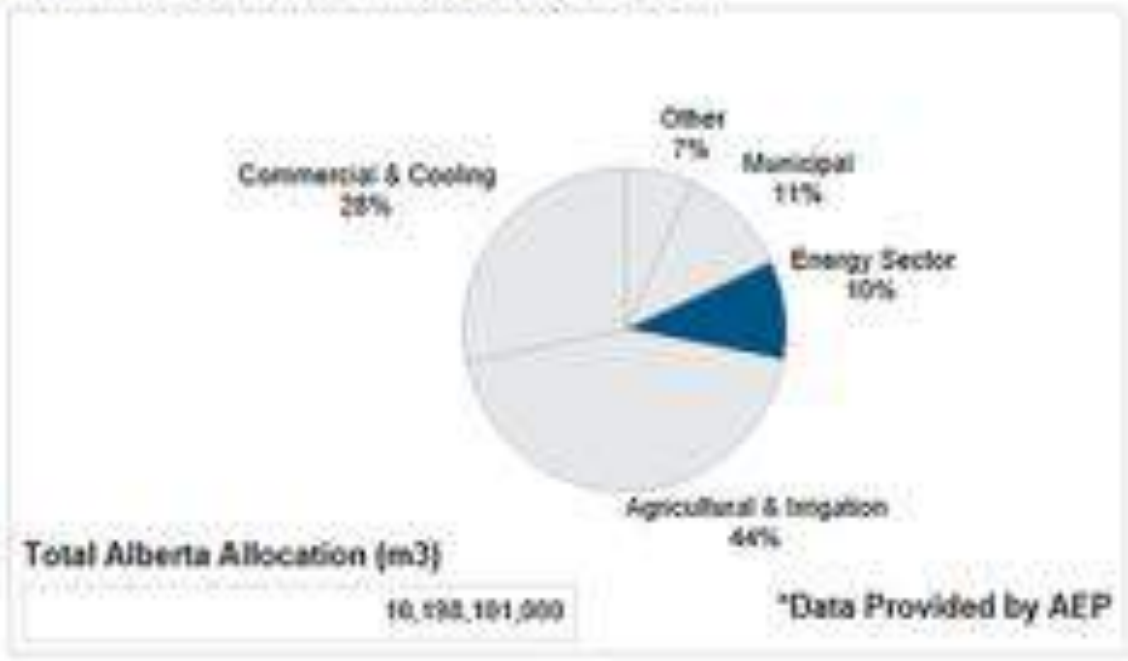
Regulations
incentivize water
recycling

Capability of
storage facilities

Close proximity of
produced water to
nearby operations

Water Use in AB

Total Alberta Water Allocations in 2016



Expected to increase across sectors with increasing population.



Prudent management is imperative to maintain public trust.

Existing Policy Issues in AB

Classification of water by source not properties

Limits on storage timeline

Conditions on water licenses that limit water sharing

Prevention of mixing water from different basins

Leads to only 4% recycled water in hydraulic fracturing operations (2017)



Policy Recommendations

Address existing policy issues through regulatory measures

Implement an incentive program to encourage recycling



Incentivize through a reduction on tax rate

Metric: water intensity, measure for saline and non-saline water sources

Metric: % of recycled water, tiered approach

Address uptake, risk mitigation, environmental footprint & meaningful consultation



Conclusions

Risk mitigation is achieved with the following steps.

Intensive monitoring of groundwater
in the vicinity of disposal sites.

Increasing the recycled
water ratio in hydraulic
fracturing operations.

Addressing policy issues.

Implementing an
incentive program.

Questions?



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Title Slide

Questions

Why is this relevant?

Sources of Risk for Disposal Activities

Risk Management Strategies

Dispose or Recycle? Decision Parameters

Hydraulic Fracturing Water Cycle

Recycling Flowback Water

Current Water Recycling Practices in AB

Comparison of AB and BC Water Recycling Practices

Comparison to In-Situ Oil Sands

Why is There More Recycling in the Oil Sands?

Water Use in AB

Existing Policy Issues

Policy Recommendations

Conclusions

Backup

Ground Water Monitoring Strategy

Hydraulic Fracturing Water Cycle

Current Makeup Water Sources in AB

Non-Saline Water Use Intensity in AB

Total Non-Saline Water Use

By Extraction Technology in AB

Non-Saline Water Use Intensity

By Extraction Technology

Water Recycling Rates

By Extraction Technology in AB

Water Recycling Technologies 1

Water Recycling Technologies 2

Definitions of Water in

Hydraulic Fracturing Activities

Shale Gas Resources in AB

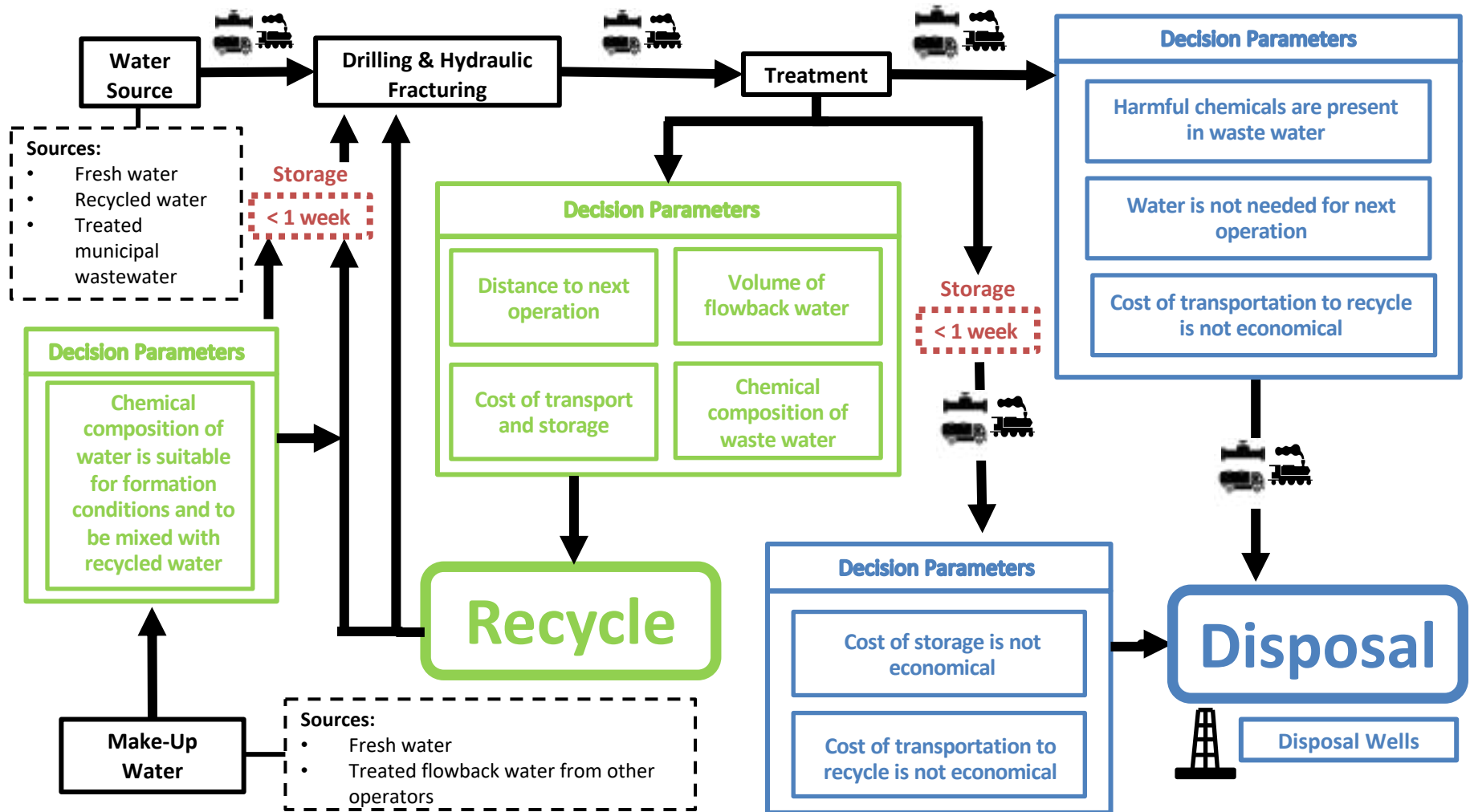
Shale Gas Resources in BC



Groundwater Monitoring Strategy

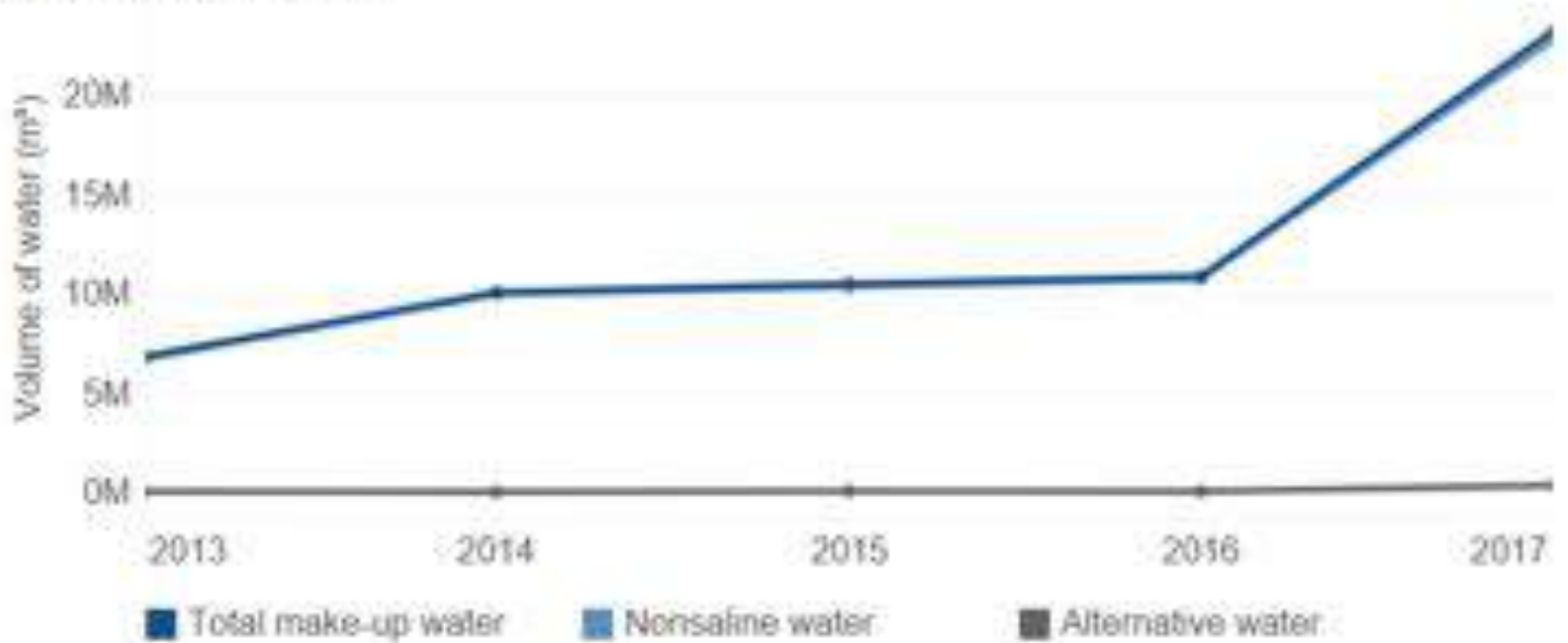


Hydraulic Fracturing Water Cycle



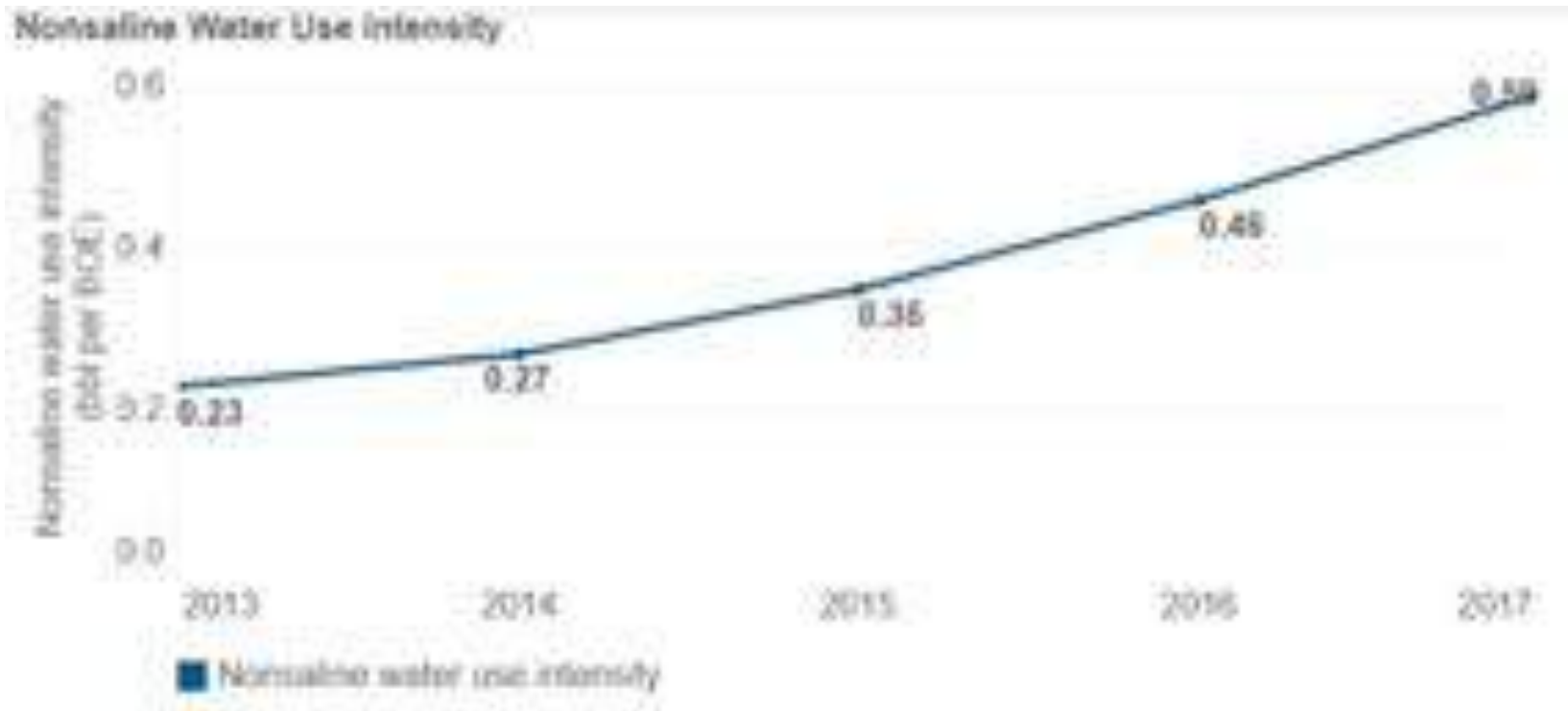
Current Makeup Water Sources in AB

Make-Up Water Sources



From Hydraulic Fracturing water use report, AER.

Non-Saline Water Use Intensity in AB

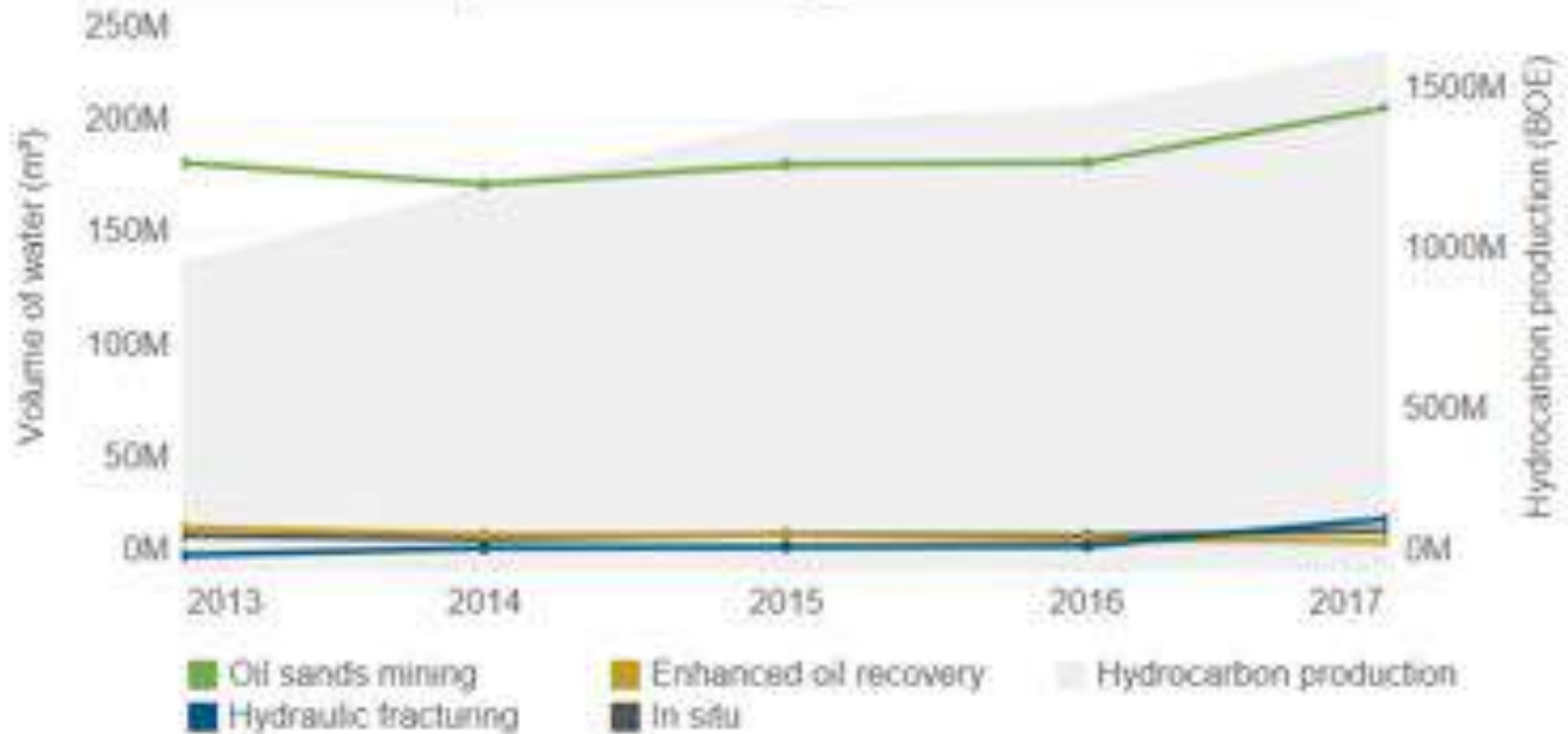


From Hydraulic Fracturing water use report, AER.



Total Non-Saline Water Use By Extraction Technology in AB

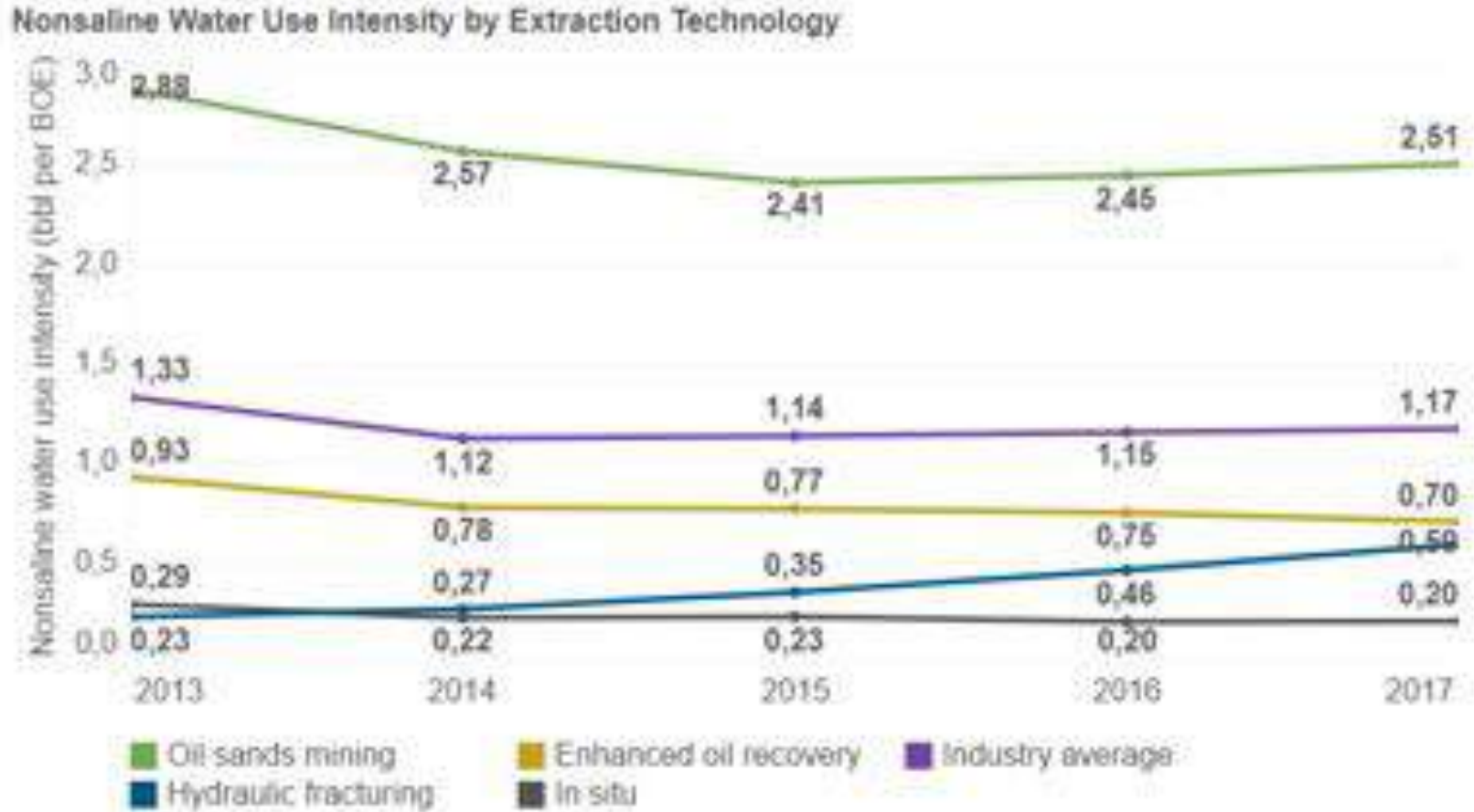
Total Nonsaline Water Use by Extraction Technology



From water use report, AER.



Non-Saline Water Use Intensity By Extraction Technology

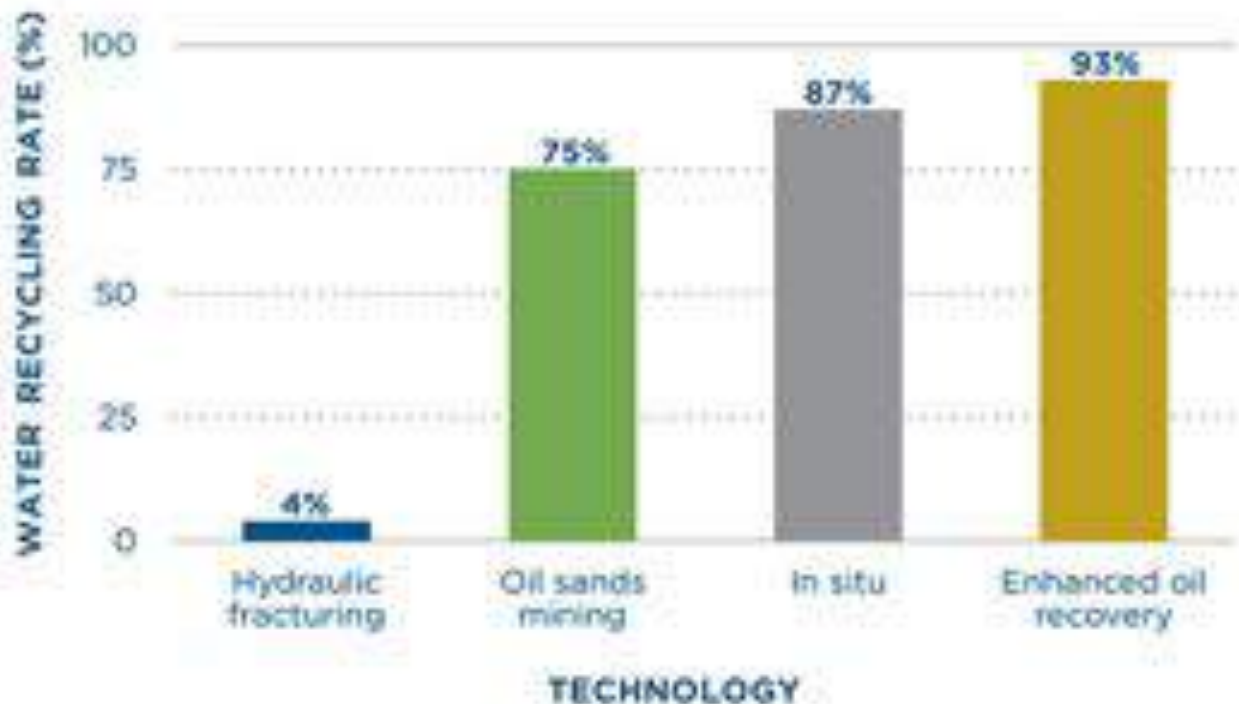


From water use report, AER.



Water Recycling Rates By Extraction Technology in AB

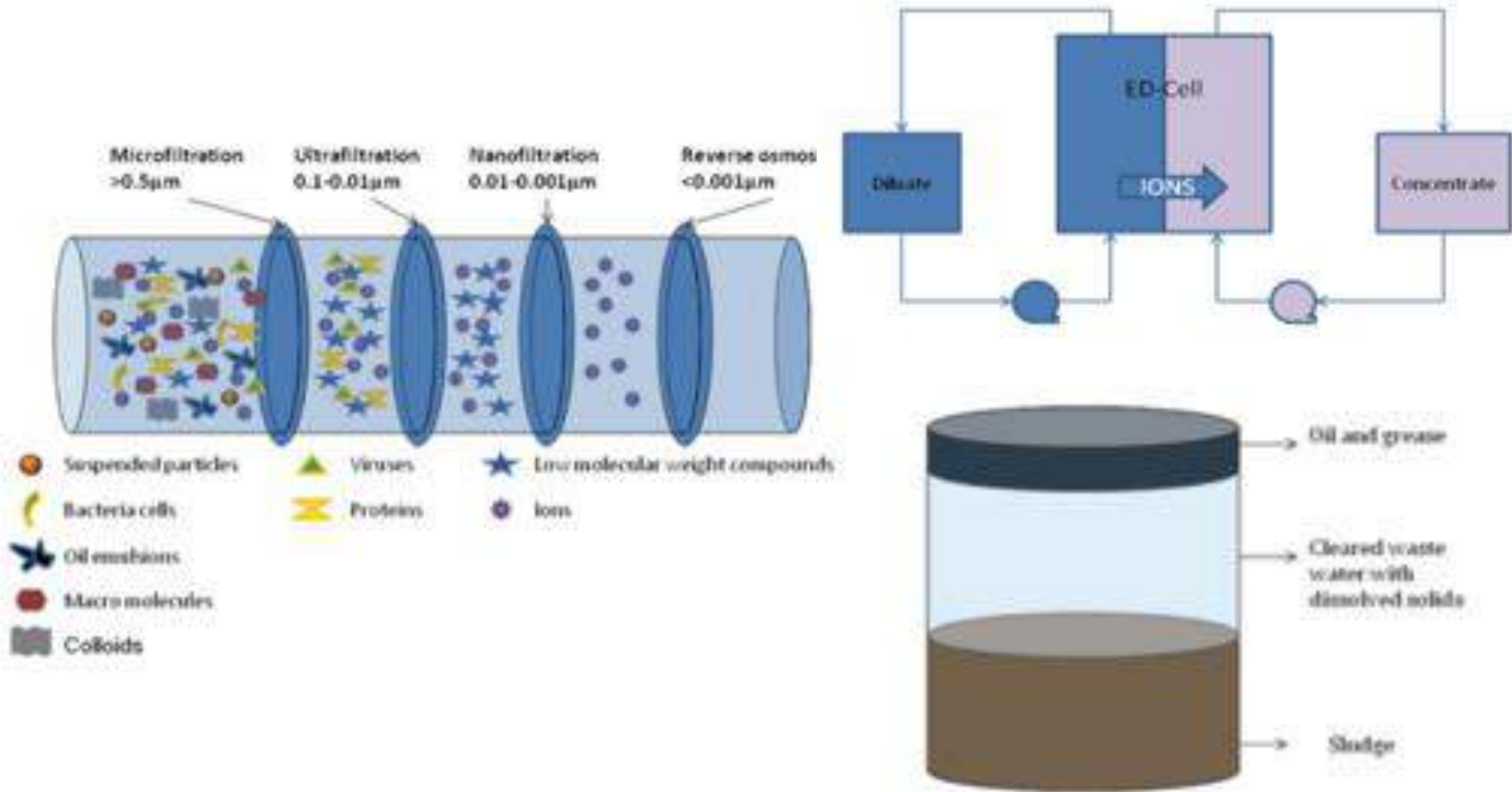
2017 Water Recycling Rates
(per cent by technology)



From water use report, AER.



Water Recycling Technologies



Water Recycling Technologies

Recycling Frack Water

Numerous companies are developing technologies to clean up water used to hydraulically fracture shale wells. Here's a look at a process offered by Halliburton.

1 WATER USE
Fracking a shale gas well uses as much as five million gallons of water. Up to 40% of it returns to the surface containing hydrocarbons, heavy metals, solids and bacteria.



COLLECTION

Contaminated water is stored temporarily in a man-made pond or in storage tanks.

ELECTROCOAGULATION CELLS

The cleaning process uses electricity to destabilize and cut suspended matter in the water.

pH ADJUSTMENT

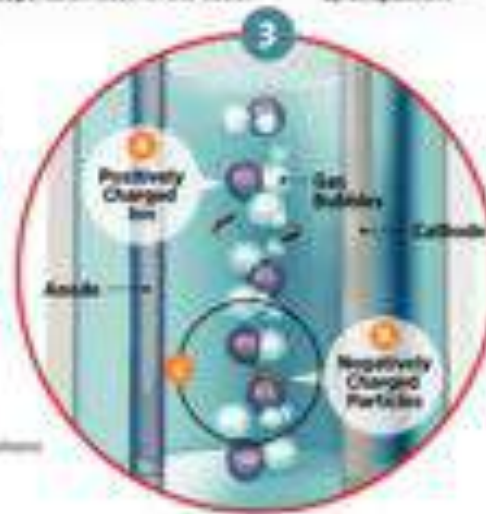
If required, the pH balance of the water can be adjusted to speed up coagulation.

FILTRATION AND REUSE

This step removes any remaining suspended materials. This water can be reused for future frack jobs.

CLEANING PROCESS

- 1 When contaminated water passes through the electrocoagulation cells, positively charged ions are released by the anode tube.
- 2 ...binding to negatively charged particles, resulting in coagulation, or clotting.
- 3 ...gas bubbles attach to the solids, sending them to the surface.



Source: Halliburton (recycling process) Pennsylvania River Run (contaminated fracture water) (credit: © Alamy/Corbis) The Wall Street Journal

2012 PENNSYLVANIA FRACK WATER

A growing percentage of water used to frack Marcellus Shale wells is being recycled.

RECYCLED WATER

PERCENTAGE OF RECYCLED WATER



* Through 2011, 24 shale gas wells in the Marcellus Shale basin in Pennsylvania had recycled about 90% of all water in Pennsylvania.

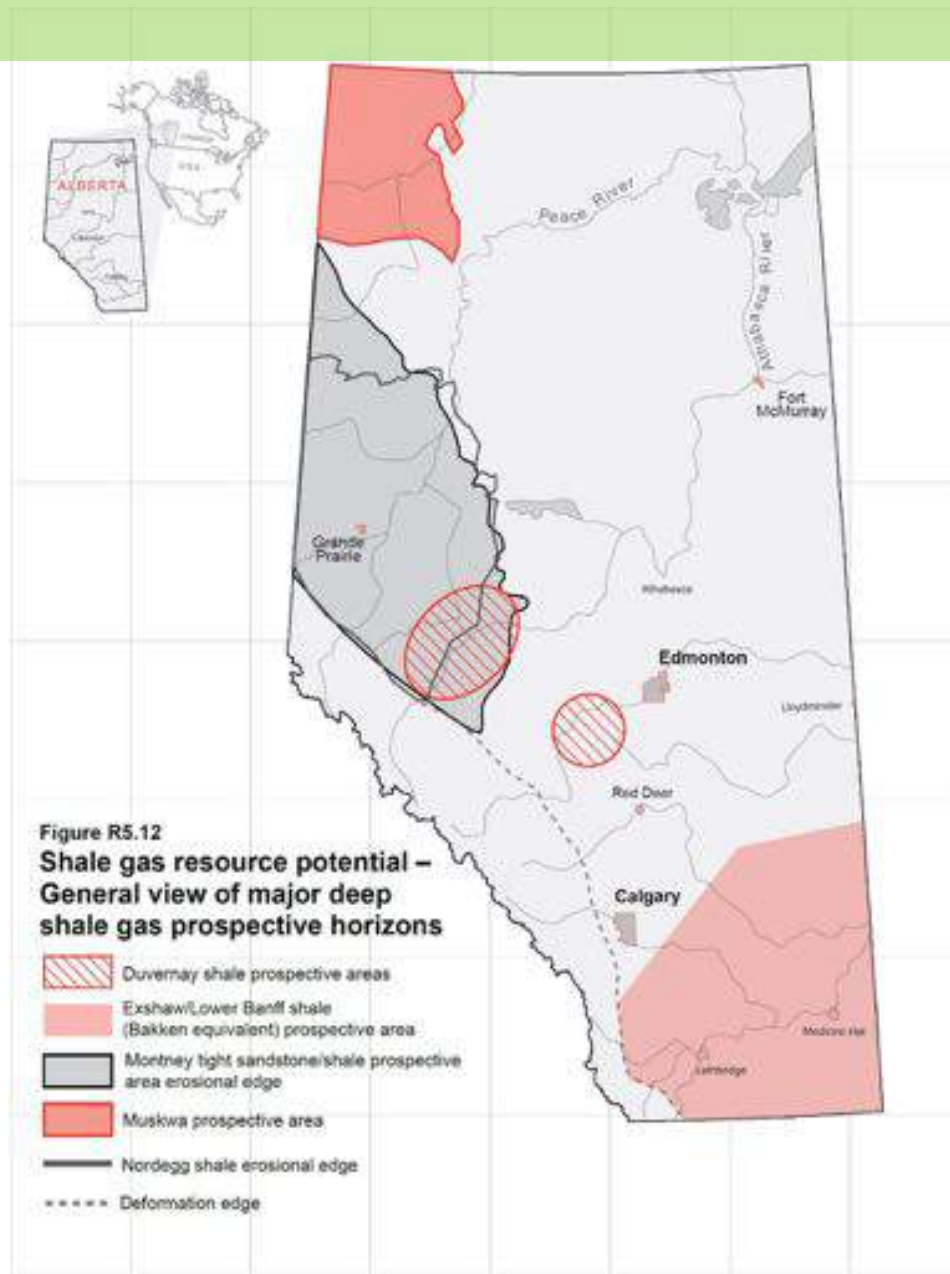


Definitions of Water in Hydraulic Fracturing Activities

Wastewater	A mixture of flowback fluids and produced waters that are not recycled. It has a high Total dissolved solids (TDS) and may also contain hazardous compounds, including methane, synthetic organic compounds, and radioactive materials.
Make up water	Water that is added to an energy process to replenish water lost. It can be obtained from either non-saline or saline water.
Recycled water	Water that was previously used in an energy activity and is then reused by operators in that same process.
Non-saline water	Water having a TDS content of 4000 mg/L or less, sometimes is referred to as fresh water.
Alternative water	Water other than surface water and non-saline groundwater, including saline groundwater, produced water, etc.
Produced vs. Flowback Water	Flowback refers to the return of injected fluids, while produced water is formation water that is high in gas and oil.



Shale Gas Resources in AB



Shale Gas Resources in BC

