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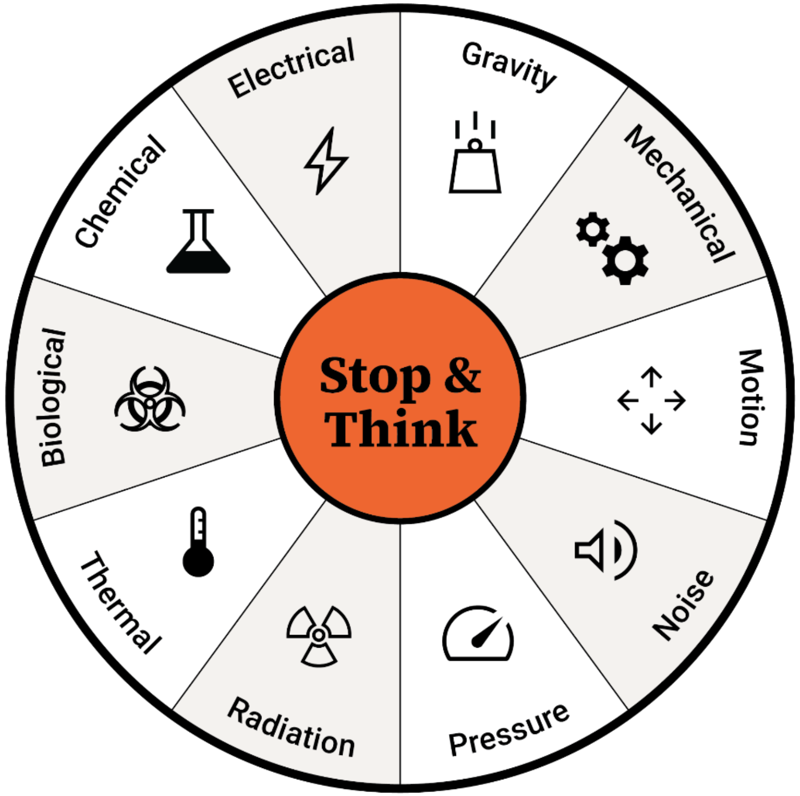
Beneficial Reuse of Produced Water:

From a Headache to a Lifeline for Data Center Development in West Texas

Stantec Moment

Stop and Review Potential Risks



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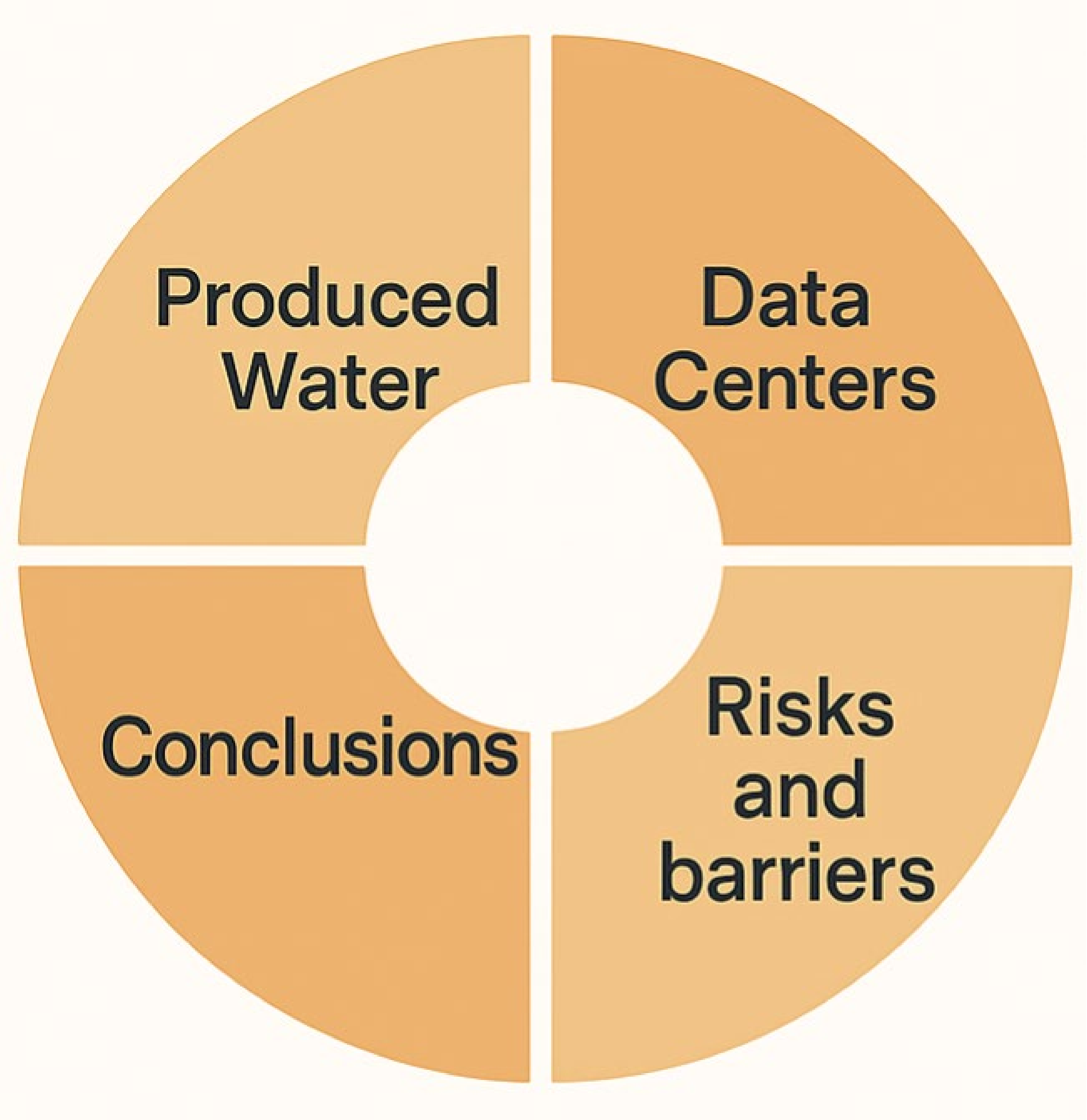
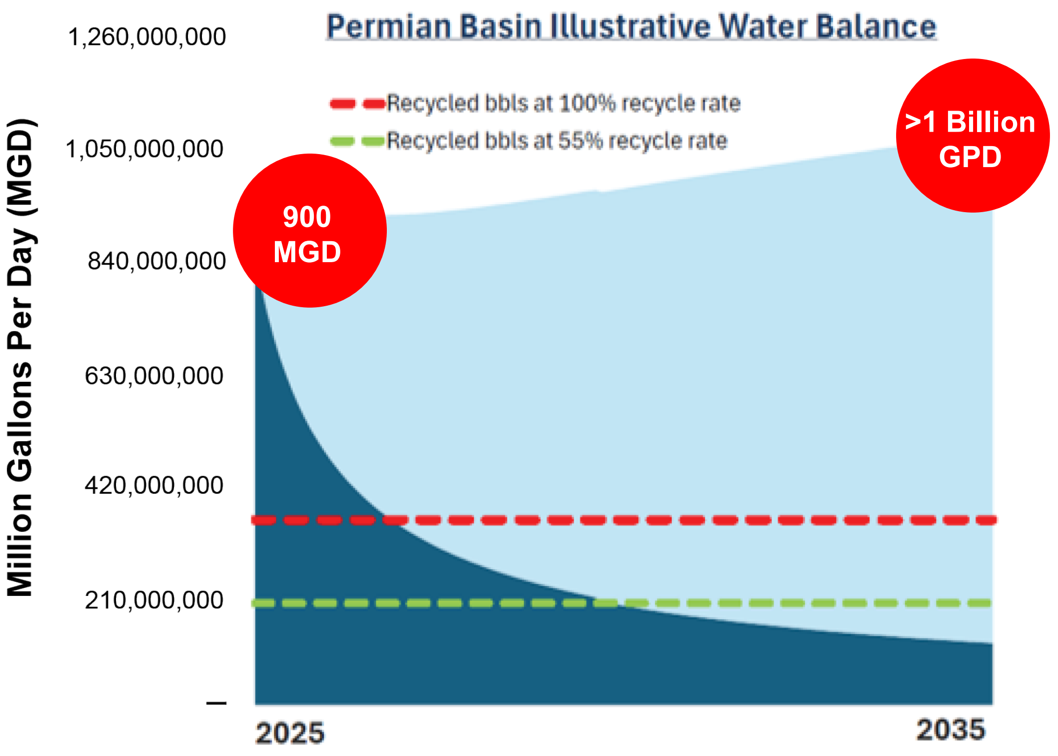
Agenda

1. Produced Water
2. Data Centers
3. Risks and barriers
4. Conclusions
5. Q&A



The Permian Basin Water Paradox

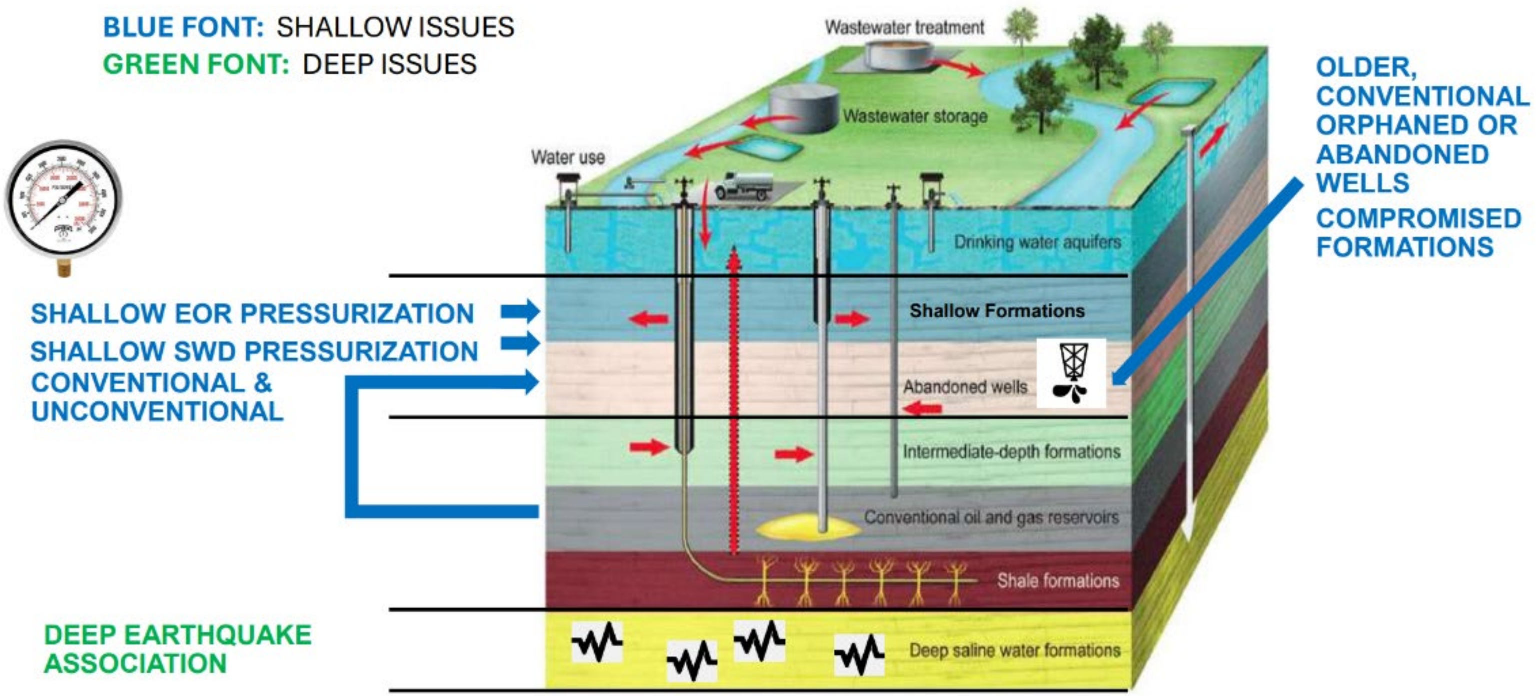
- 4 – 8 Barrels of water/ barrel oil
- Current:
  - Produced: 20 million+ bpd
  - Recycle Demand: 5 million bpd
  - Injection Need: 15 million bpd (>600 MGD)
  - Best Case Injection Need: 10 million bpd (>400 MGD)
- By 2035
  - Produced: 25 million+ bpd
  - Injection Need to grow to >20 million bpd (>800 MGD)



Adapted from Source: Water Management: Relentless Progress and Evolution
Scott Mitchell, CEO of Deep Blue, 2025

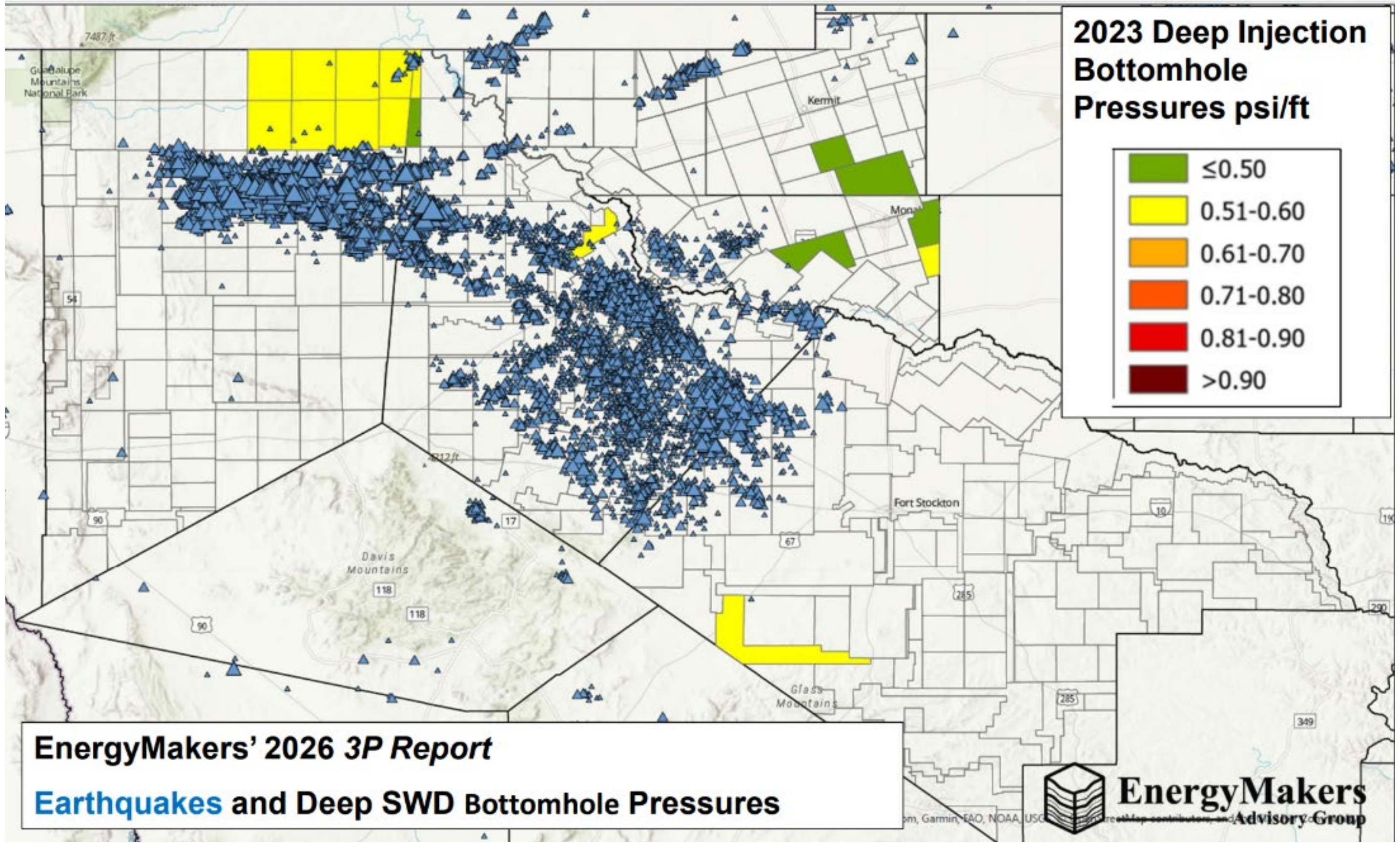
What's changing

- Loss of injection capacity
- Seismicity
- Well integrity failures
- Disposal is harder and more costly

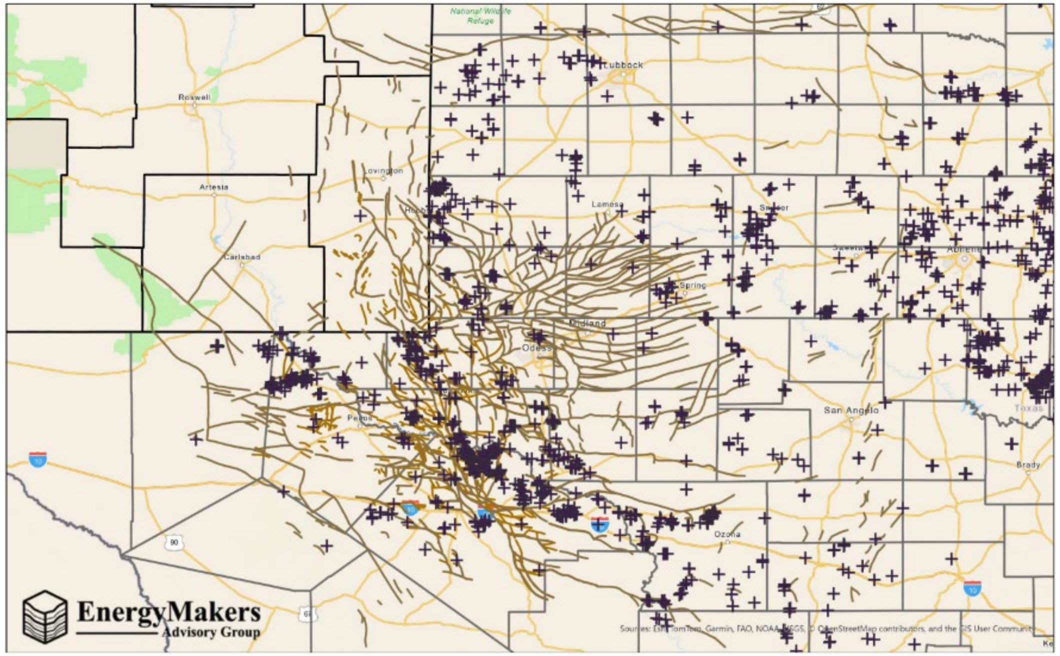


Deep well injection challenge

- Earthquakes triggered by Deep well injection
- Pressures are increasing in deep wells due to insufficient pore space
- Earthquakes trigger action from the RRC, closing wells in the area of the event
- Reduced injection capacity → added cost of produced water management



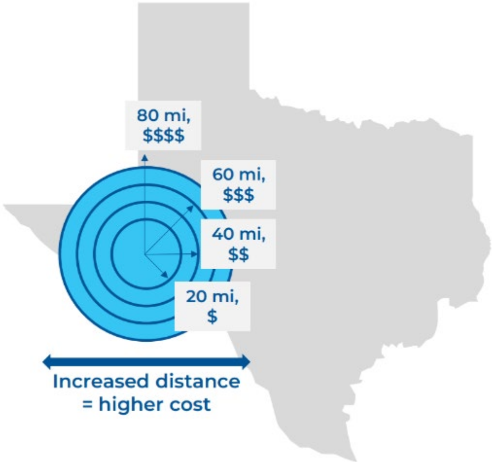
Shallow well injection challenges



- RRC Orphan wells as of Jan 2025
- Visible leaks in certain counties

What are the options?

Inject elsewhere



- Transporting produced water out-of-basin for disposal will be expensive
    - Western Midstream Partners' "pathfinder" pipeline estimated cost of $400 to $450 million
- Not a long-term solution • "Kick the can…"

Treat for volume reduction

Options exist but they are not free!

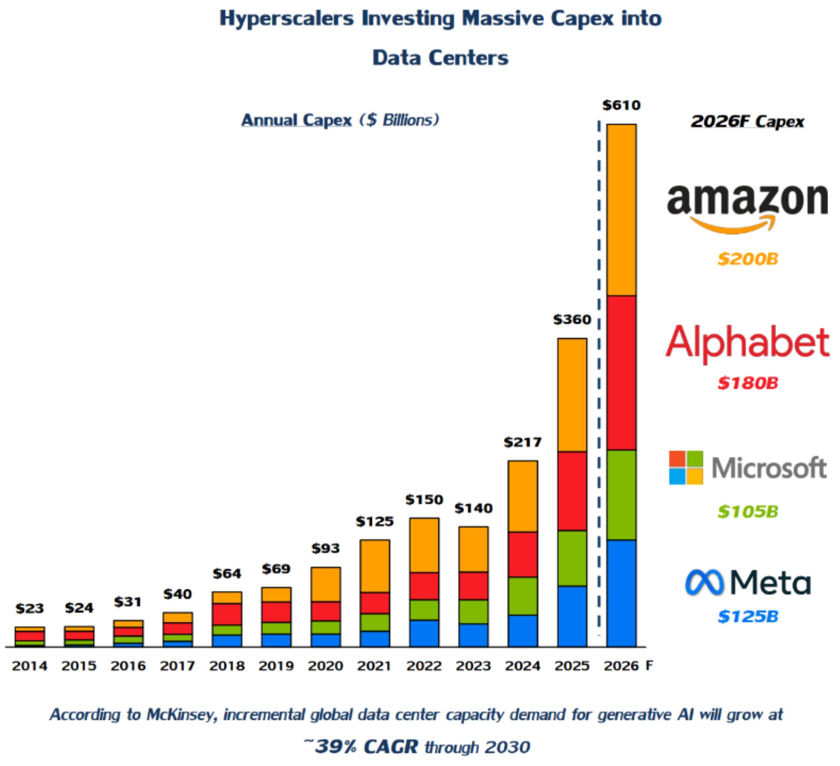
Produced Water Makeup & Variability

		Mean	Max	Min	25th percentile	50th percentile	75th percentile
Alkalinity	mg/L as $CaCO_3$	272	870	100	128	207	336
Ammonia	mg/L	432	750	320	330	400	495
COD	mg/L	1,626	3,100	930	1,250	1,400	1,950
pH	SU	6.6	8.1	3.9	6.3	6.7	7.0
TDS	mg/L	128,641	201,474	100,830	113,441	122,280	134,525
TOC	mg/L	103.5	248.1	2.4	28	90.6	173.3
TSS	mg/L	342.9	790	85	142.5	375	422.5
Turbidity	NTU	116.4	200	23	36	110	200
MBAS	mg/L	1.10	2.1	0.047	0.92	0.97	1.33

Source: Water Management: Characterization of Produced Water and Surrounding Surface Water in the Permian Basin
Pei Xu and Mike Hightower - New Mexico Produced Water Research Consortium New Mexico State University, 2023

- Complex water chemistry – Suspended solids, oils, grease; dissolved solids; dissolved organics; NORM; metals; chemical additives; microorganisms
- Produced water quality is highly variable: by region, within an oil or gas play, with time
- Limited produced water quality data in existing database

Data Centers & Why Permian?



- Power availability: Low cost of natural gas & significant renewable generation
- Available and affordable land
- Friendly regulatory environment
- Proximity to transportation and fiber infrastructure
- Skilled labor
- Ample volumes of produced water that can be treated to meet cooling demands

Data centers: water demand is design-dependent

- Direct Evaporative Cooling (Swamp Cooler) - Very energy efficient however impose a significant water demand and also more sensitive to water quality
- quality, particularly hardness and residual biologicals
- Chiller Plant:
  - Air Cooled - very low make-up water demand during operation, however, impose a higher electrical demand
  - Water- Cooled (Wet Cell Cooling Tower) - a lower electrical demand, however, impose a significantly higher make-up water demand

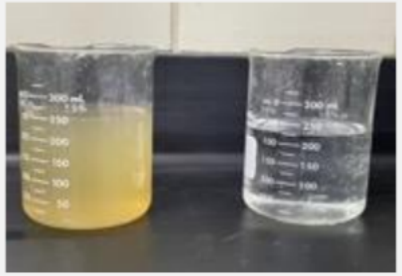
Evaporative Cooling Water Volumes & Quality

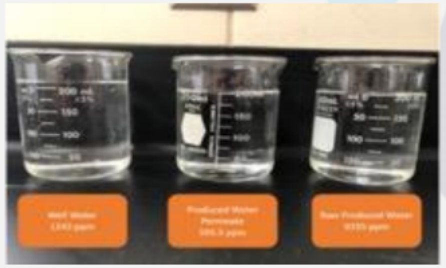
- Volumes can vary based on technology but rule of thumb in TX 10 MGD per GW
- High Water Quality requirements
- There is a big gap in the Water Quality
- This assumes 5 COCs

pH	S.U	8.2
TSS	mg/L	2.8
TDS	mg/L	550
Calcium	mg/L	13.2
Magnesium	mg/L	7
Sodium	mg/L	194
Chloride	mg/L	132
Sulfate	mg/L	114
Silica	mg/L	7.6
Iron	mg/L	0.001
Alkalinity	mg/L	16.4

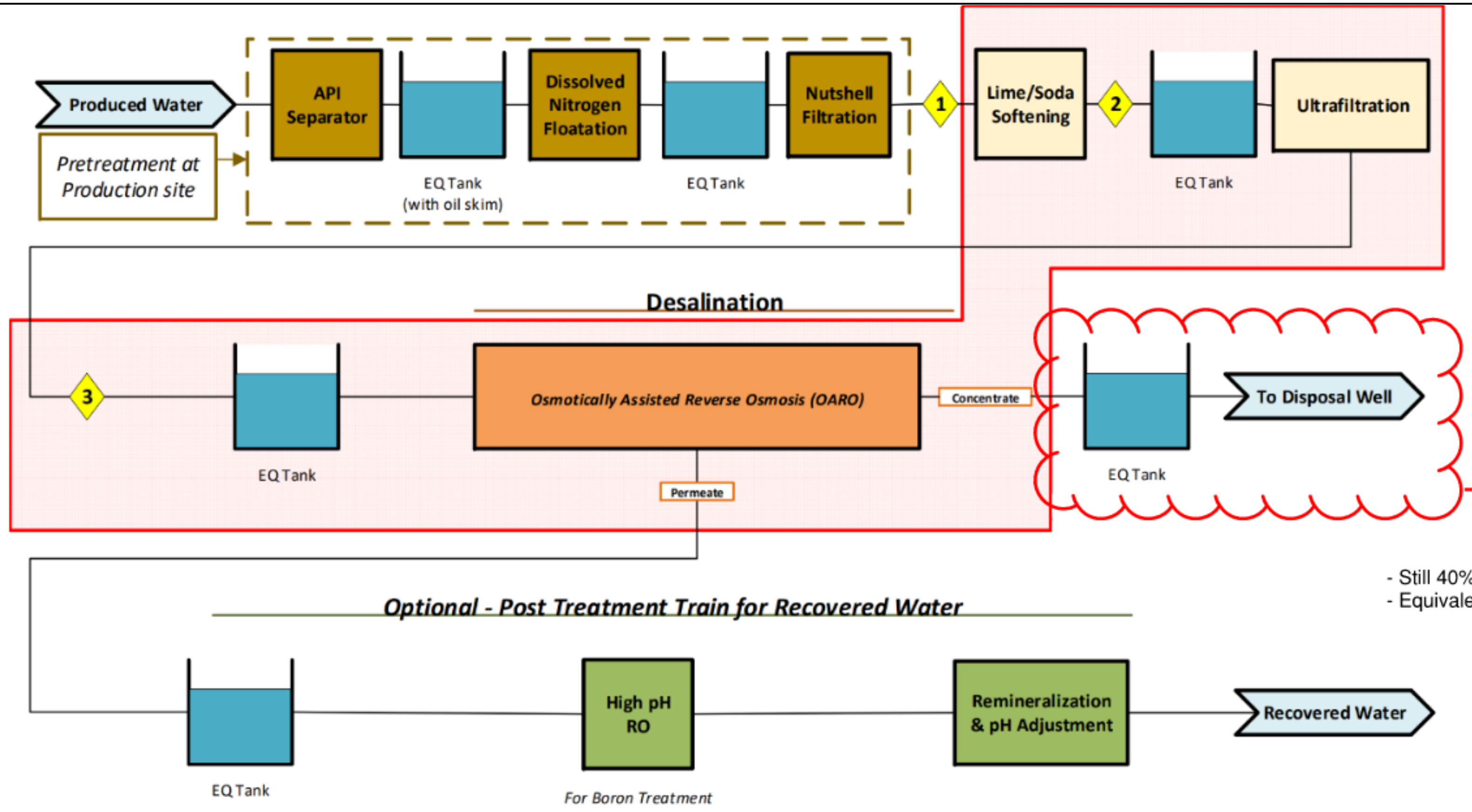
Treatment train options

Preliminary Treatment	Pre-Treatment	Treatment	Post- Treatment	EPA Fit-for-Purpose Application
Bulk solids and oil/water separation	Oil, water, solids separation/bacteria and pH treatment	Desalination – reverse osmosis, thermal processes, ED	GAC, zeolite filtration Ammonia, (S)VOC removal/destruction	Human cell line and WET testing, Fate and Transport
"Raw Water" 200-500 ppm oils High salinity	"Clean Brine" 30 ppm oils, low TSS and Fe, low bacteria, balanced pH	"Desalinated" 99.5% solids removal 90% organics removal 99.5% inorganics removal	"Purified Water" NTU<10 Org compounds <2 ppm TDS < 100-800 ppm Ammonia <1-2 ppm	"Purified Water" Industrial, Commercial, Agricultural, Ecological, Recreational, Domestic Uses





Concentrate/Brine management

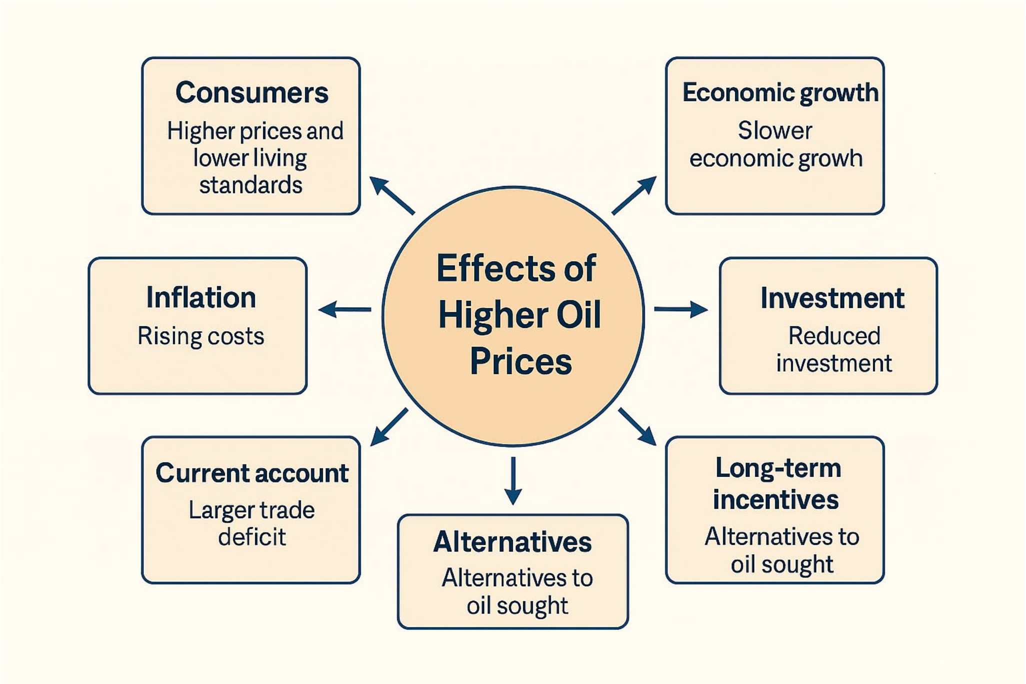


- Still 40% - 65% of the overall volume to disposal
- Equivalent of 160 - 260 MGD

Conceptual BFD using OARO Technology

Cost of Treatment and Impact on Economics

- Ranges from \$1 - \$3/barrel of water
- Assuming 5 barrels of water/barrel of oil → \$5 - \$15/barrel of oil additional OPEX
- Or \$0.12 - \$0.36/gallon of oil or ~5%-10% increase



Risks & Opportunities

- Risks
  - Technical
    - Treatment technologies with lower costs are not fully mature
    - Regardless, this would be first of its kind at this scale
    - Water midstream structure not built out fully to allow for economies of scale to be realized
  - Operational
    - Oil or Data Center companies are not advanced water treatment companies
  - Environmental/Regulatory
    - Liability of the treated produced water
    - Framework still in the works
  - Commercial
- Opportunities

Conclusions

- Alternative means of produced water management is an imperative. Treatment for volume reduction seems to be a viable option.
- Water supply is not unlimited and produced water beneficial reuse offers a rare opportunity to introduce new water into the water cycle.
- Technology exists but cost is the main barrier.
- Regulatory framework for discharge and use for beneficial crops also a challenge.
- Datacenter offtake offers a win:win for the oil and tech industries as well as for Texas as a whole.
- Power development for datacenters also need water.

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Thank you