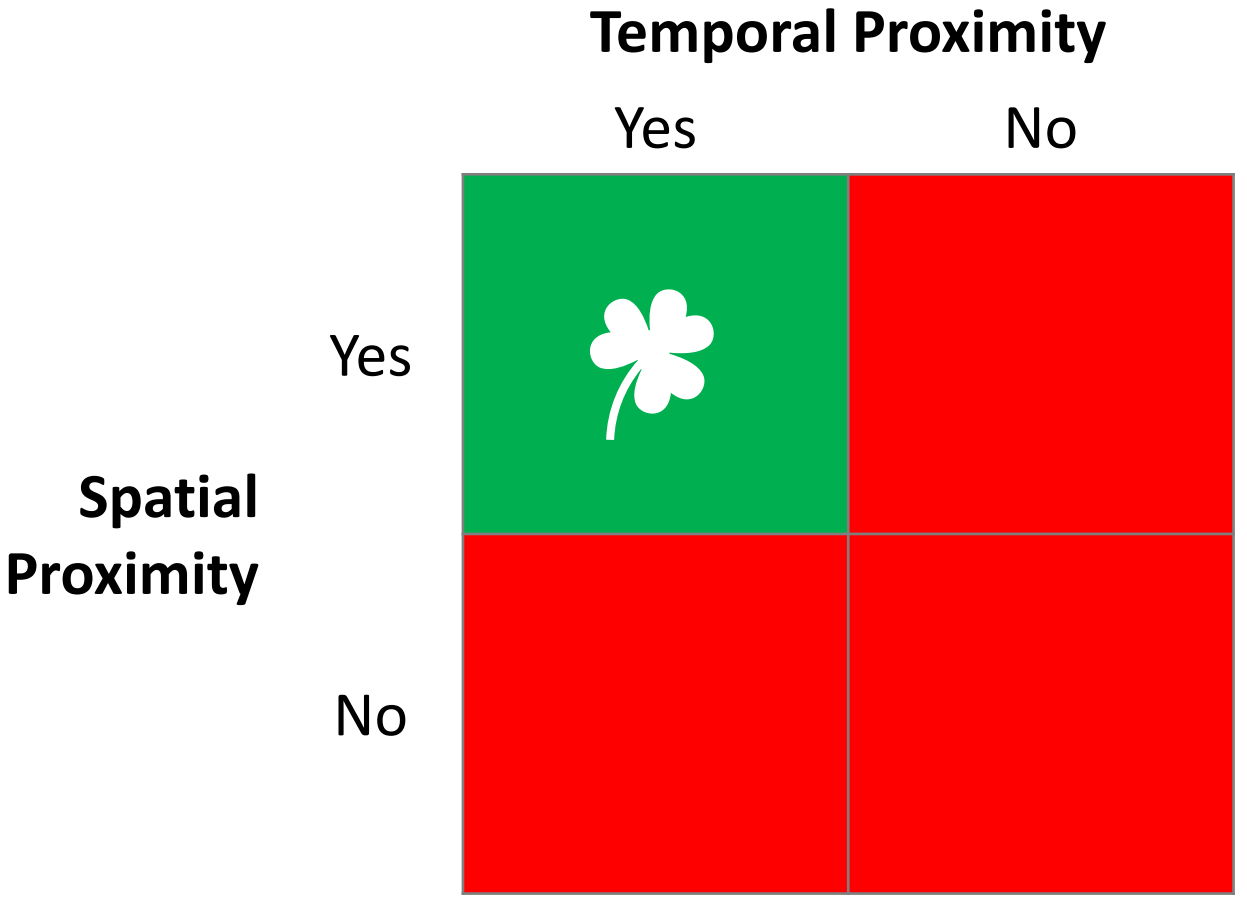
PRODUCED WATER SOCIETY SEMINAR 2020

Trading at Water Terminals: Creating Standards for Large-Scale Produced Water Recycling

Aaron D. Horn, XRI Holdings LLC

Is Produced Fluid a Commodity or Waste?

- Alignment in space and time
  - Spatial proximity
  - Temporal proximity
- Infrastructure creates alignment
  - Pipeline network connectivity
  - Storage



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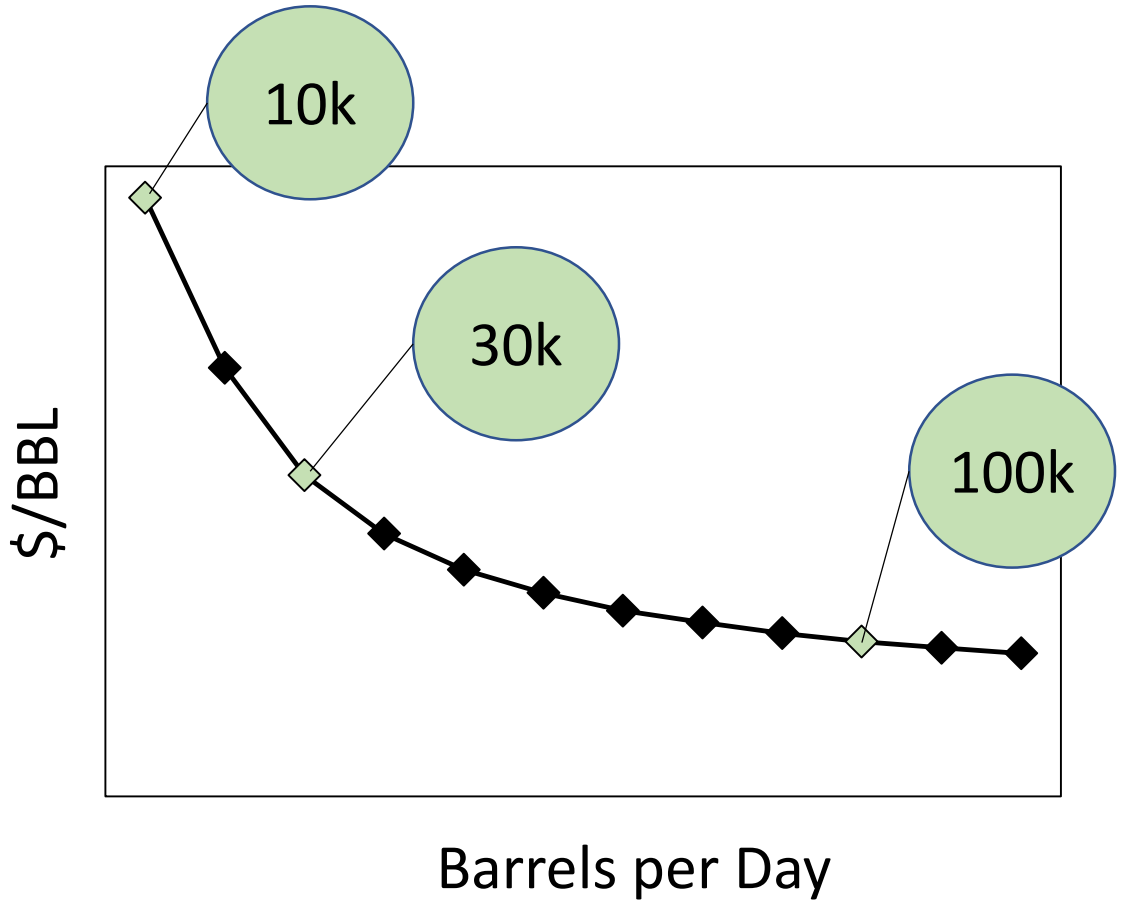
Spatial Proximity	Temporal Proximity: Yes	Temporal Proximity: No
Yes		Storage
No	Pipeline Connectivity	Storage & Pipeline Connectivity

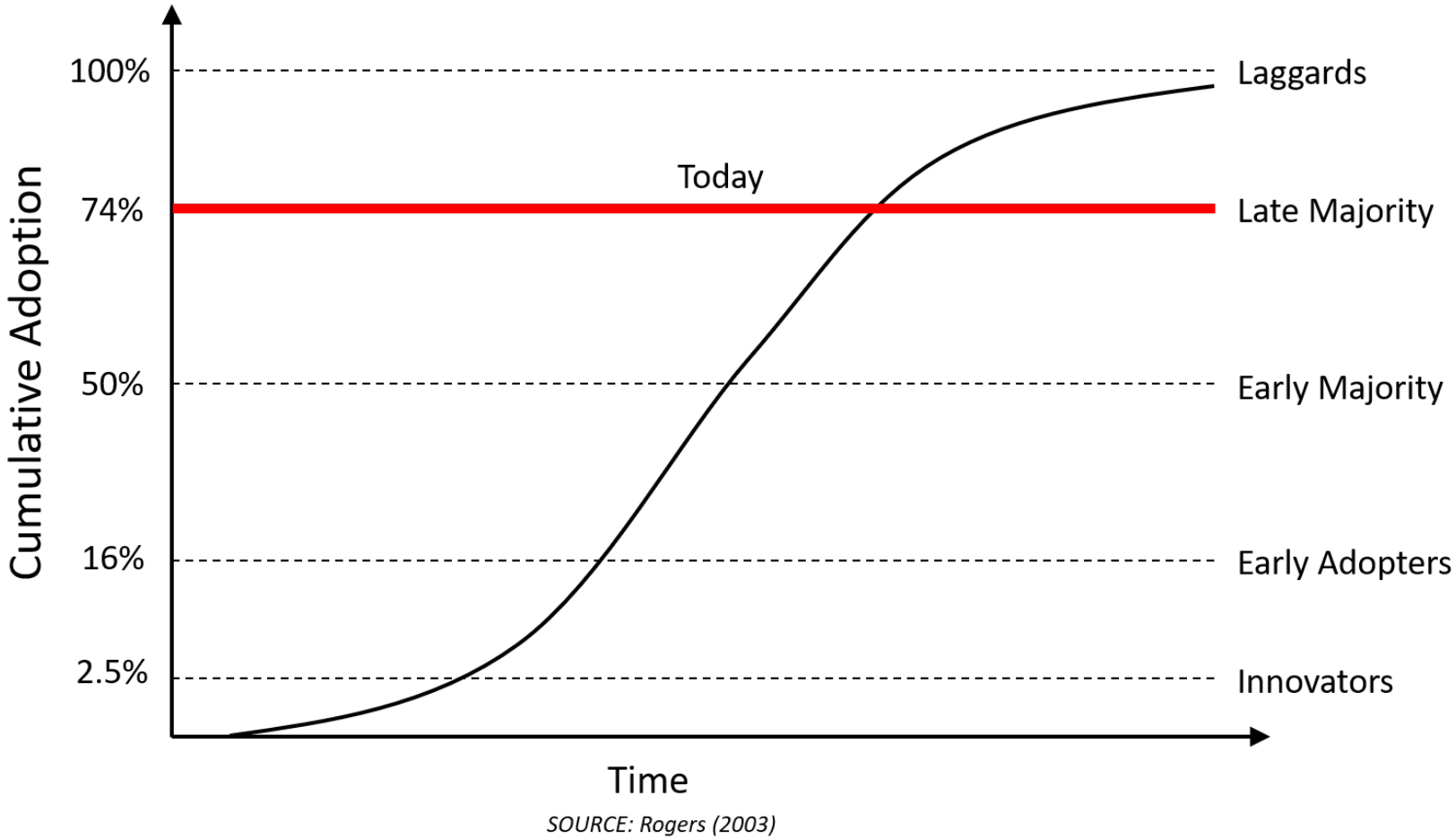
Economies of Scale

- Size matters
- Scale drives down $/bbl
- Cost to treat, store, and transport



Single-Party Recycling: Adoption Curve

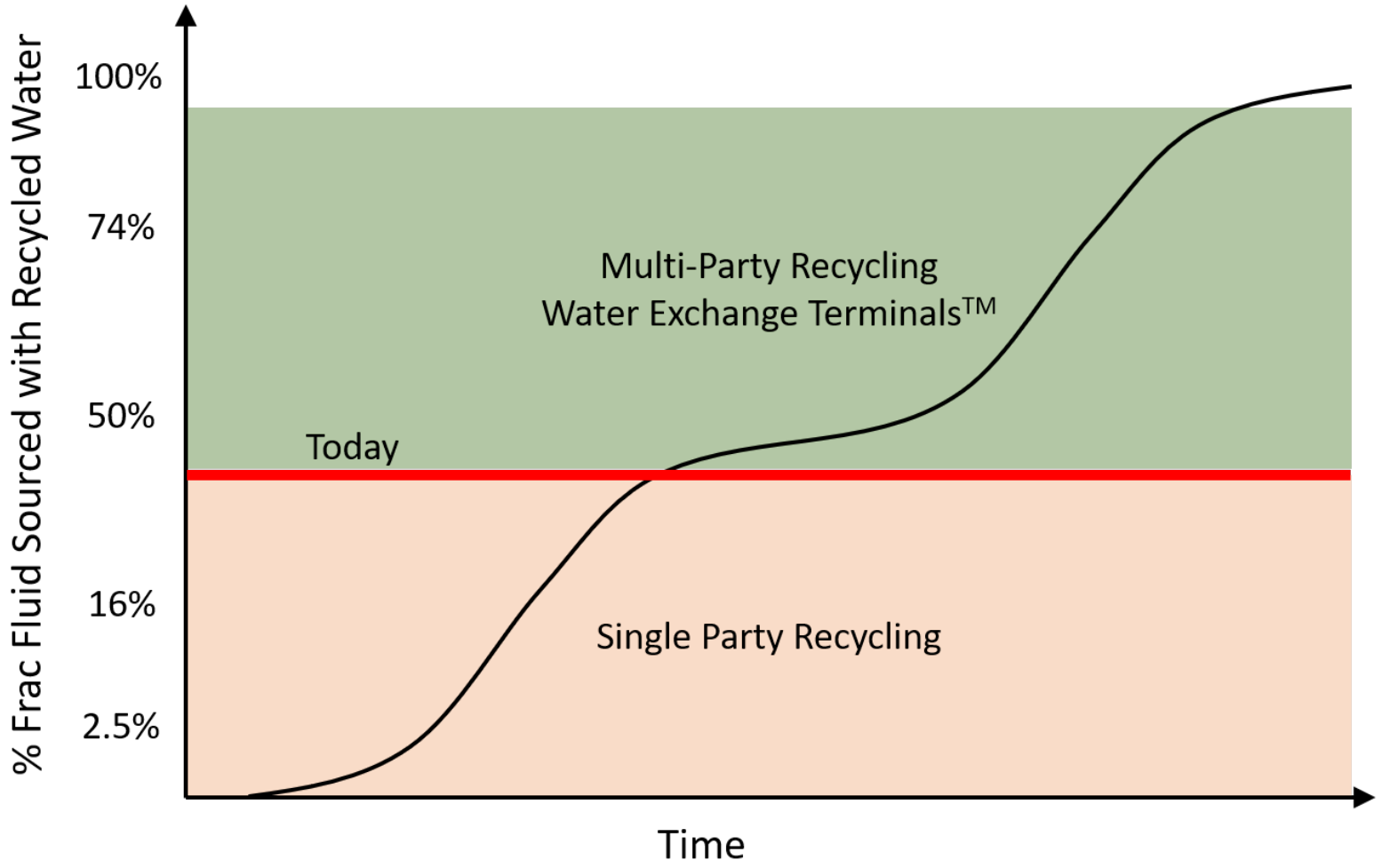
- Most are recycling
- Chemistry rarely limits recycling
- Logistics is the challenge
- Must make economic sense



SOURCE: Rogers (2003)

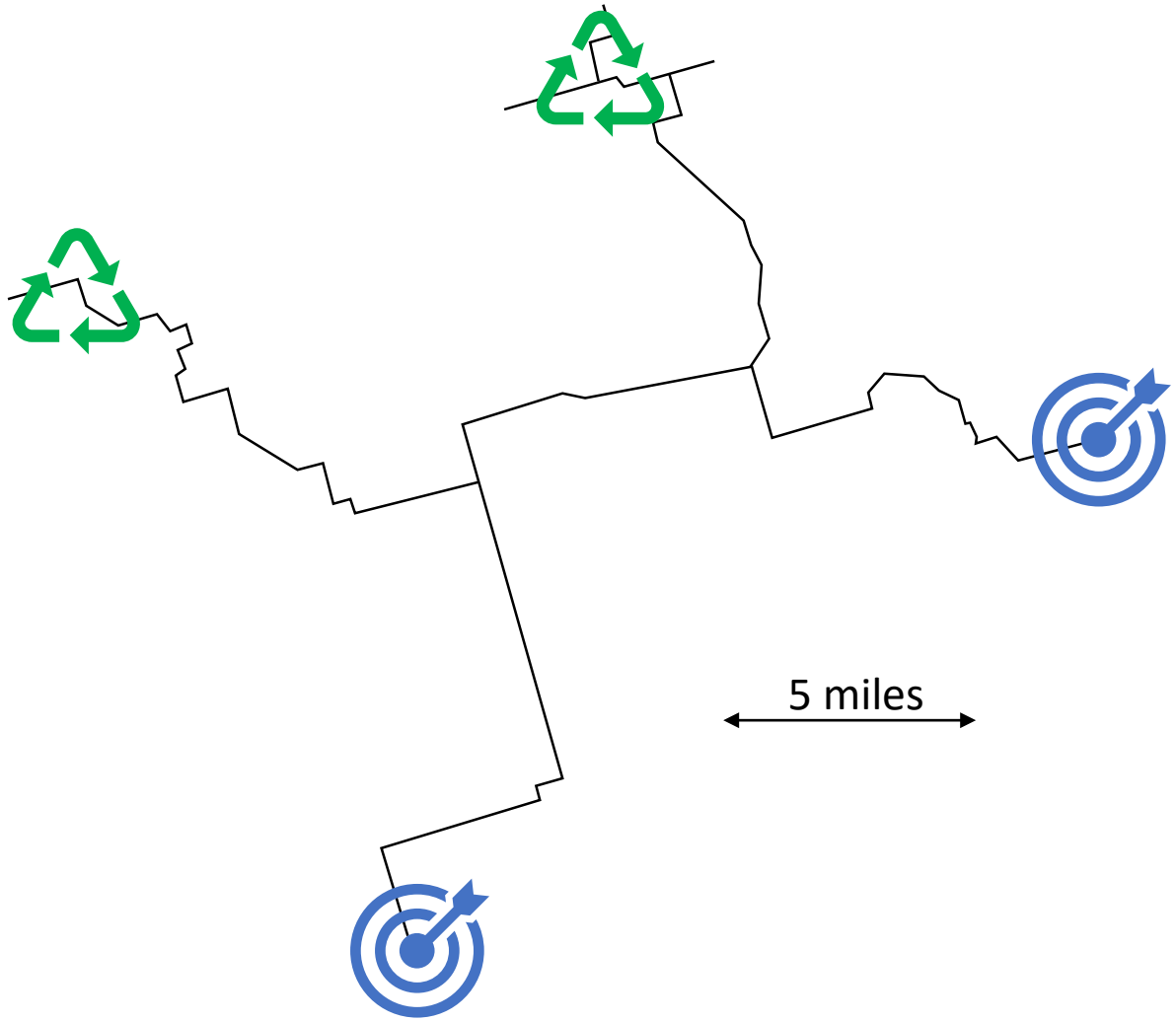
Multi-Party Recycling: Adoption Curve

- Change Y-axis to % of total frac water sourced with recycled water
- < 50% today
- > 50% requires collaboration



Water Exchange Terminals (WET) and Pipeline Connectivity

- Gathering
- Treatment
- Storage
- Connectivity
- Disposal wells as backstop



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Key Performance Indicators from Producers

KPIs from 14 requests for proposals in 2019 from 14 different operators

Turbidity, NTU	Iron, mg/L	Oil, mg/L	Oxidation Reduction Potential, mV	pH Range	
10	1	5	150	5.0	8.0
20	2	5	150	5.5	7.5
20	2	5	200	6.0	8.0
20	5	10	200	6.0	7.5
20	5	40	250	6.0	9.0
25	5	50	250	6.0	8.0
25	5	50	300	6.0	8.0
30	5	100	350	6.5	7.5
30	5			6.5	7.5
30	10			7.0	7.5
30	10				
50	10				
100	10				
	10				

Note: There were also five instances of a request for non-detect for hydrogen sulfide gas.

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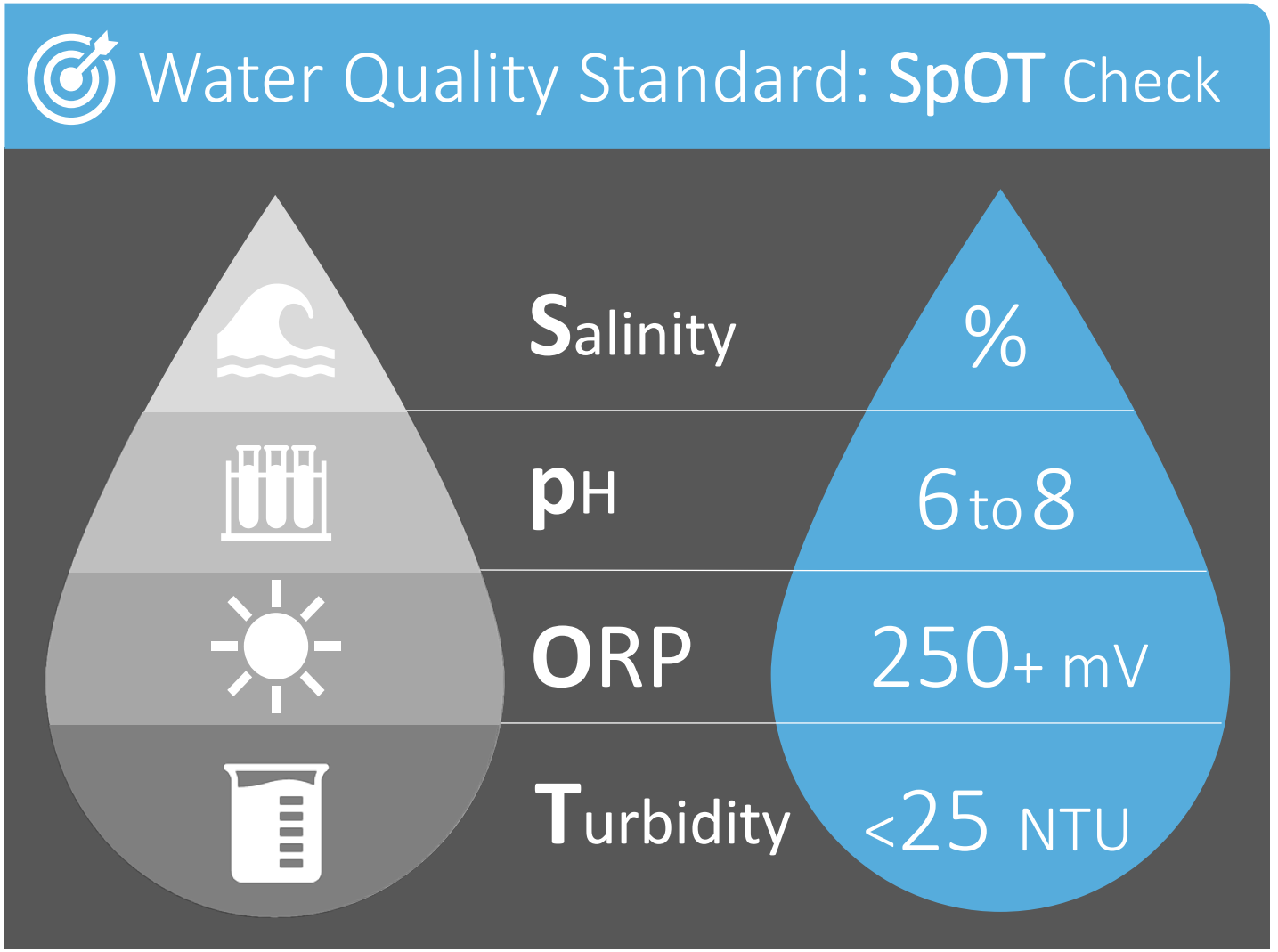
Iron, ORP, and Turbidity

Hourly samples for several months of treatment yielded over 2,000 data points measuring ORP, NTU, and iron on a produced fluid recycling project.

	Turbidity, NTU				
ORP, mV	0 - 25	25 - 50	50 - 75	75 - 100	> 100
> 400	3.5	18.6	22.0	24.1	28.9
350 - 400	2.3	10.1	15.0	25.0	28.1
300 - 350	2.8	12.9	19.2	22.4	28.6
250 - 300	3.7	10.9	9.3	22.4	29.4
200 - 250	5.3	17.3	19.3	19.5	29.4
150 - 200	7.0	15.5	9.7	26.2	29.1
100 - 150	19.1	17.3	26.2	25.7	29.3
50 - 100	14.3	24.3	27.8	27.6	29.2
0 - 50	13.8	26.8	27.8	26.0	28.6
< 0	30.0	30.0	30.0	30.0	30.0

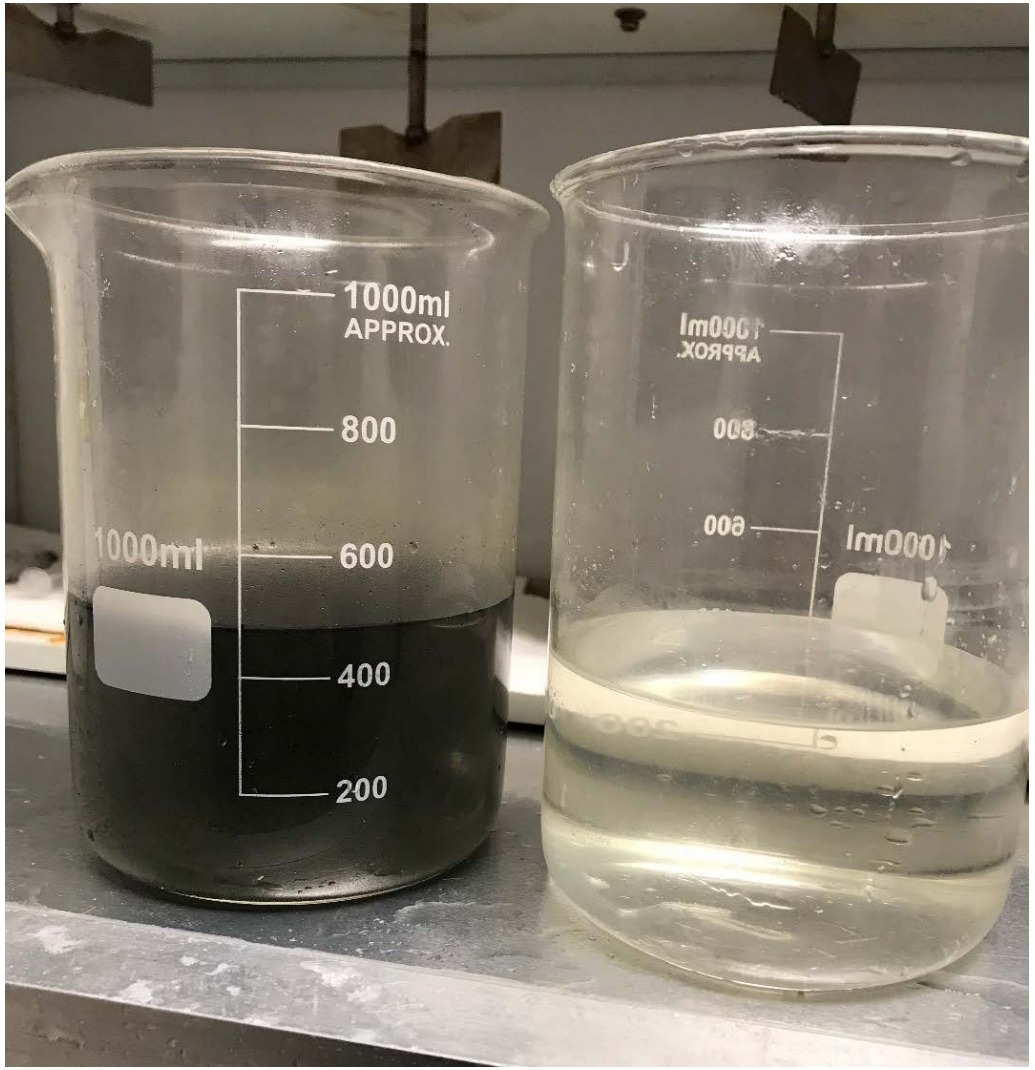
SpOT Check

- All easily measured in field
- Salinity and pH reported
- ORP > 250 mV
- Turbidity < 25 NTU
- Oil inferred from turbidity
- Iron inferred from turbidity and ORP



Untreated / Treated Produced Water

- Picture taken by XRIFQ operator
- Provided in hourly report
- Untreated = 428 NTU
- Treated = 10 NTU



Key Takeaways

- Produced water is a commodity if in **spatial and temporal proximity** to the frac; otherwise, it's a waste.
- **Water Exchange Terminals** connect multiple operators and create economies of scale necessary to drive down operating cost.
- Proposed water quality standard: **SpOT Check**

Thanks!

Aaron D. Horn | XRI Holdings LLC | aaron.horn@xrifq.com