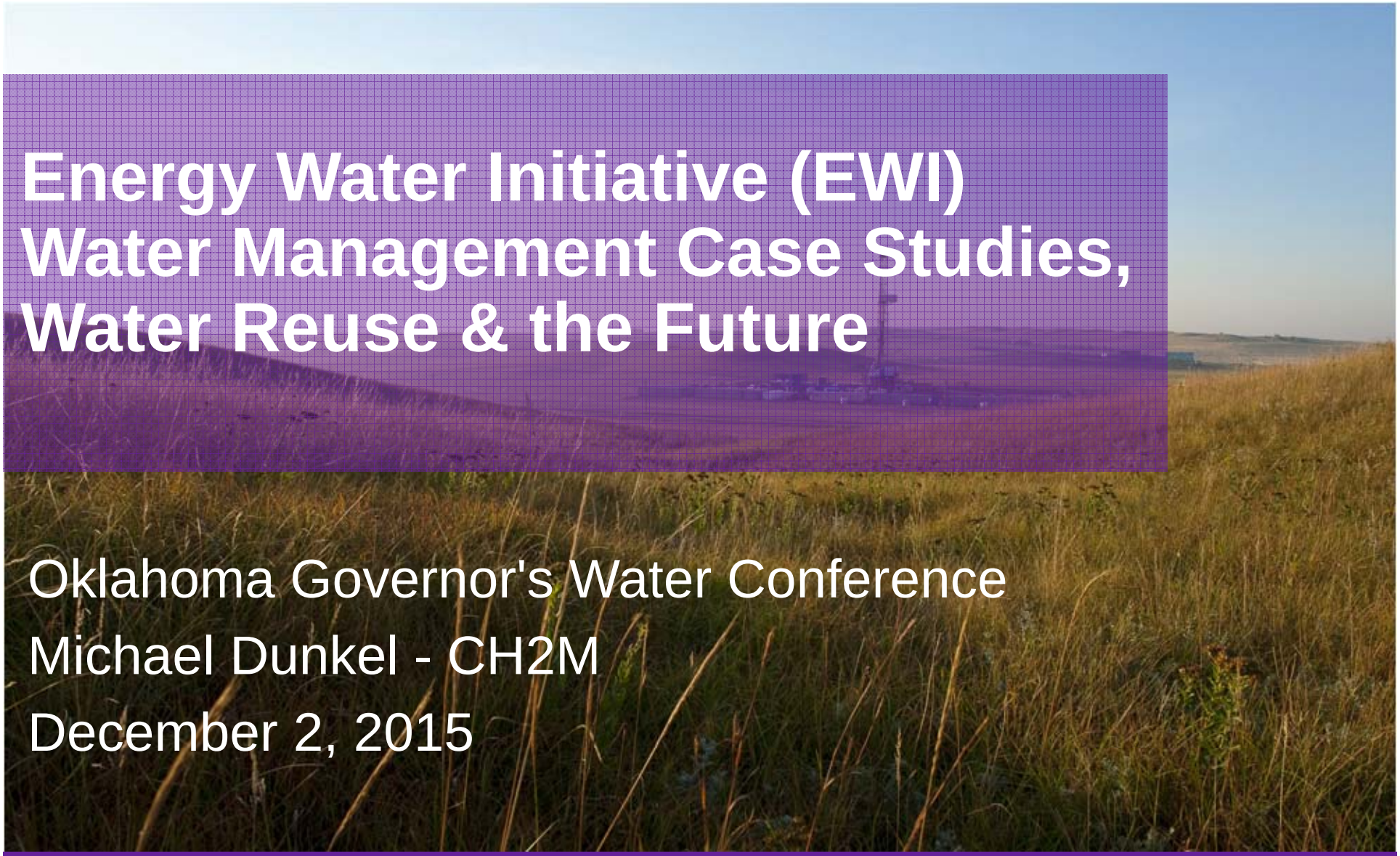


Energy Water Initiative (EWI) Water Management Case Studies, Water Reuse & the Future

Oklahoma Governor's Water Conference

Michael Dunkel - CH2M

December 2, 2015

“Coming together is the Beginning.

Keeping together is Progress.

Working together is SUCCESS.”

- Henry Ford

EWI Case Study Participants

Energy Water Initiative (EWI)

- Collaborative effort among oil and natural gas companies to study, communicate and improve lifecycle water use in onshore Ops

- Recognize the importance of water management and conservation, and the role technology and knowledge-sharing can play in continuous improvement

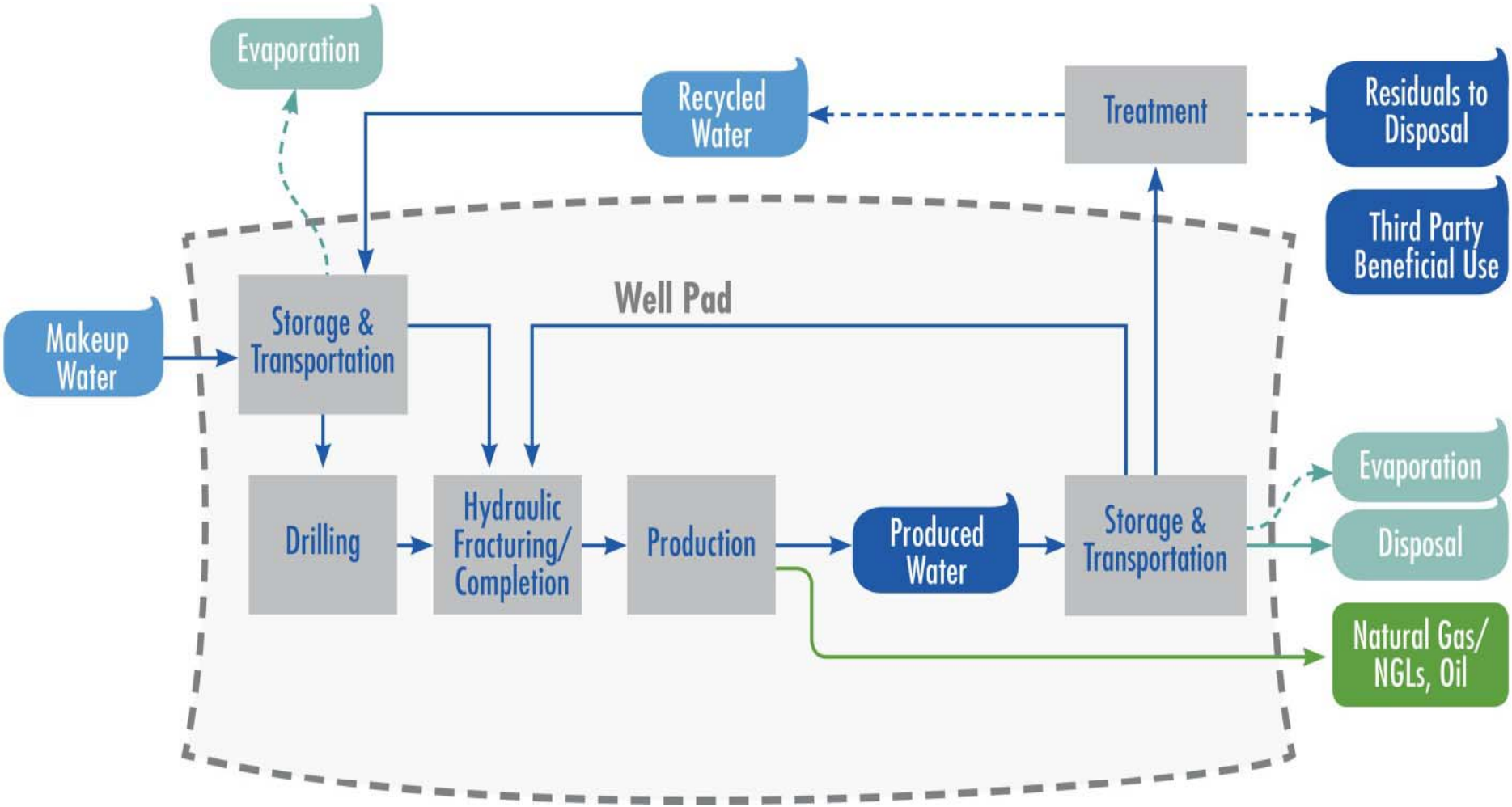
- Develop recommended management practices and technologies to efficiently use and conserve water resources

- Provides fact-based information to regulators, NGOs, and other stakeholders

Case Study Project Objectives

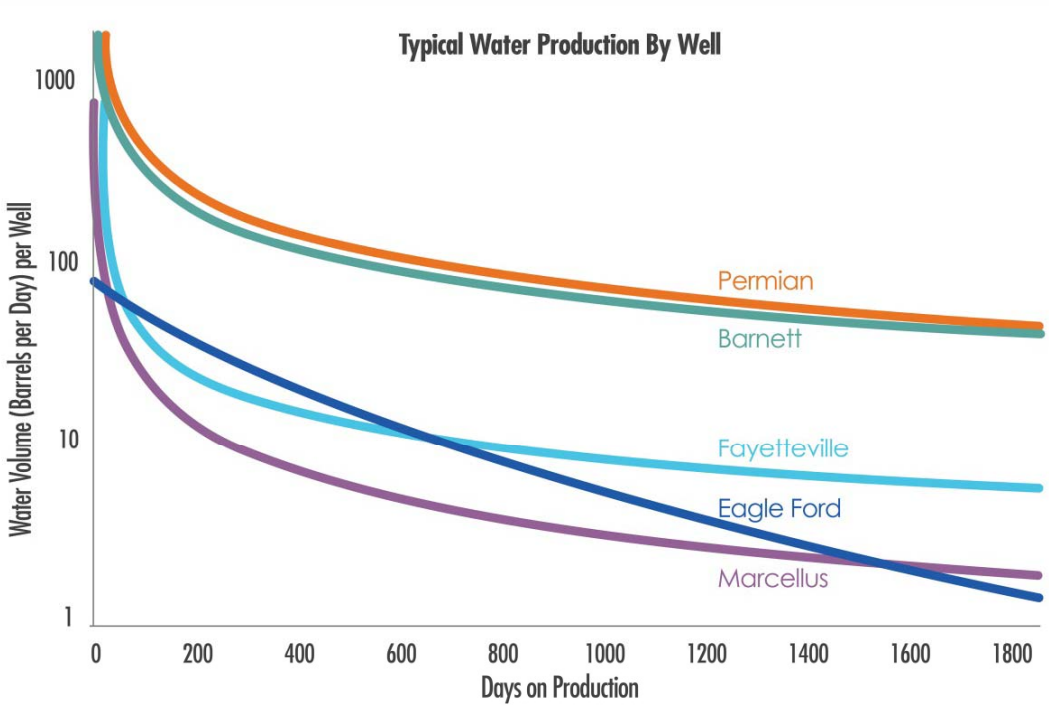
- Illustrate the diverse, regional water resource challenges the industry faces
- Share innovative strategies and lessons learned:
  - Continually evolving water stewardship practices
- Educate stakeholders
- Share advancements in industry

Typical Water Use and Management



Typical Water Production by Well

- Eventually produced water production decline
- Water, oil and gas are separated
- Water is reused or properly disposed of according to regulations



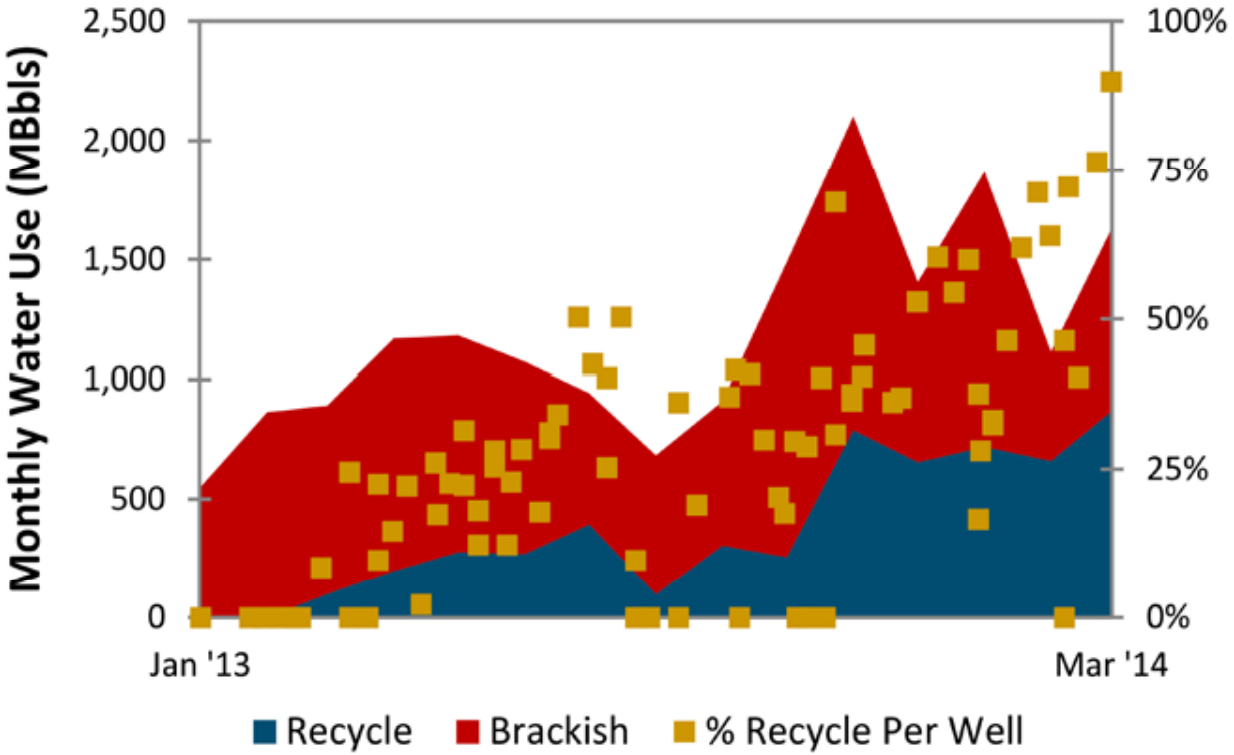
1000 gallons = 31.75 barrels
1000 barrels = 31,500 gallons

Trend 1: Improvement in Chemistry

- Enables industry to use non-freshwater
- Water quality and quantity varies
  - Crosslink: higher quality, less volumes
  - Slickwater: lesser quality, higher volumes

Case Example: Apache

- Apache is conducting slickwater stimulation without fresh water
- Recycling 100% of produced water



Trend 2: Treatment Tech. Innovation

- Increased viability of use of produced water
- Due to technological improvements, operators are better able to use lower quality water
- Treatment of produced water is an option in certain circumstances

Pioneer partnered with a startup company with a new carrier gas extraction (CGE) process that desalinates produced water with less energy and lower operating costs than comparable commercial technology. The first-of-its-kind plant …

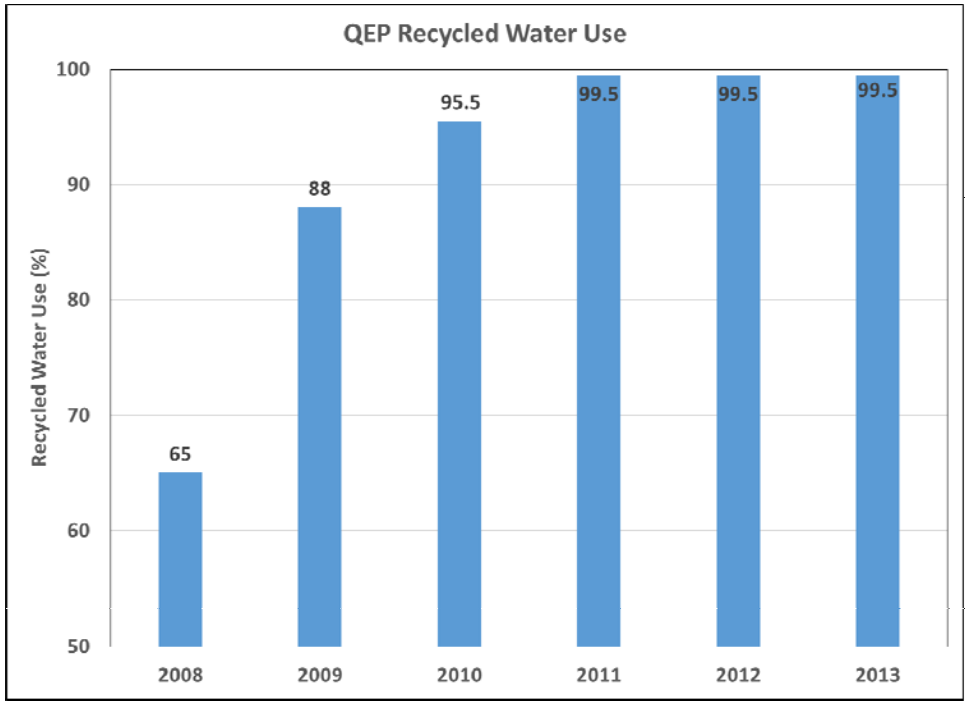
Trend 2: Treatment Tech. Innovation

- Innovations in water treatment applications
- Goal is low cost and environmentally safe
- Limited disposal options: making reuse more viable
- Disposal include:
  - Injection wells
  - Treatment to discharge

Case Example: QEP Recycling

- Liquids gathering system (LGS) facilitates an increased use of water recycling
- The LGS is used by multiple operators and water is treated to different standards depending on necessary requirements
- Recycling water reduces fresh water use and air emissions

QEP Wyoming Green River Basin



Case Example: Newfield Exploration

- Recycling over 98% of all produced water in Utah operations
- Separate treatment facilities for each completion and waterflood operation

Case Example: Southwestern Energy

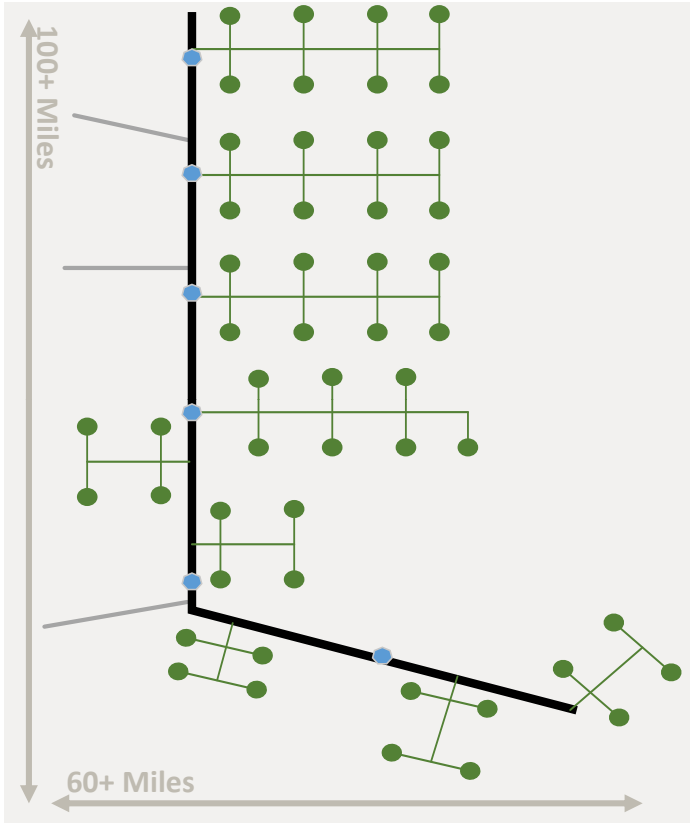
- Developed centralized waste treatment facility
- Achieved near-zero disposal of produced water
- Clean, treated water can either be used for operational needs or discharged via NPDES permit

Trend 3: Water Conveyance Improvements

- Companies are increasingly using pipelines
- Decreasing truck traffic, road impact, and safety issues
- Temporary lines can be used for short term needs
- Systems need to be flexible
- Layflat hose provides compact, large capacity pipe

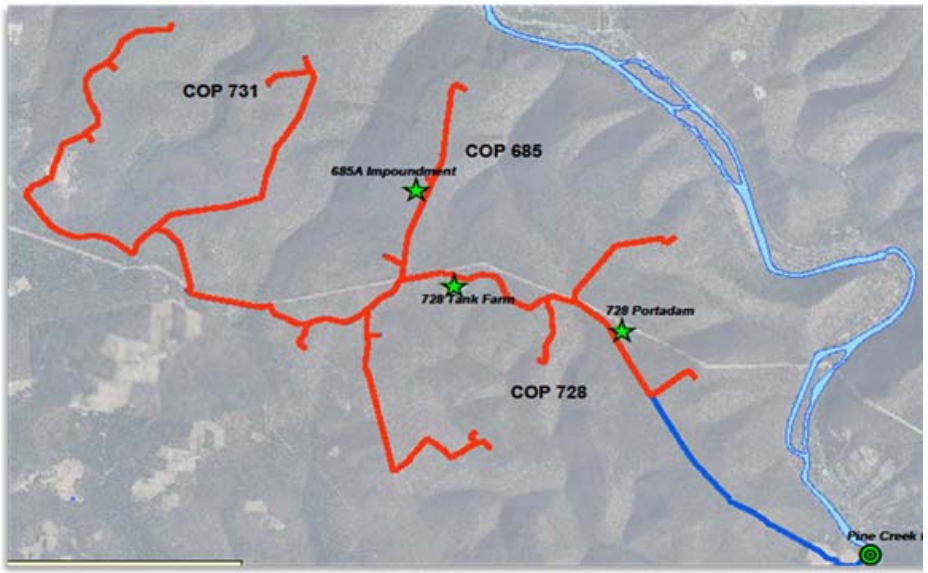
Case Example: Pioneer Natural Res.

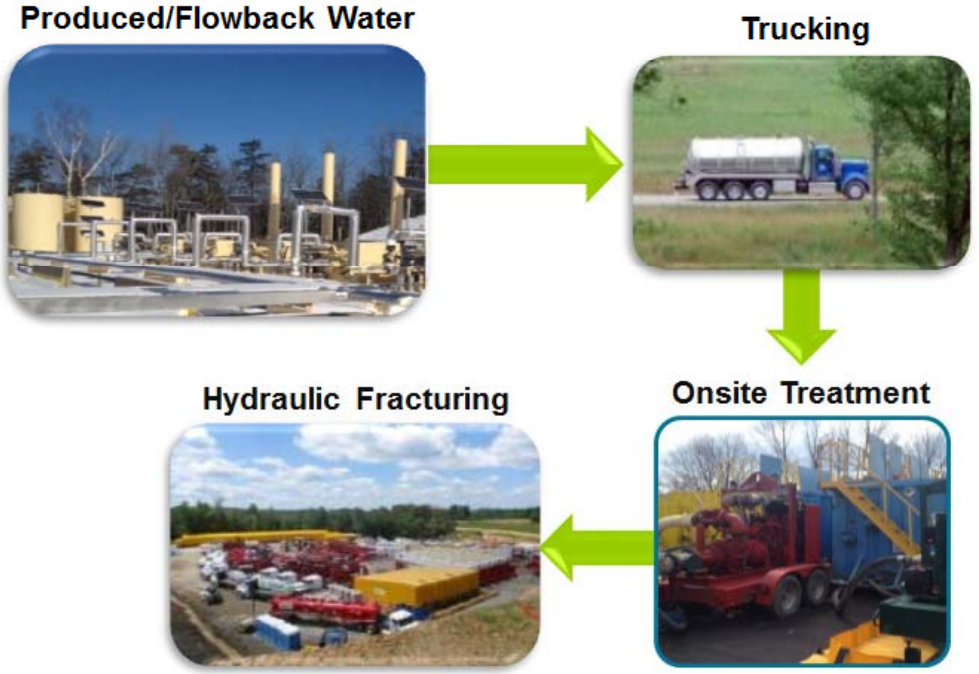
- Construction through 2019
- 20 subsystem networks
- 125+ water storage ponds connected
- Non-fresh source water from Odessa and potentially Midland's effluent water
- $100 million in 2015 on water infrastructure



Case Example: Anadarko Petroleum

- Constructed a pipeline network for water in Marcellus
- Treats flowback and produced water for reuse onsite
- Eliminated more than 80,000 truck trips in 2014





Case Example: BP

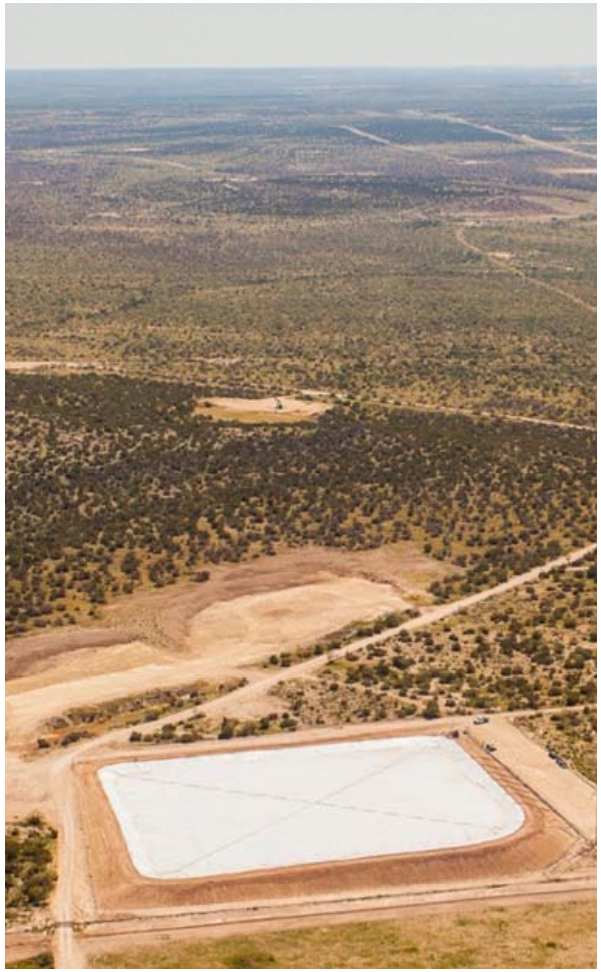
- Co-location production and disposal facilities reduce truck traffic by 14,810 trips in 2013

Trend 4: New Water Storage Designs

- Steel fracturing tanks and in ground, modular, lined, and monitored impoundments used to store water
- New designs provide flexibility for quantity stored
- Type of storage unit can be influenced by surface owner, regulations and topography

Trend 4: New Water Storage Designs

- Regulations and industry practices prevent leaks, protect groundwater, and safeguard the environment
- Advances in the design of large storage systems address variables such as slopes, soil composition, moisture control, dual liners, sump, liner thickness, covers and monitoring wells

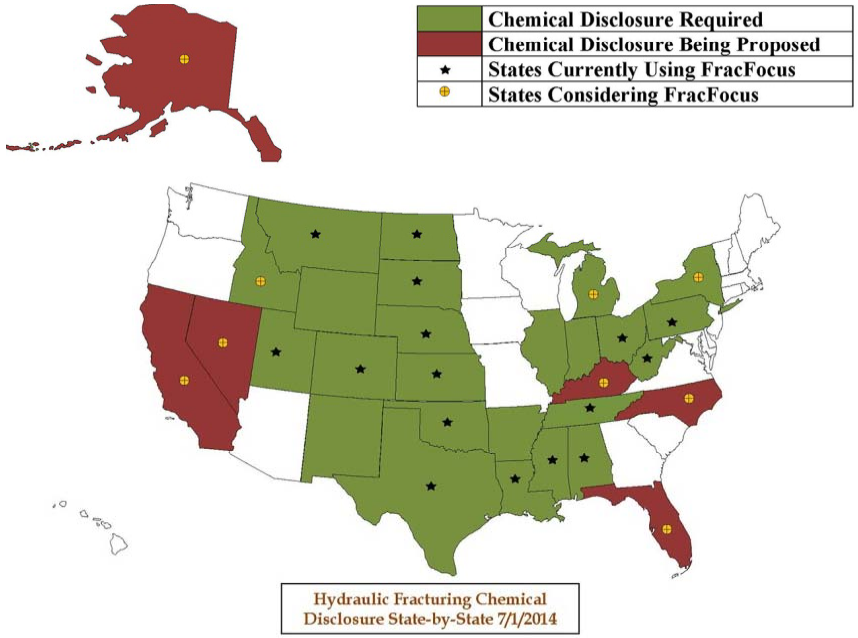


Case Example: Devon Energy

- Store brackish water in in-ground impoundments
- Constructed with felt and 40-mil HDPE liners
- Equipped with water level transducers connected to SCADA system

Trend 5: Transparency with Stakeholders

- Increased data gathering and public disclosure
- EWI is an example of industry collaboration
- FracFocus is a national registry managed by Ground Water Protection Council (GWPC)
- 85,000 disclosures to FracFocus (2011-2014)



Trend 6: Dedicated Water Staff

- Dedicated teams to facilitate water management
  - Separate entity (LLC)
  - Corp. experts
  - Asset-based water teams

- Improve water management planning, technical support, and performance
- Companies are centralizing lessons learned, establishing standards, identify subject matter experts

“Coming together is the Beginning.

Keeping together is Progress.

Working together is SUCCESS.”

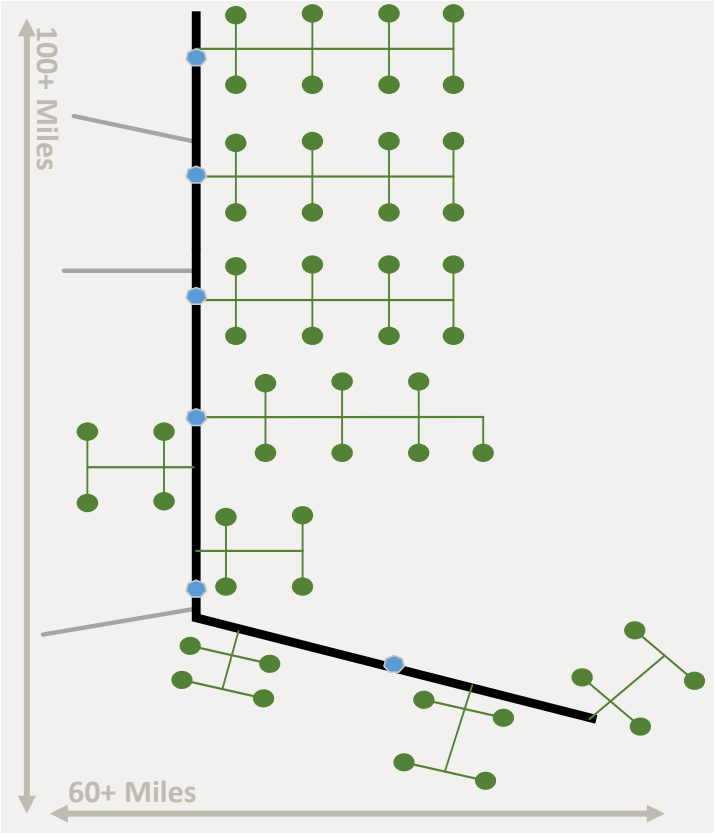
- Henry Ford

Six Trends for Progressive Water Management

- Improved Chemistry
- Treatment Technology Innovations
- Water Conveyance Improvements
- New Water Storage Designs
- Transparency with Stakeholders
- Dedicated Water Staff

Future: Water Infrastructure Reduces Costs & Promotes Reuse

- Trucking can be a large component in water costs
- Pipelines and storage can reduce trucking
- Infrastructure allows more volume processing and lower treatment costs for reuse



Challenges of Water Infrastructure

- Changing rig schedules and strategic plans
- Costs are front loaded
- Fractionated ownership of mineral interests
- Right-of-way access
- Medium to longer term time horizon required
- Not the traditional “core business” for oil companies

Benefits to Everyone

- Lower costs
- Easier to recycle and have multiple water supply options
- Lower community impacts
  - Fewer trucks on the road
  - Easier to substitute brackish for fresh water

Thank You