Water Reuse and Recycling in the Oil and Gas Industry: Devon's Water Management Success

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Presentation Agenda

- Introduction
- Devon's Water Management Success
  - North America
  - Barnett Operations
  - Treatment Technology
- Devon's Water Management Future
  - Cana-Woodford
  - Permian Basin
- Summary and Conclusions

Introduction

North American Shale Plays

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

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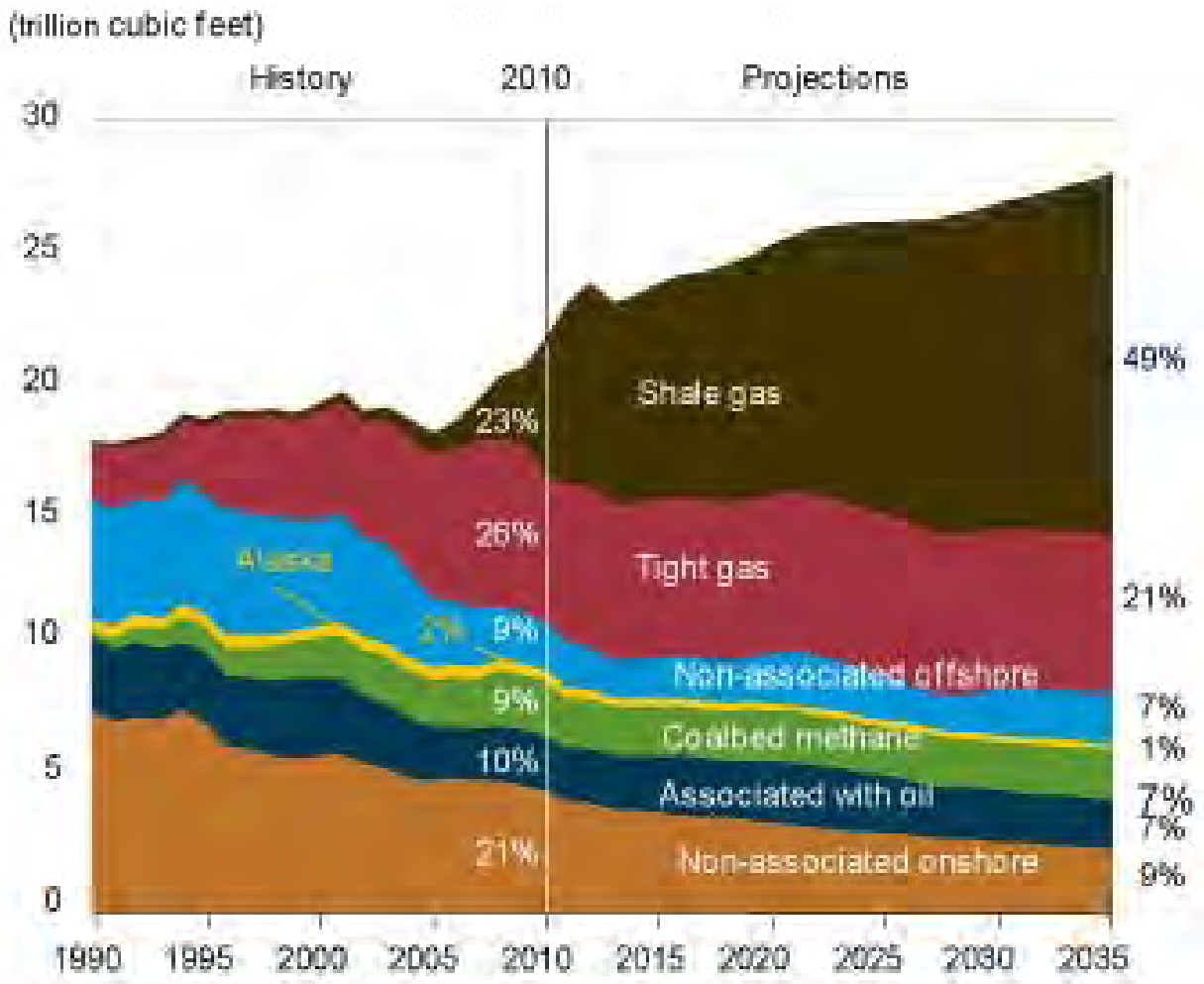
Historic and Future Gas Supplies

From U.S. Energy Information Administration | Annual Energy Outlook 2012



Devon Energy Production Company

Devon Energy is a leading independent energy company engaged in the exploration, development and production of natural gas and oil.

The company's operations are concentrated in various North American onshore areas from the Canadian arctic to the U.S. Gulf Coast.

Devon holds interests in nearly 13 million onshore acres including over 662,000 net acres in the Barnett Shale. Devon has drilled nearly 5,000 wells into the Barnett Shale since 2002 and has about 7,500 remaining drilling locations.

Devon is committed to water conservation and reuse where feasible

Devon's Water Principles

- Educating and working closely with governmental authorities, communities, businesses and members of the public concerning water usage needs and the necessity of water management
- Identifying usage needs, determining resource availability and monitoring water use
- Applying conservation practices and identifying opportunities to improve water use efficiency
- Supporting research to develop fresh water minimization practices for operations
- Employing economically and operationally feasible alternatives to fresh water usage
- Advocating for appropriate regulations on water use and reuse
- Continuing to employ prudent operating practices to ensure the protection of surface and groundwater
- Planning for operations to continue if water availability becomes constrained

Drivers for Strategic Water Management and Recycling

Traditional water supply approach:

- Satisfies near-term requirements
- Is operations driven

There are emerging risks:

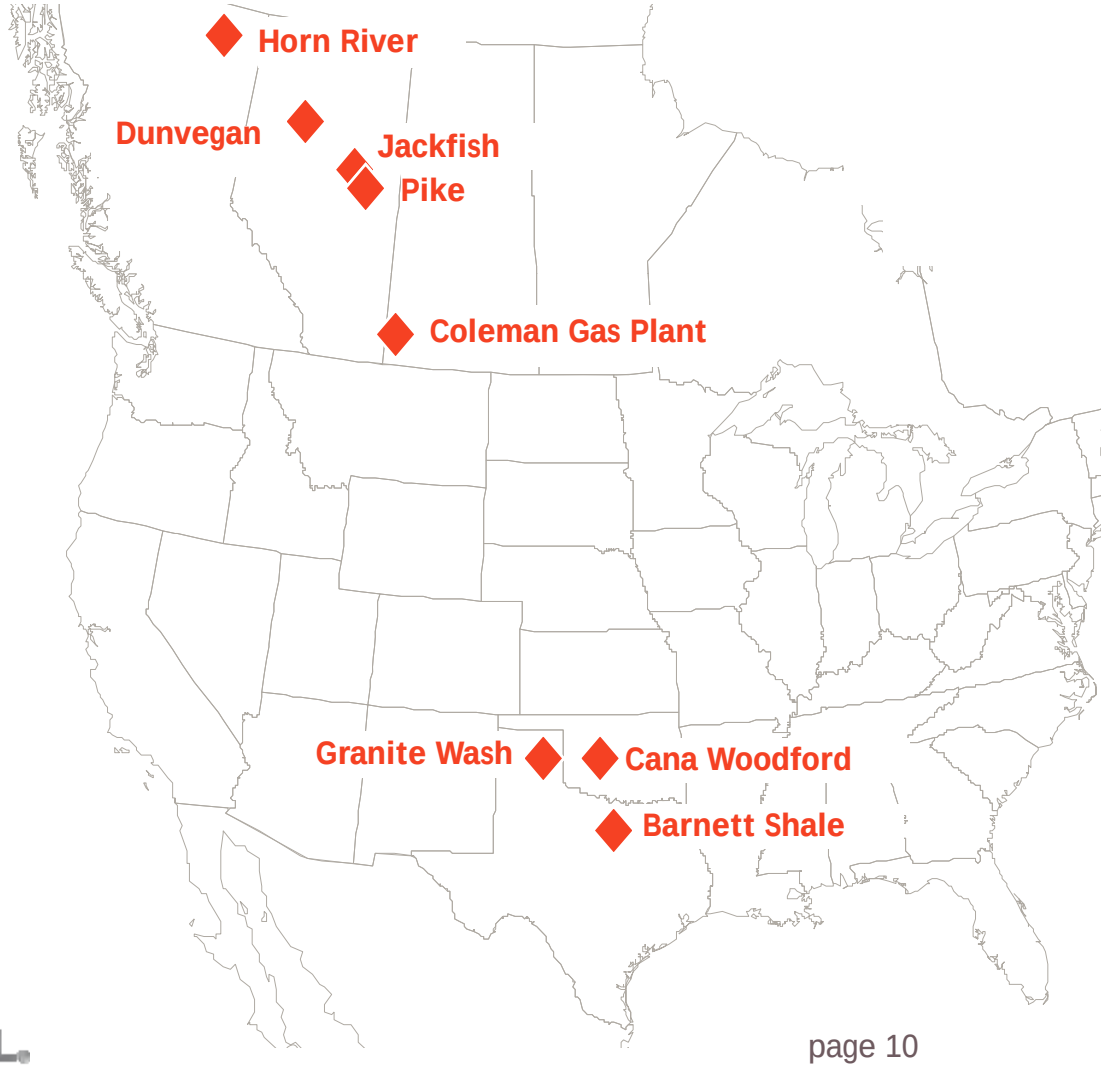
- Increasing demand
- Increasing stakeholder interests
- Permitting uncertainty
- Increasing competition for supplies

Potential Outcome

- Supply interruption
- Increasing costs
- Schedule delays

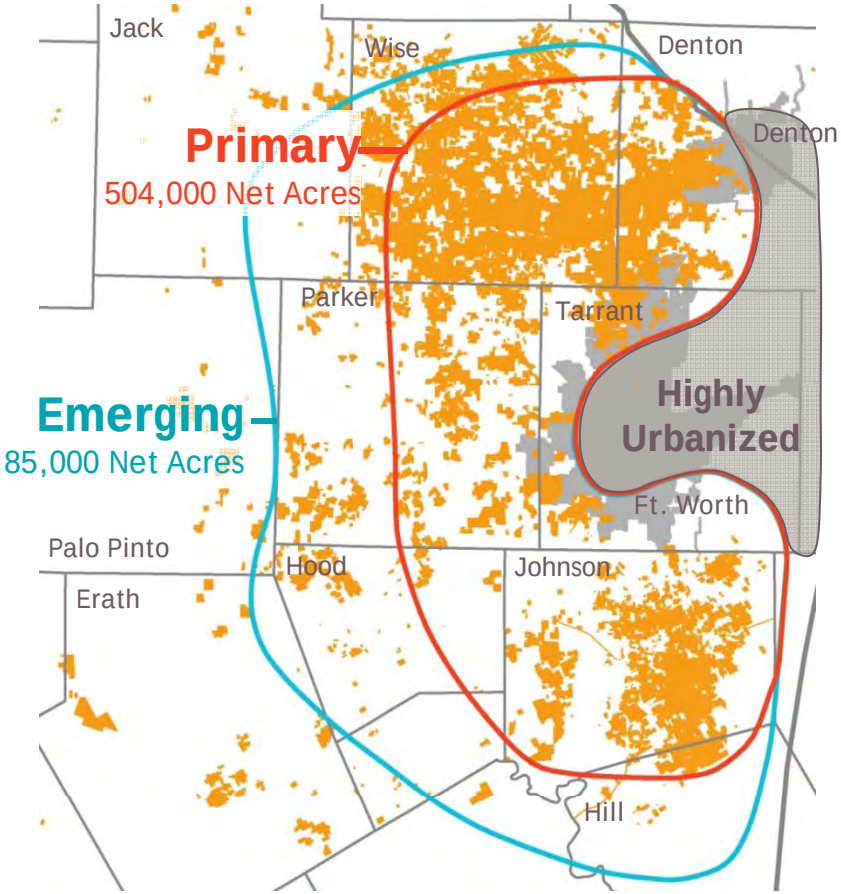
Devon’s Water Management Implemented Successes

Water Recycling/Reuse Operations



Devon in the Barnett Shale

Devon's Position



Devon Completions

Year	Wells
2006	314
2007	469
2008	584
2009	298
2010	420
2011	310

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Barnett Water Requirements Drilling

Each Barnett Shale well requires about 6,000 barrels (252,000 gallons) of freshwater for the drilling process.

This represents about 6% of the total water use per well.

This water is mixed with bentonite clay to create the "drilling mud."

Some of the drilling mud may be reused multiple times.

Barnett Water Requirements Completions

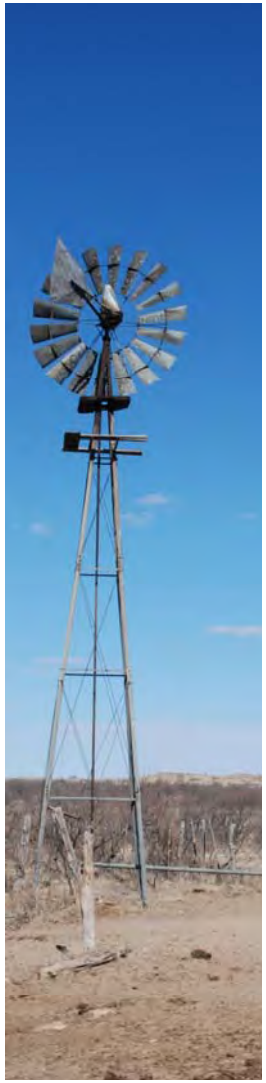
- Typically 6-10 stages for horizontal Barnett Shale wells
- Approximately 4 million gallons of freshwater required per well
- Represents 94% of the total water requirement for a Barnett Shale well

Devon's 2010 Water Use in the Barnett Shale

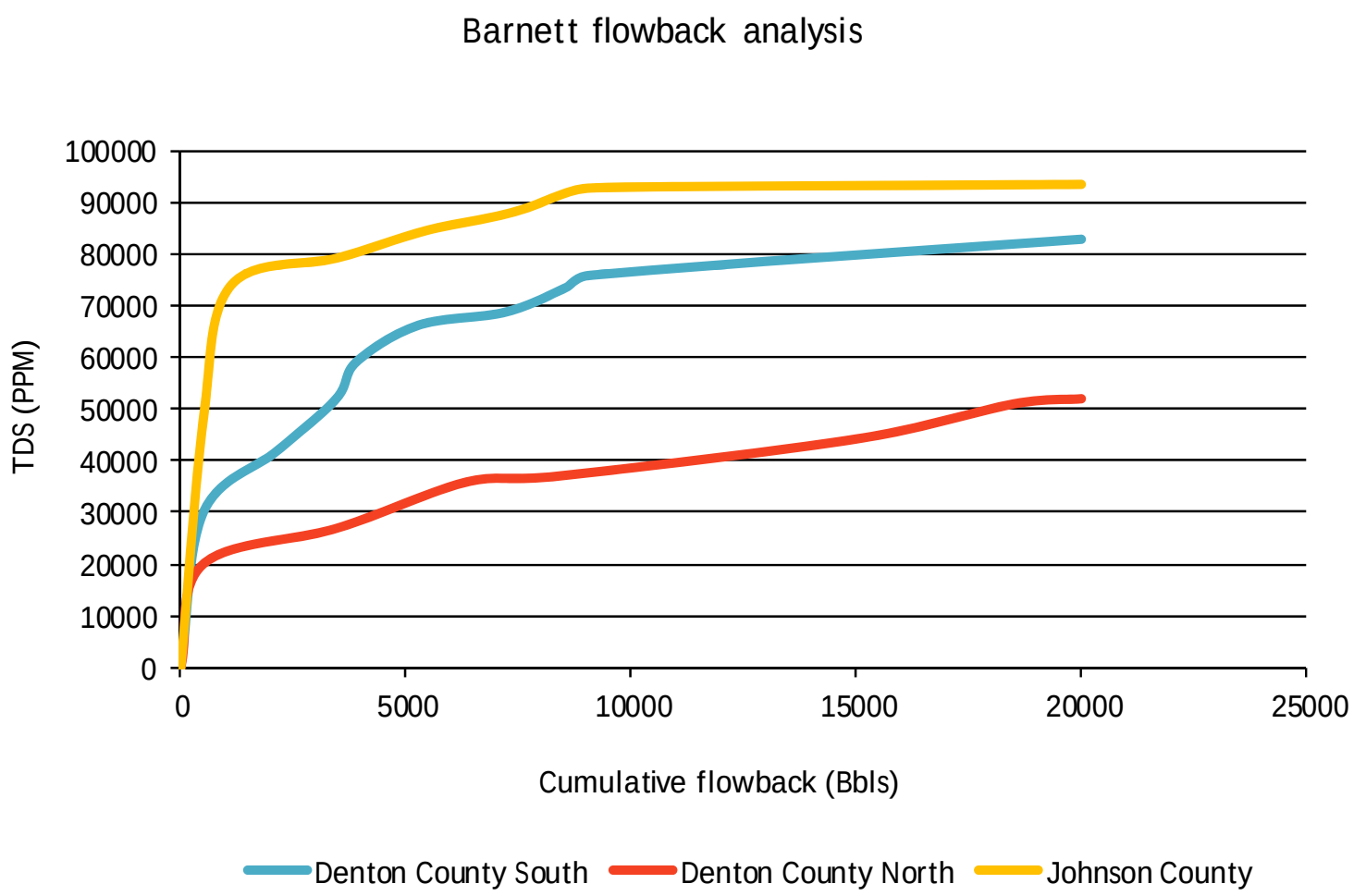
Completion requirements	
Horizontal wells fractured (420)	41.3 Million Bbls
Vertical wells refractured (150)	4.5 Million Bbls
Total	45.8 Million Bbls
Sources	
Surface water	11.5 Million Bbls
Groundwater	32.3 Million Bbls
Recycle water	2.0 Million Bbls

Water Management Considerations

- Water Supply
  - Regulatory constraints
  - Physical limitations
- Wastewater Disposal
  - Regulatory constraints
  - Salt water disposal wells
- Reuse and Recycling
  - Flowback water quality challenges
  - Required water quality for fluid performance
- Transport and Storage
  - Regulatory constraints
  - Logistics and cost



Flowback Water Quality



Pre-Treatment Goal – Clean Saltwater

Critical for High Efficiency Operations

Chemical Precipitation

Removes

- Frac polymer
- Suspended solids
- Targeted parameters

Rover

- Mobile version
- 10,000 bbl/day
- 292 gpm

Final Treatment Goal – Fresh Water

NOMAD - Railroad Commission Approval in 2005

Vaporizes flowback water and condenses it - clean, distilled water

Remaining concentrate removed for disposal or utilized for as “kill fluid”

2,500 Bpd flowback capacity – approx. 2,000 Bpd of freshwater generated

Devon Recycling Facility

Freshwater storage and completion activity

Water Recycling Results

- 22,500 bbls per day at peak
- 13.9 million barrels processed (584 million gallons)
- 10.8 million barrels of distilled water generated (454 million gallons)
- 100+ wells fracked with recycled water

Recycling statistics (1/11):

- Feed water
  305,415 Bbls
- Freshwater produced
  213,547 Bbls
- Concentrate produced
  91,868 Bbls

Devon’s Water Management Future

Opportunities for Water Re-Use

Cana-Woodford Shale

Exceptional produced water quality in the Cana Woodford Shale

- Very low total dissolved solids (TDS)
- Early stages of produced water quality is approximately 12,000 TDS
- Later stages of produced water quality is approximately 20,000 TDS
- Potential exists to reuse these fluids, thus reducing the demand for fresh water

Current quantities available for re-use:

- 26,000 barrels per day of produced fluid from 196 wells
- Approximately 1.1 MGD

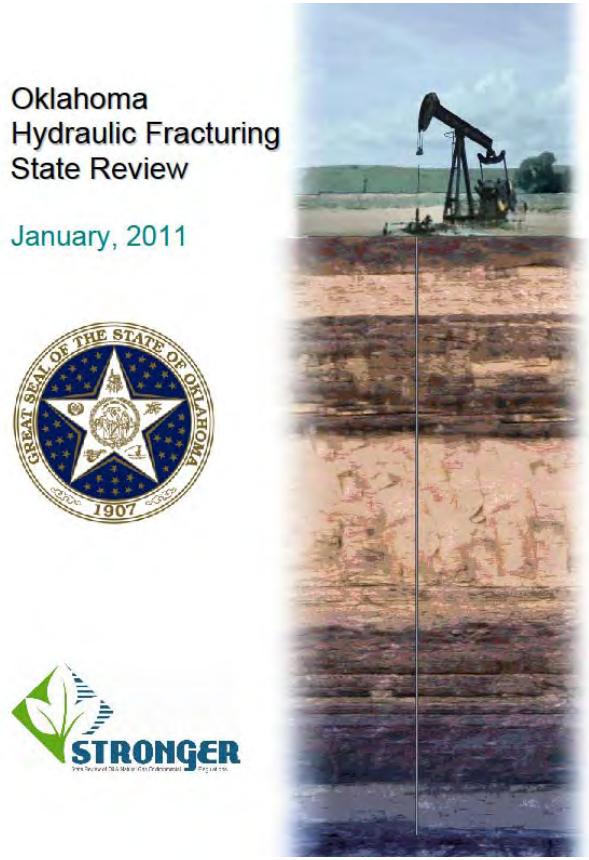
Developing a New Pit Rule

for produced water

With the development of the Cana-Woodford Shale, Oklahoma regulators and Devon recognized the use of larger pits to store produced waters from the flowback process

Earlier regulations allowed only for temporary storage

New revised regulations include enhanced construction and design requirements and permitting options



Water Re-Use Facility

Settling pond, Cana-Woodford

SWD well/injection pumps disposal capacity of 30,000 bpd @ 1500 psi

Truck unloading station with above-ground settling tank capacity of 6,000 barrels (bbls)

Fully automated with level alarms, meters for allocation, and chloride level

Currently taking 20,000 bpd from infill well produced water

Plan to recycle 4MM bbls in 2012

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Water Re-Use Facility

Storage Pond, Cana-Woodford

575’ x 575’ = approx. 7.5 Acres

Depth 12’

502,000 BBL Capacity (21 Million Gallons) plus 2’ Freeboard

60 Mil High Density Polyethylene Liner

Leak Detection System

Automated Monitoring:

- Level indication
- Chloride concentration

Water Re-Use Pipeline

Cana-Woodford

12”, 10”, and 8” Star fiberglass pipe, rating 450 psi @ 200 degrees (infill Flowback temp 175 deg F)

Will handle 30,000 bpd flowback rate for all 30 sections

Can deliver 70+BPM to 10 infill sections for stimulation

Capable of delivering 30-70 BPM to remaining 20 infill sections for stimulation

Flowed 150,000 BBLS in last 2 weeks from Brooks wells

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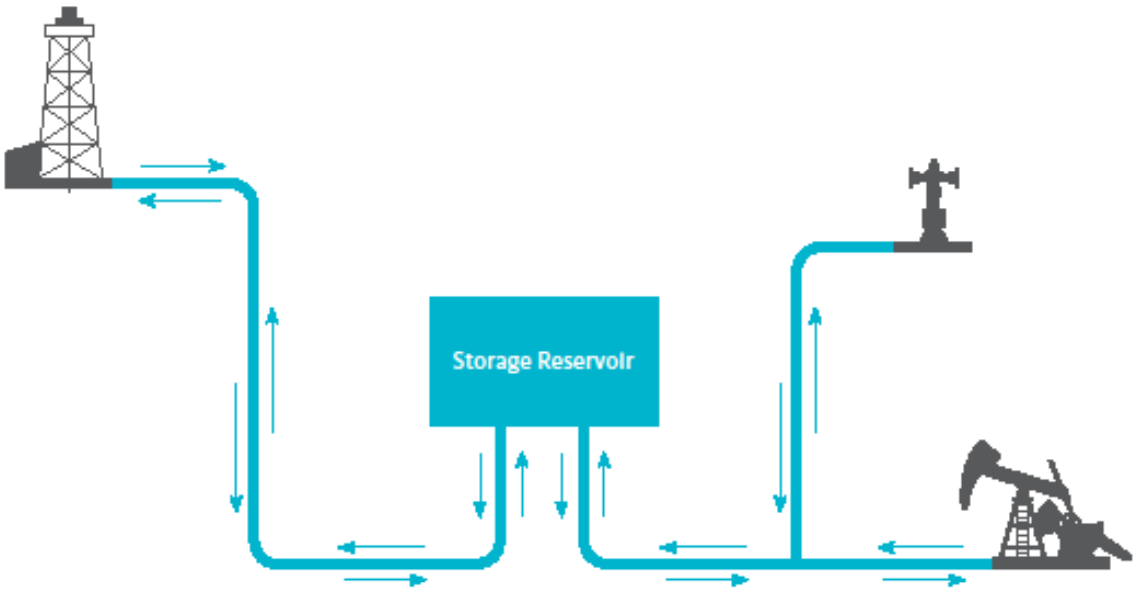
Cana-Woodford Re-Use Facility

Summary

A disposal well is located next to the re-use facility to handle excess water

Pipelines to handle 30,000 bpd will soon connect to 30 sections.

Result: re-use water will contribute to completion of 270 wells



Permian Basin Planning Projects

Project Objective: Establish costs and constraints related to implementation of alternate supplies

Geography: Eastern New Mexico and West Texas

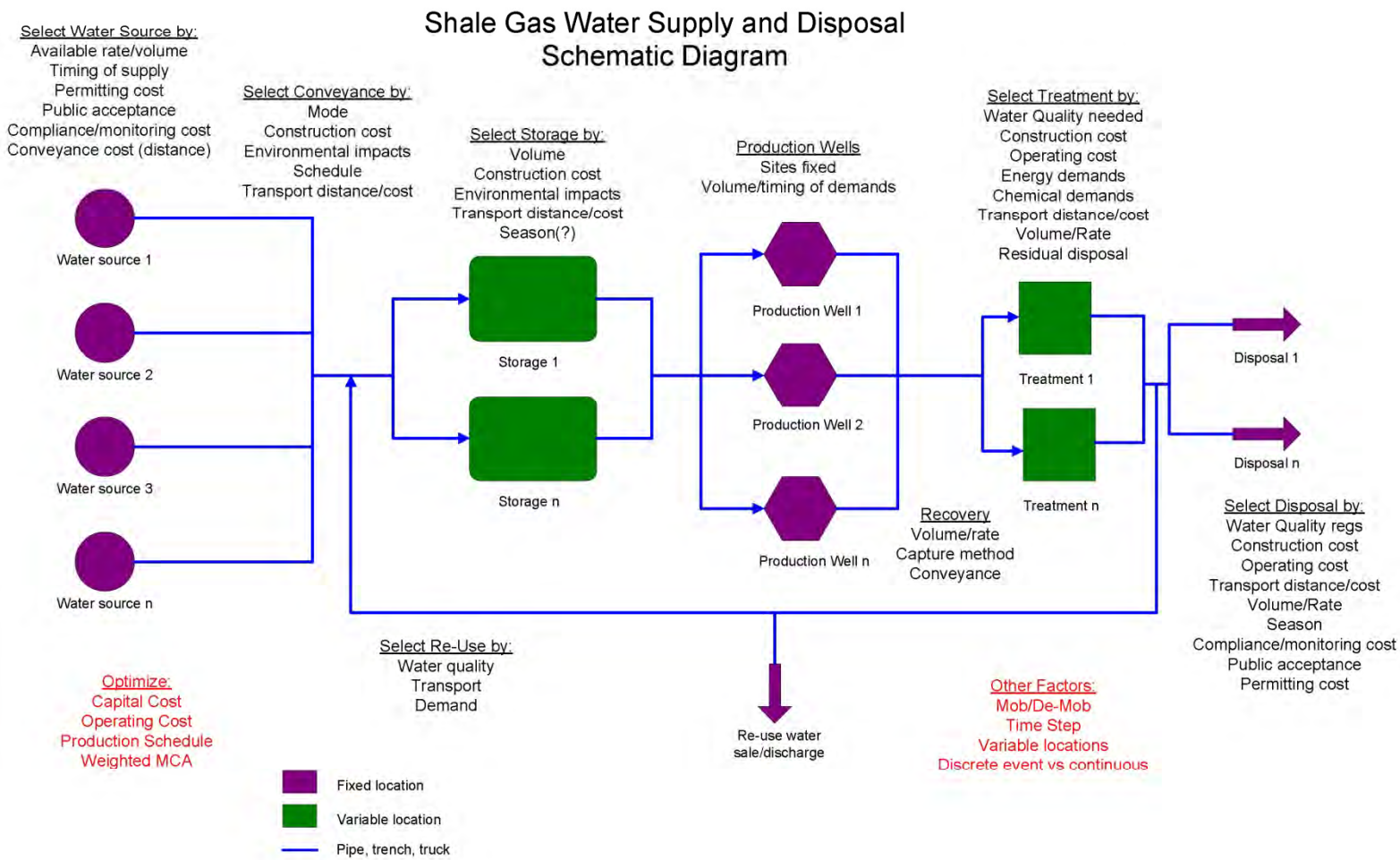
Scope:

- Project water demand
- Evaluate water source options
- Near-term (1 year) plans
- Long-term (20-year) plans

Challenges:

- New Area (TX)
- Regulatory Changes (NM)
- Need for flexible drilling plans
- Still developing supply and disposal locations and costs

Voyage Tool – Complex Evaluations to Reduce Risk



Summary and Conclusions

Effective water management is important to operational success

Challenges include economic and regulatory uncertainty

Devon is committed to water conservation and reuse where feasible

Devon has been recycling water in the Barnett Shale since 2005, greatly reducing its fresh water demand

Devon is proactively developing tools, testing technology, and working with regulators to maximize its water efficiency now and in the future.

Thank You.

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