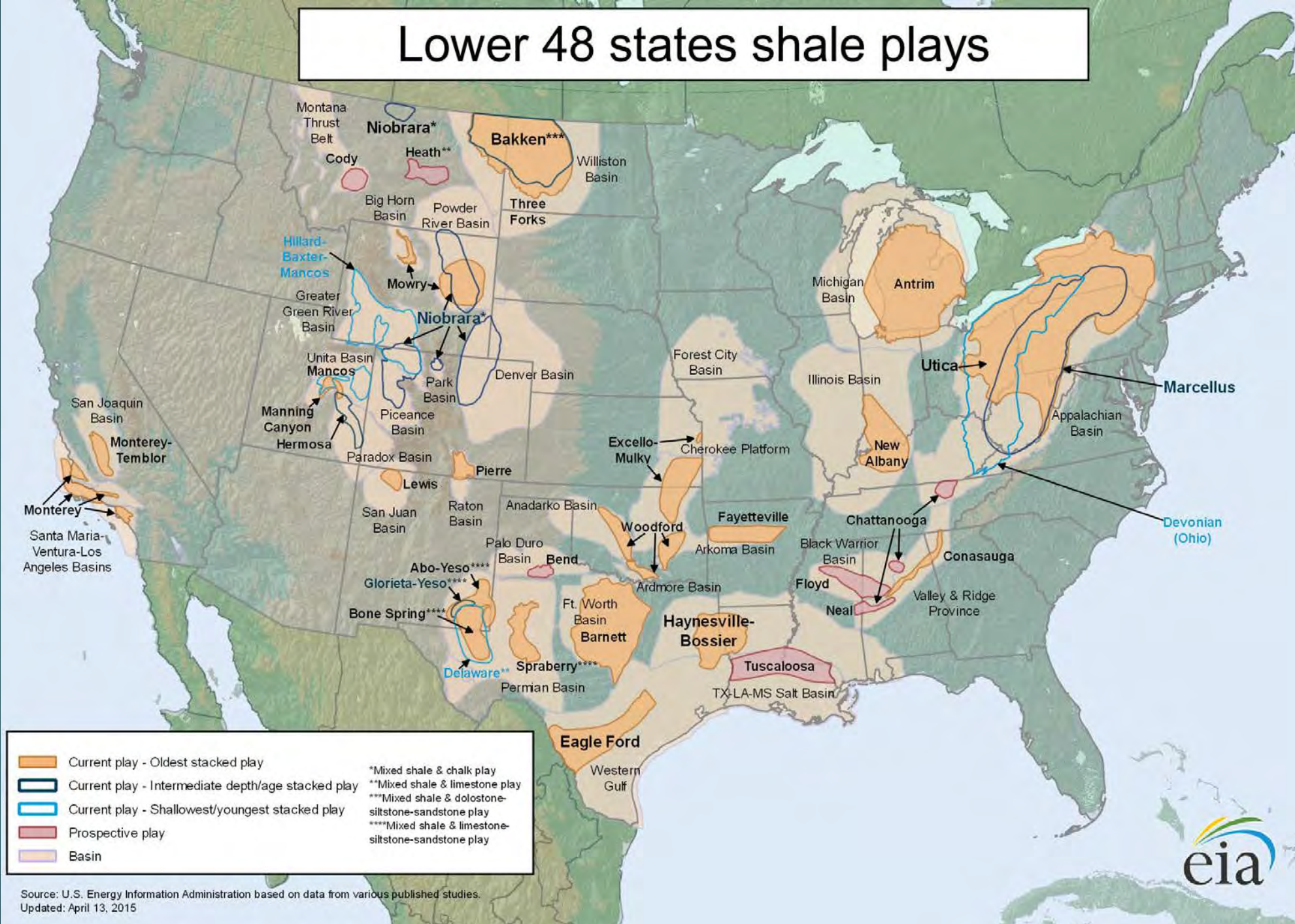




Water Issues In The Oil & Gas Industry

NEW MEXICO STATE LAND OFFICE

Lower 48 states shale plays

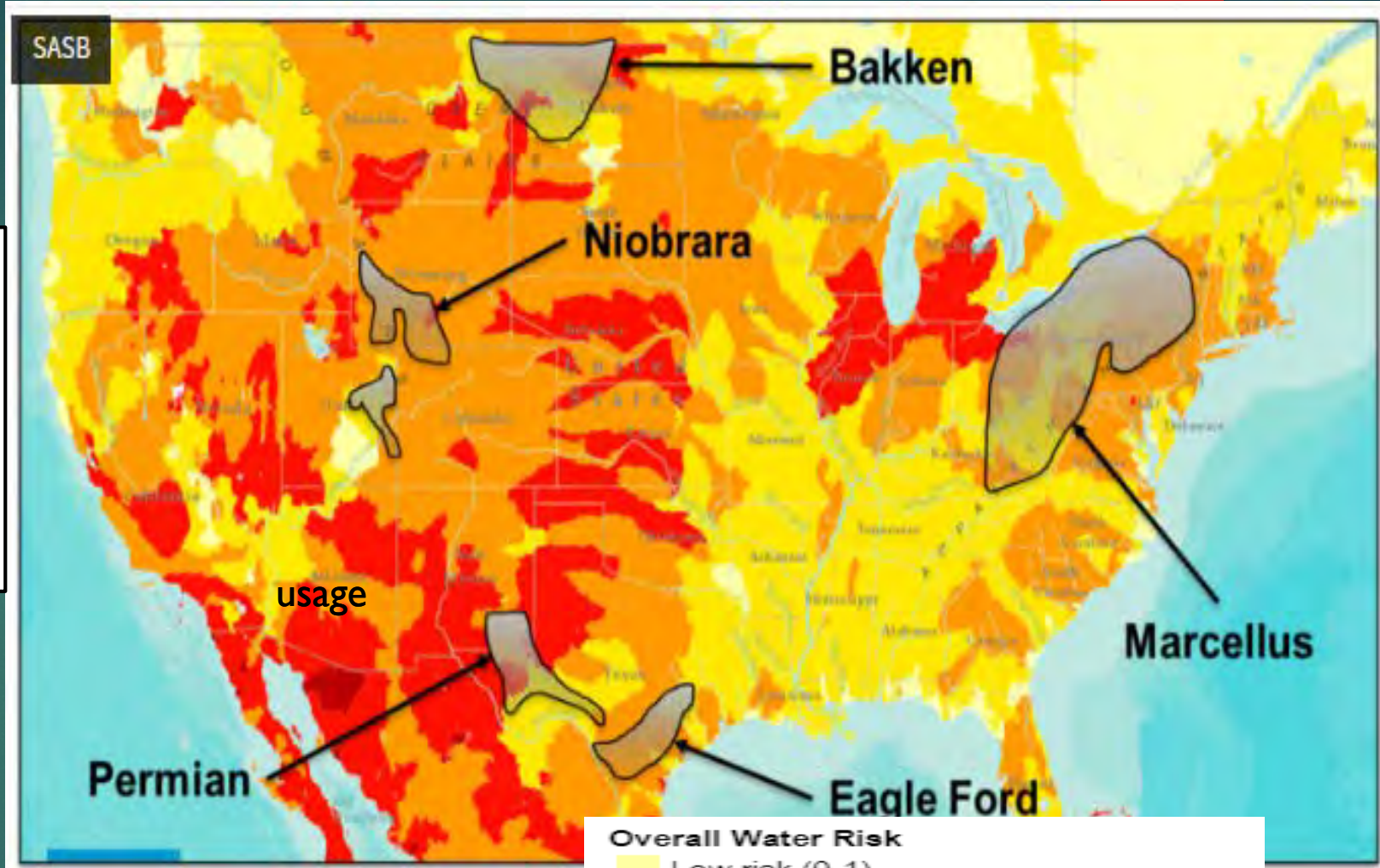


Source: U.S. Energy Information Administration based on data from various published studies.
Updated: April 13, 2015



- Risk/stress varies by region
- Marcellus
 - Low
- Bakken
 - Low to medium high
- Permian
 - Medium to high/very high

“Investors should consider a key nuance with respect to water usage – specifically, water withdrawals from high water-risk areas.”



Overall Water Risk

- Low risk (0-1)
- Low to medium risk (1-2)
- Medium to high risk (2-3)
- High risk (3-4)
- Extremely high risk (4-5)
- No Data

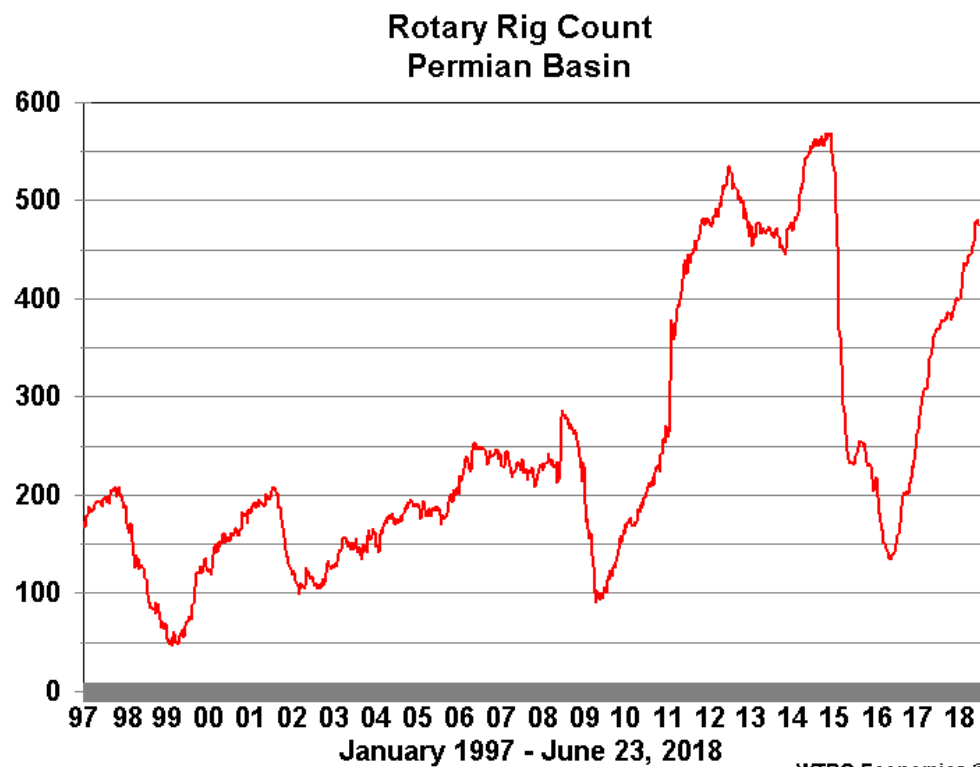
Definition

Overall water risk identifies areas with higher exposure to water-related risks and is an aggregated measure of all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories.

“While total water usage for hydraulic fracturing is relatively low, localized use in water-stressed areas may present a significant, material risk for investors in companies that have committed to these regions.”

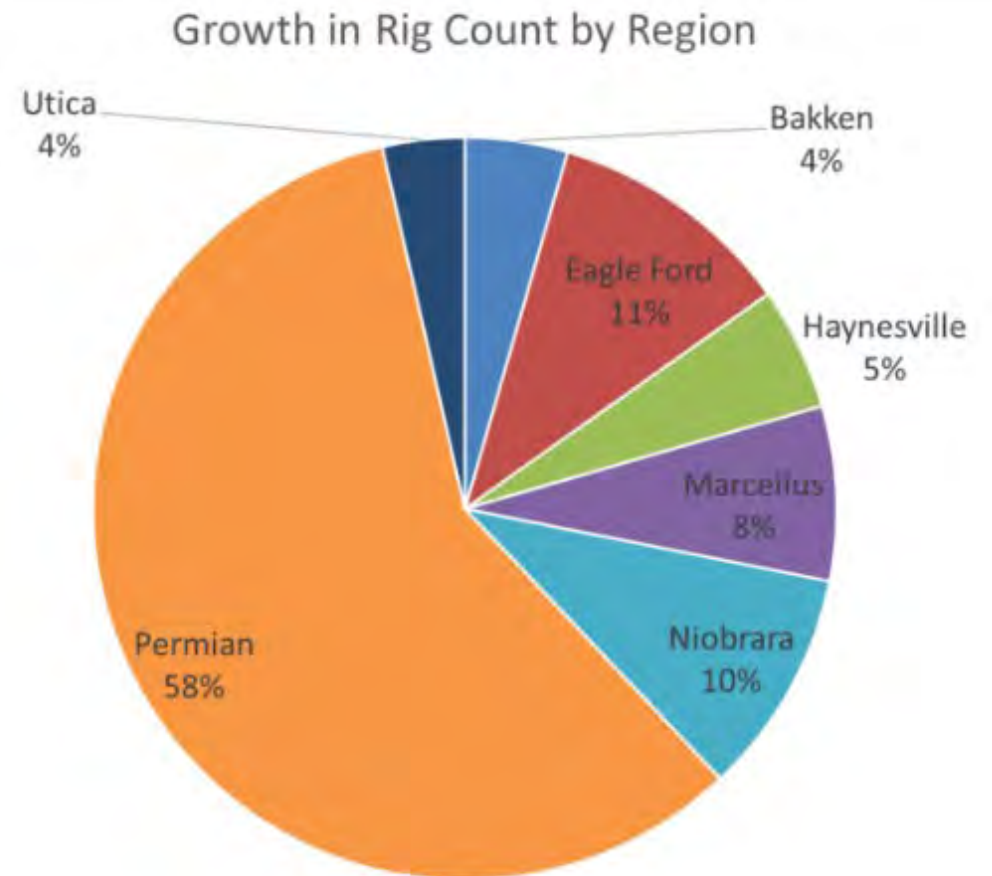
The Permian

- ▶ World's most strategically important oil producing region
- ▶ Oil Production: 6MMBD by 2025
 - ▶ $\approx$ 6% of global oil production
 - ▶ $\approx$ 40% of U.S. oil production
 - ▶ $\approx$ 12% compounded annual growth in NM Permian production 2018 to 2025
- ▶ Gas production: >15 bcf/d by 2025
- ▶ NGL production: $\approx$ 2.5MMBD by 2025



Source: Baker Hughes, WTRG Economics

WTRG Economics © 2018
www.wtrg.com
(479) 293-4081



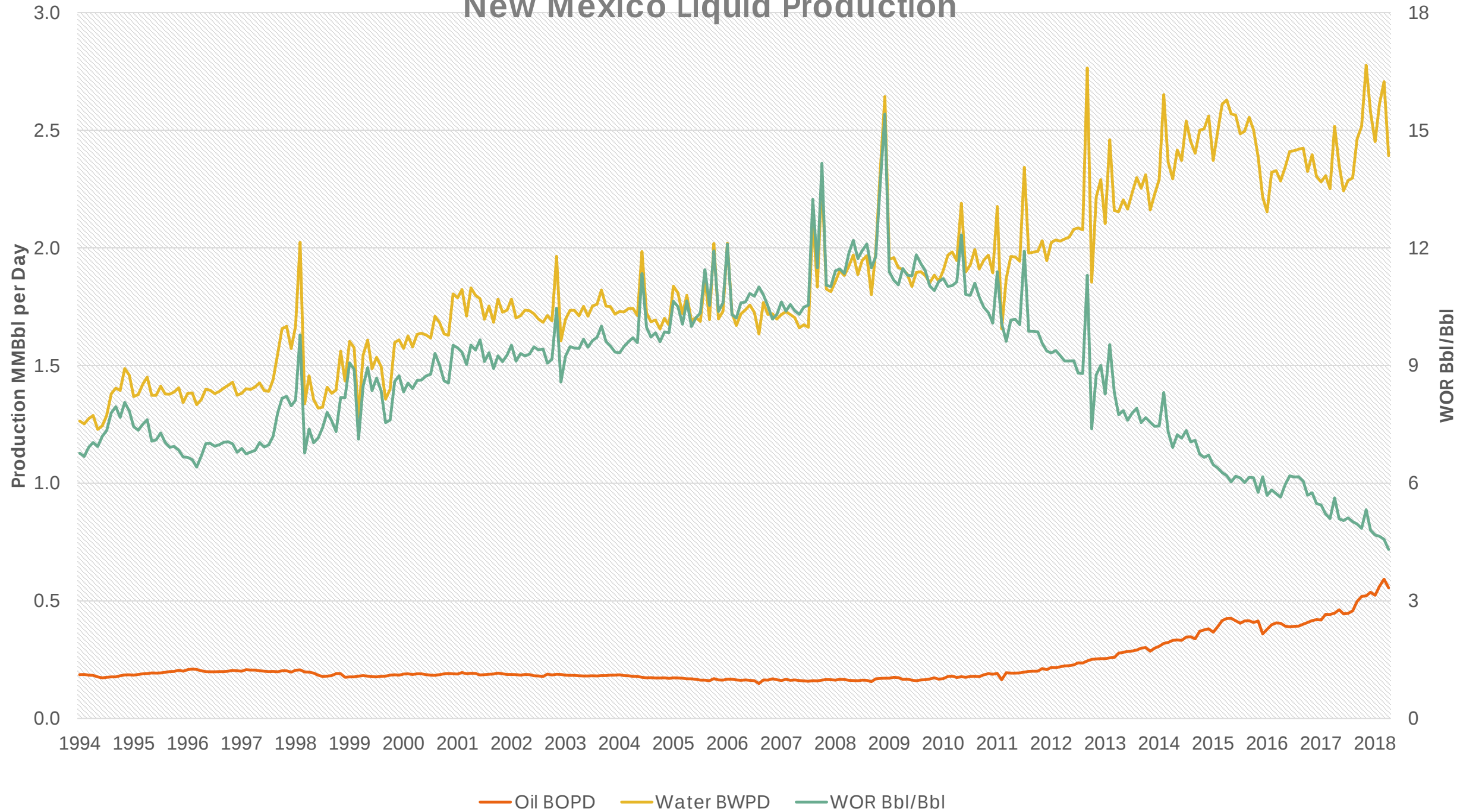
Water Issues In The New Mexico Oil And Gas Industry

► New Mexico Production

Year	Oil (bbls)	Nat. Gas (mcf)	Water (bbls)
2014	125,014,444	1,243,056,350	892,309,132
2015	147,661,607	1,272,091,806	908,526,136
2016	146,389,039	1,257,499,589	857,540,710
2017	171,432,658	1,293,985,678	877,841,832

► Note: 1 bbl = 42 gallons
mcf = 1,000 cu. ft.

New Mexico Liquid Production



> 70% of the Permian's wells are located in areas of extreme water stress

> 36% of hydraulically fractured wells in the U.S. overlay regions experiencing groundwater depletion

FIGURE 8: NUMBER OF WELLS DRILLED BY WATER STRESS CATEGORY & PLAY

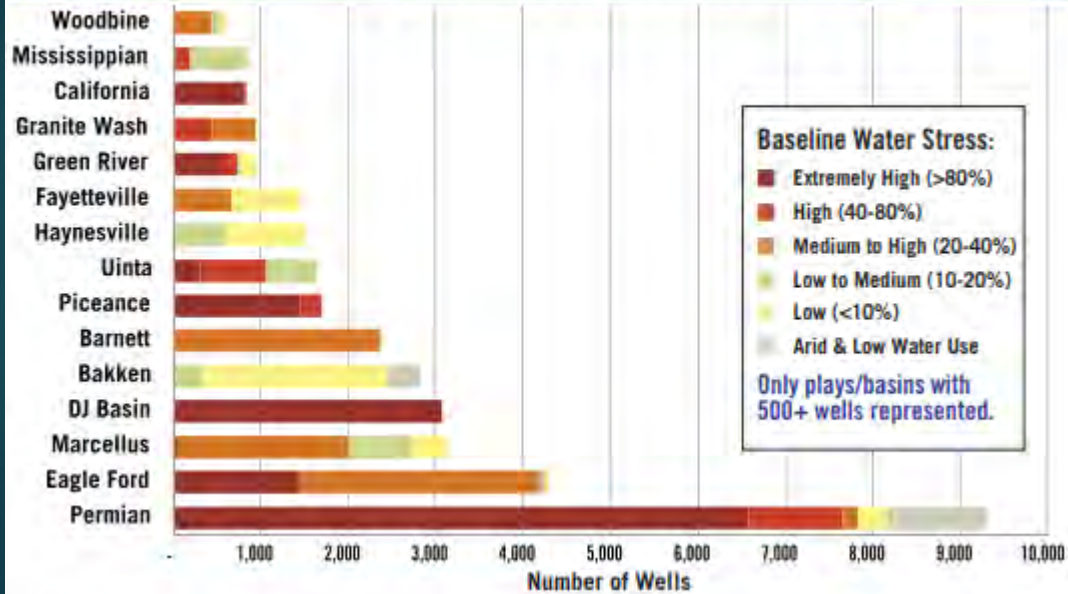
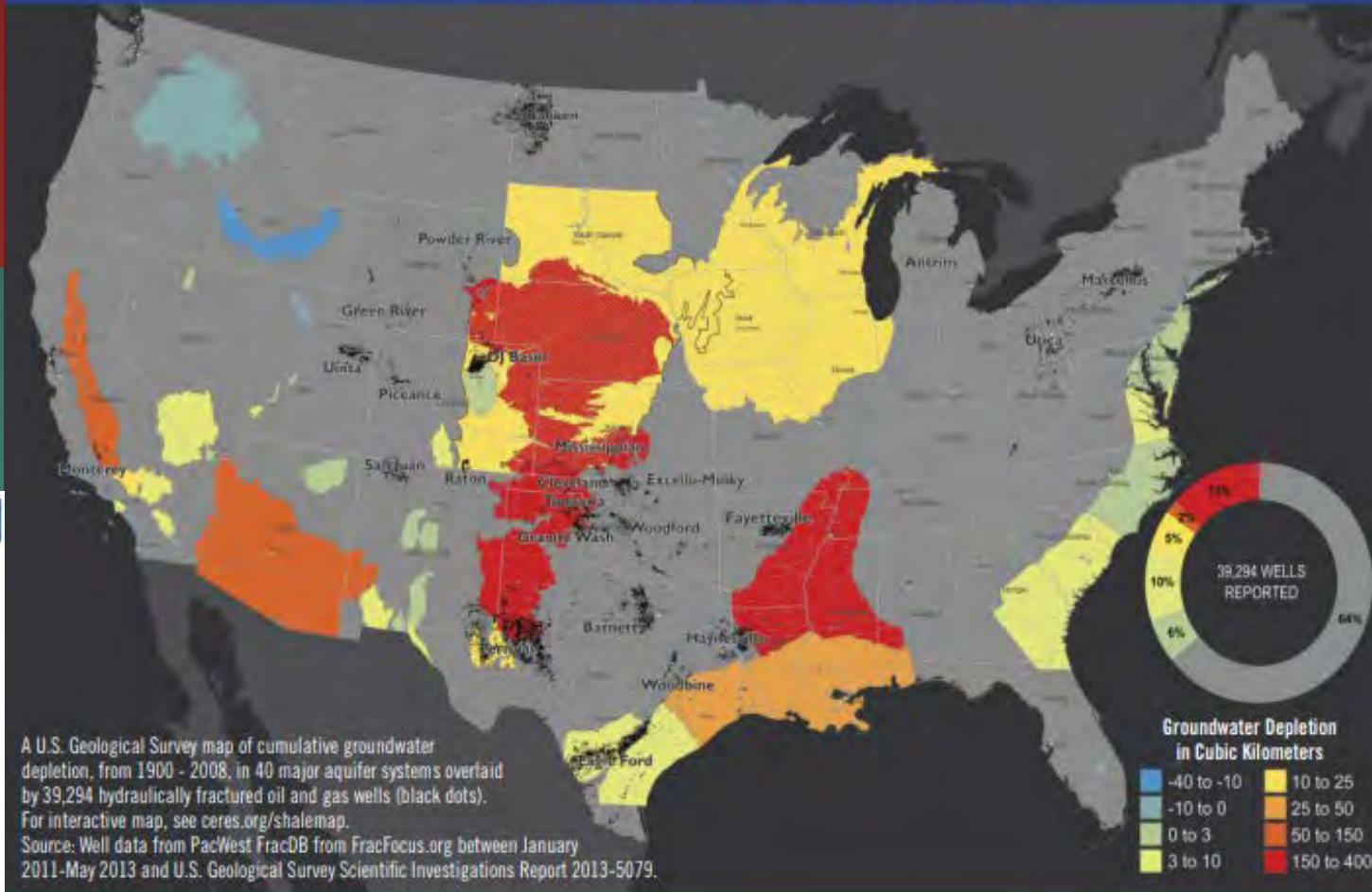


FIGURE ES2: GROUNDWATER DEPLETION & SHALE ENERGY DEVELOPMENT



“Water-to-oil ratios not only increase over time, but can easily exceed 7:1, making it one of the highest water cut plays in the Lower 48...”

“Produced water has created an impending supply risk to the overall Permian region because escalating costs will raise breakevens...”

“The total volume of produced water is expected to grow by several million barrels over the next five years and the low cost, simple solutions will become exhausted...”

Permian produced water: slowly extinguishing a roaring basin?

15 May 2018



Report summary

Permian operators are pushing oil growth higher than we've seen in any other unconventional basin. Each incremental barrel of oil, however, also results in the production of several barrels of associated water. All of that fluid brings with it significant costs. Water-to-oil ratios not only increase over time, but can easily exceed 7:1, making it one of the highest water cut plays in the Lower 48. All-in water management costs can reach US\$3/bbl. Produced water has created an impending supply risk to the overall Permian region because escalating costs will raise breakevens. The total volume of produced water is expected to grow by several million of barrels over the next five years and the low cost, simple solutions will become exhausted. What specific impact does produced water have on Permian economics and how does that influence growth potential as the cost curve shifts? What are operators doing to manage this ever-growing risk?

Water Issues In The New Mexico Oil And Gas Industry

- ▶ Fresh water is necessary during the drilling process so that aquifers are not contaminated (relatively small amounts, less than 1 acre foot)
- ▶ Fresh water is also used in fracking operations (much larger amounts, as much as 3 acre feet or more)
- ▶ Fracking is necessary in the development of shale (unconventional) plays. Reservoirs are created.
- ▶ New Mexico, like some of the other western states, is water-poor.
- ▶ Alternatives:
 - ▶ Using produced water for frack jobs
 - ▶ Recycling
 - ▶ Treatment

Water Issues In The New Mexico Oil And Gas Industry

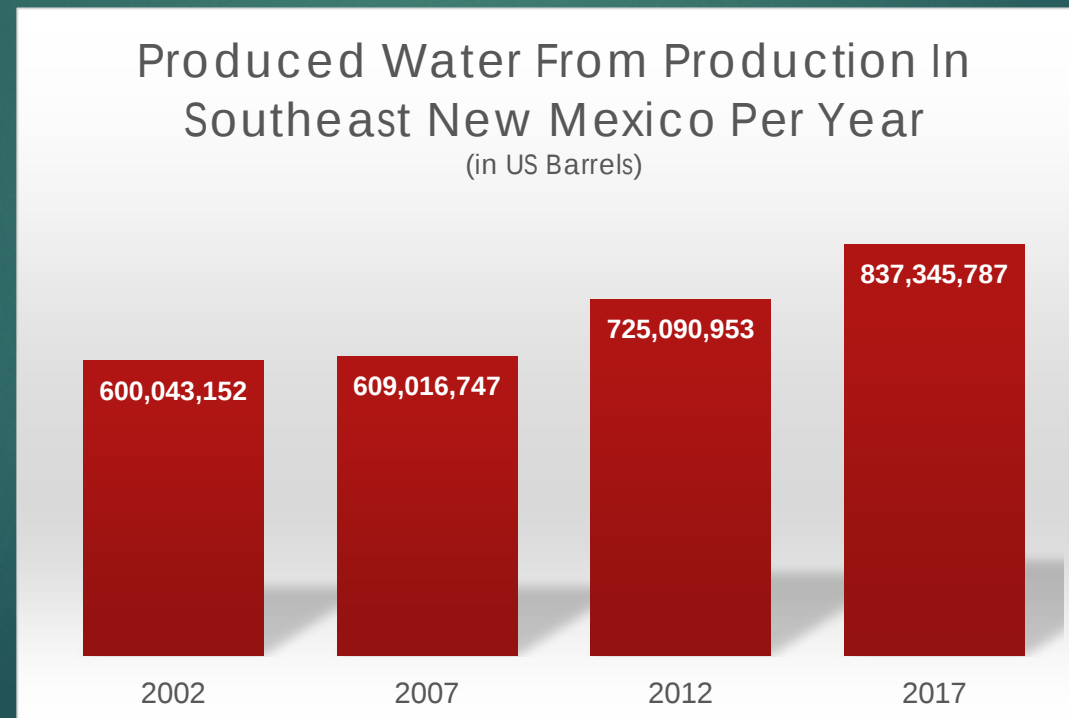
- ▶ Salt water, from ancient seas, is produced along with the oil and gas
- ▶ Total Dissolved Solids in such produced water ranges from around 2,500 ppm to as much as 300,000 ppm
- ▶ By comparison, TDS of seawater is around 35,000 ppm

Water Issues In The New Mexico Oil And Gas Industry

- ▶ The New Mexico Oil Conservation Division regulates the use and certain dispositions of produced water.
- ▶ Salt Water Disposal/Injection (19.15.26 NMAC)
- ▶ Pits, below grade tanks, closed-loop systems (19.15.17 NMAC)
- ▶ Recycling facilities (19.16.34 NMAC) “To encourage the recycling, re-use or disposition of produced water...” “No permit is required for registration . . . For the disposition by use of PW for drilling, completion, producing, secondary recovery...”
- ▶ Surface waste management facilities (19.15.36 NMAC)

Summary of Current Disposal Activities in New Mexico

- ▶ There are currently 832 active salt water disposal (SWD) wells and 96 active approved orders that the well is yet to be spud
- ▶ For this total of 928 SWD wells, 826 wells or 89 percent operate in the New Mexico portion of the Permian Basin
- ▶ The demand for proper disposal has grown with the expansion of horizontal drilling and completions in the Permian Basin

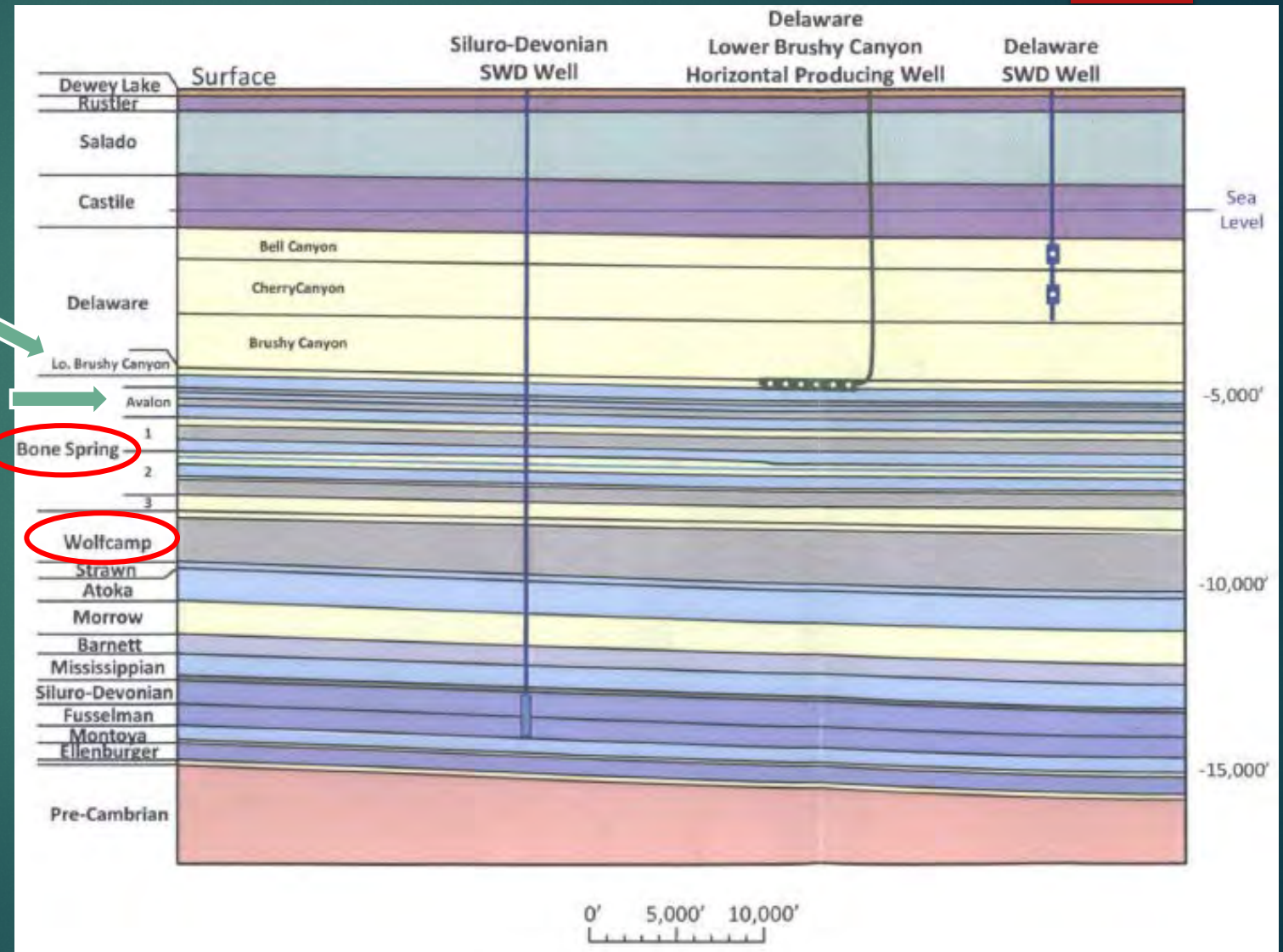


Recent Developments in Disposal Activities in Southeast New Mexico

► Expansion in Exploration and Development of Permian Targets

During the last two years, there has been a significant increase in the drilling activity for the Wolfcamp Formation. This interval is directly below the Bone Spring Formation, with its multiple zones for horizontal development, and has been the dominate target of the last decade.

Other targets that have been developed by horizontal well drilling during the last decade include the Avalon Shale which occurs at the top of the Bone Spring Formation and the lower Brushy Canyon Formation at the base of the Delaware Mountain Group.



Recent Developments in Disposal Activities in Southeast New Mexico

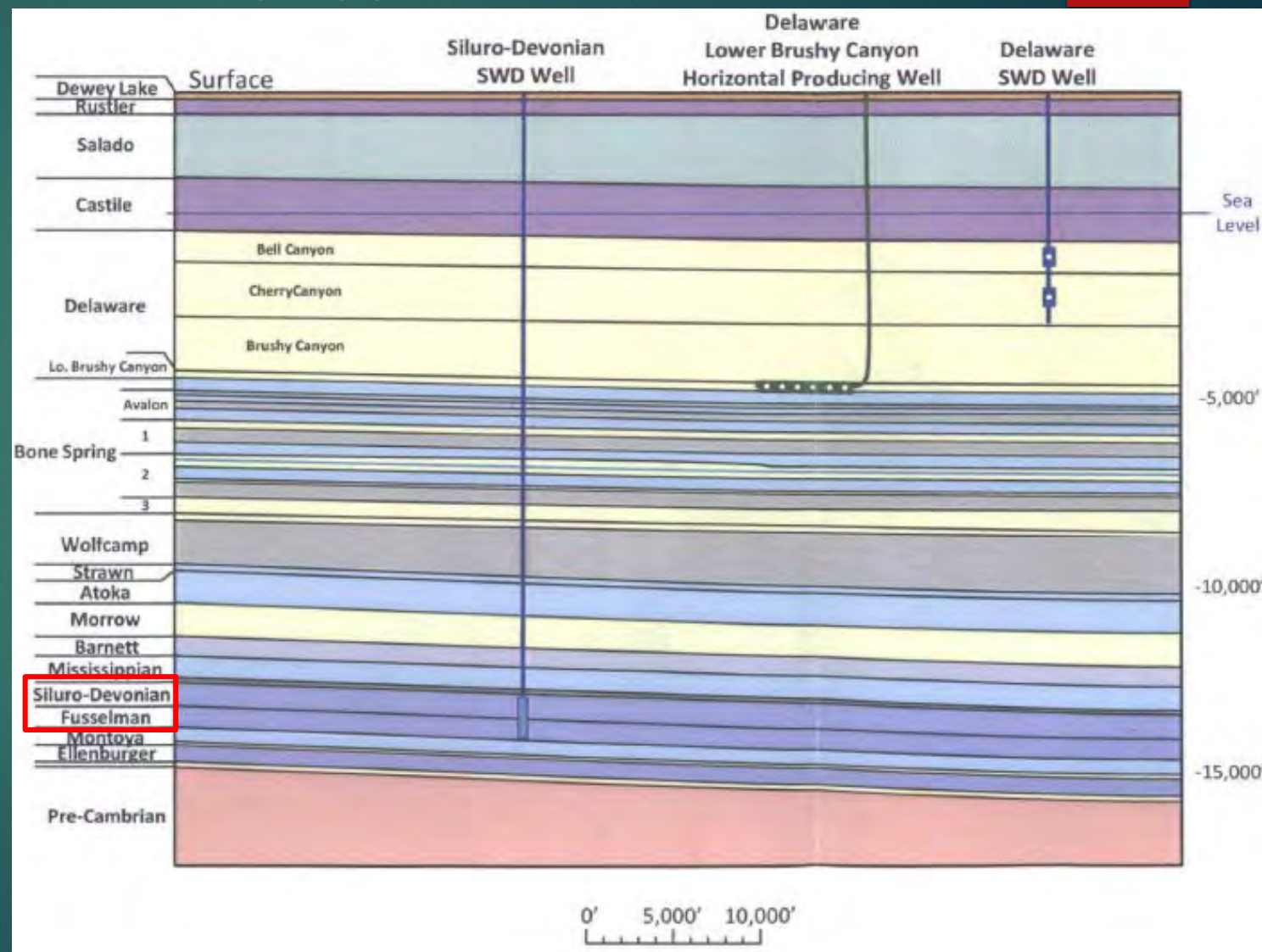
► Devonian and Silurian Interval

To address the growing demand for additional disposal capacity, the Division reviewed several intervals approved for current SWD wells.

Following this review, the Division identified the Devonian and Silurian formations as a recommended alternative to large volume disposal in shallower zones.

Additionally, the potential for use of the Devonian strata was also noted in the *New Mexico State Demonstration for Class II Wells*.

These formations are also known as the Thirtyone Formation, the Wristen Group, the Fasken Formation, and Fusselman Formation as well as the Siluro-Devonian depending on location. These units are found in significant thickness and permeability in the areas with the expanded Permian development.

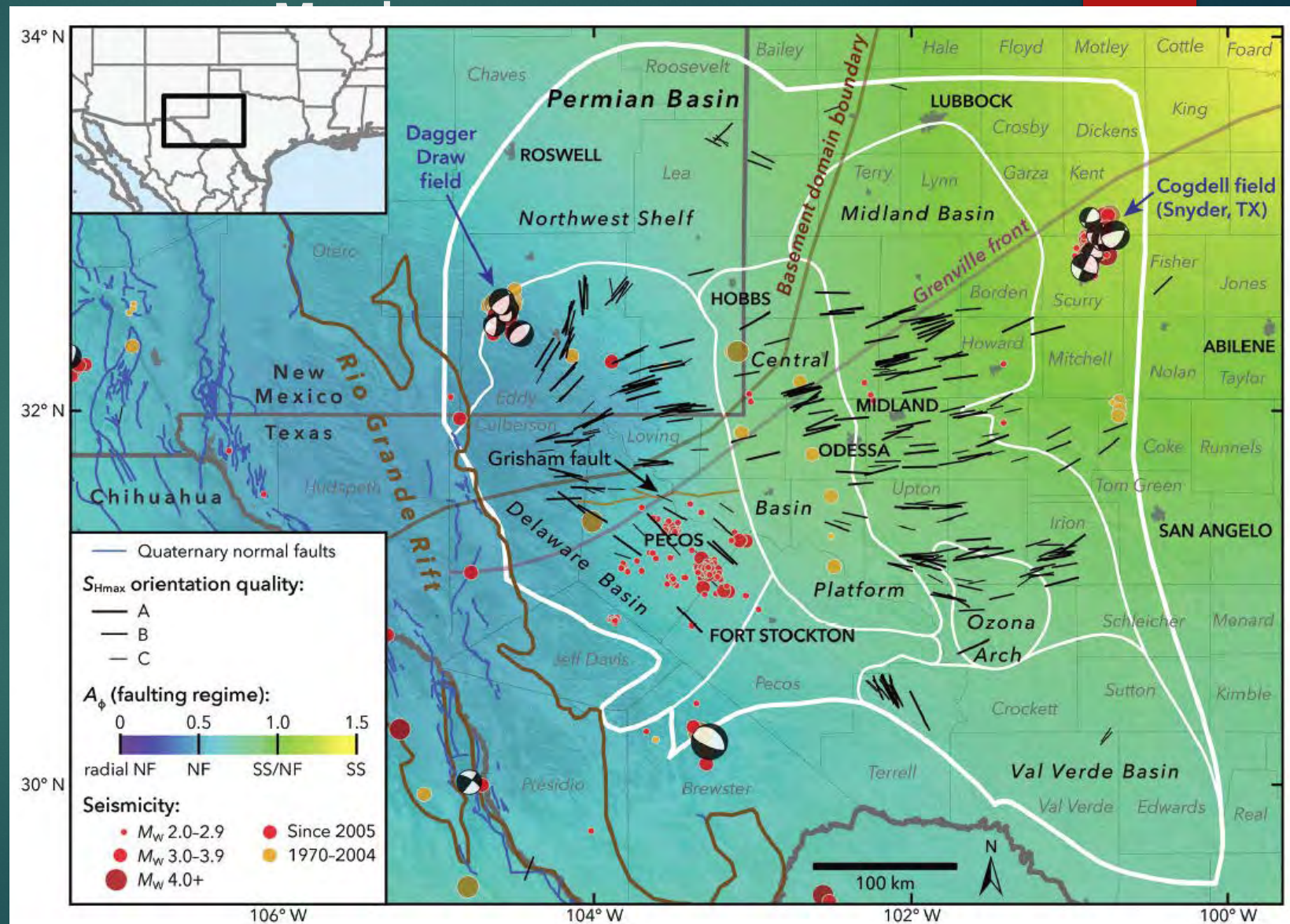


Recent Developments in Disposal Activities in Southeast New

- ▶ Devonian and Silurian Interval and Induced Seismicity

The Division also required supplemental information to be added to an application for a deep Devonian SWD well that would consider the overall seismic potential for the life of the disposal well.

This assessment was to be based on current models offered by academic or governmental agencies using both publicly-available data or proprietary data such as deep 3-D seismic.



Water Issues In The New Mexico Oil And Gas Industry

- ▶ In May 2018 Administrator Pruitt announced new EPA study examining how EPA, states, and stakeholders regulate and manage PW.
- ▶ EPA focusing on available approaches to manage PW
 - ▶ How federal approaches under the CWA can interact more effectively with state regs, requirements and policy needs
 - ▶ Whether adjustments to federal regulations are necessary and appropriate

Water Issues In The New Mexico Oil And Gas Industry

- ▶ Produced water may be:
 - ▶ Disposed of in SWD wells
 - ▶ Recycled and re-used
 - ▶ Treated for re-use in the oil patch and for other uses

Water Issues In The New Mexico Oil And Gas Industry

► Salt Water Disposal Wells

- There are currently 970 active salt water disposal wells in New Mexico
- These are managed through the Underground Injection Control program by the New Mexico Oil Conservation Division
- The UIC program is a federal one under the Clean Water Act, but in New Mexico, the state has primacy
- The SWD wells on state trust land require easements issued by the NM State Land Office which collects rental and disposal fees for the use of the trust land

Water Issues In The New Mexico Oil And Gas Industry

- ▶ There are unresolved issues related to the disposal of produced water
 - ▶ Injection into producing oil and gas zones such as the Delaware Mountain Group
 - ▶ “Waters out” production
 - ▶ Pushes resources off of state land
 - ▶ Produced water disposal is one of the major operating costs in oil and gas operations and disposal systems will become further stressed as drilling activity increases and the productivity of wells improves as a result of larger stimulations
 - ▶ Induced seismicity
 - ▶ Naturally-occurring faults
 - ▶ Volumes and injection pressures in a particular well or area

Water Issues In The New Mexico Oil And Gas Industry

- ▶ Where can we go from here?
 - ▶ Incentivize recycling
 - ▶ Recycle for other uses
 - ▶ Increase the water supply
 - ▶ Regulation changes may be necessary

Oil and Gas Act places certain authority over produced water at OCD

Regulatory Snapshot

- ▶ PW = “water that is an incidental byproduct from drilling for or the production of oil and gas” (NM Stat. 70-2-33(K)).
- ▶ “No permit shall be required from the state engineer for the disposition of produced water ...” (NM Stat. 70-2-12.1).

Regulatory Snapshot

OCD regulates the use and certain dispositions of produced water

- ▶ SWD / Injection (19.15.26 NMAC);
- ▶ Pits, below grade tanks, closed-loop systems (19.15.17 NMAC);
- ▶ Recycling facilities (19.16.34 NMAC);
- ▶ Surface waste management facilities (19.15.36 NMAC).

Rule 34 encourages recycling

NM Regulatory Snapshot

- ▶ “To encourage the recycling, re-use or disposition of produced water ...”
- ▶ “No permit or registration is required ... for the disposition by use of PW for drilling, completion, producing, secondary recovery ...”
- ▶ “Any other use of PW requires prior approval ...”

Policy Questions

- ▶ Who owns PW?
 - ▶ Liability vs asset
- ▶ PW does not fit in the Prior Appropriation paradigm
 - ▶ Not public trust water
 - ▶ Water right = real property right
 - ▶ No water right = no real property right
- ▶ PW as personal property
 - ▶ Is it the operator's?
 - ▶ Is it the surface owners?
 - ▶ Is it the mineral owners?

2025 Produced
Water
Scenario

2 MILLION
ACRE FEET OF
NEW WATER

- ▶ 6MM Bbls Oil
- ▶ Into 7 Water Oil Ratio
- ▶ $6\text{MM Bbls Oil} * 7\text{MM Bbls water} = 42\text{ MM Bbls water}$
- ▶ $42\text{ MM Bbls water} * 265 = 15,330,000,000\text{ Bbls / yr}$
- ▶ 1,997,931 acre feet / yr

ELEPHANT BUTTE LAKE NEW MEXICO





- ▶ Ag water
 - ▶ Stock water
 - ▶ Irrigation
- ▶ Threatened and
flows
- ▶ Municipal



NM Water Confluences

- A. Permian Operations consume water—how much??
- B. Permian Region and NM are water short.
- C. Permian operations produce water.

A + B + C = opportunity



Water Confluences

- ▶ Permian operations consume water
- ▶ Permian region is water short
- ▶ Permian produces water
- ▶ Permian-sized opportunity to turn on the water



The Opportunity

“In New Mexico’s arid environment, conserving our resources by recycling produced water for more beneficial uses presents a significant economic development and water supply opportunity,”

said New Mexico Energy, Minerals and Natural Resources Department Cabinet Secretary Ken McQueen.

“For years New Mexico has advocated recycling of produced water in oil and gas completion activities. Continued collaboration with EPA on this issue will no doubt encourage even greater recycling and additional reuse opportunities.”