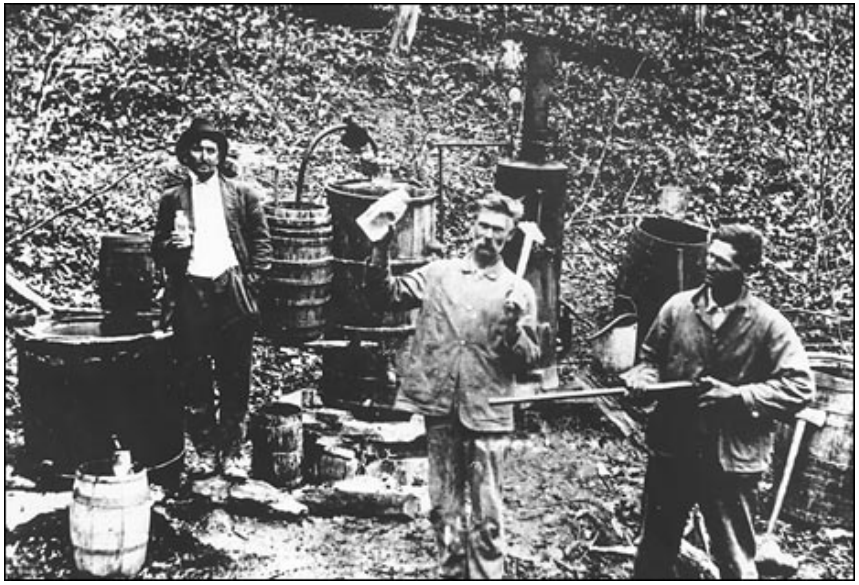
Moving Produced Water From A Waste to a Resource

RICK MCCURDY
SENIOR ENGINEERING ADVISOR

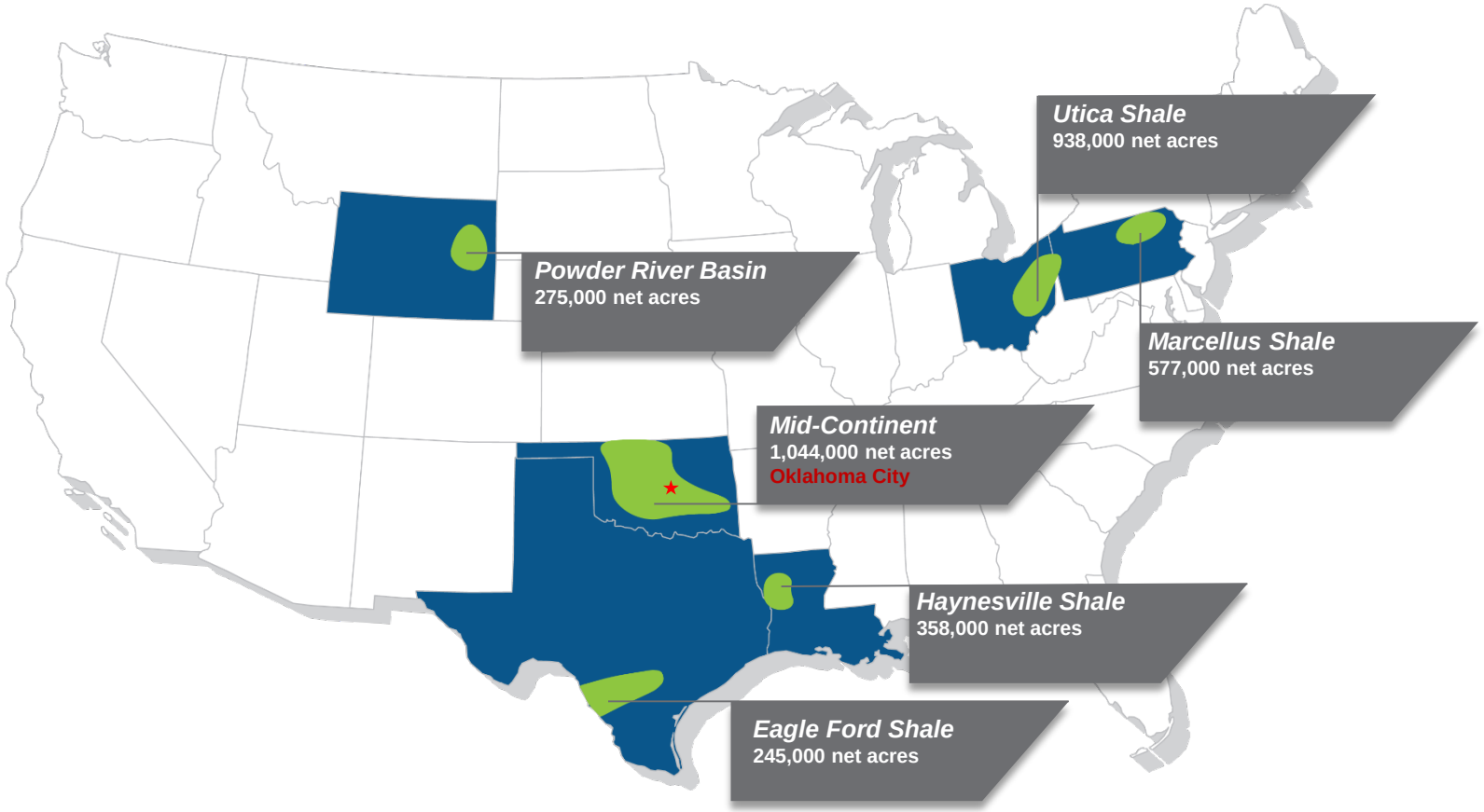
CHESAPEAKE ENERGY

AGENDA

- Chesapeake Energy
- Water Use In Oil & Gas Operations
- Water Intensity of Various Energy Sources
- Water Use in Value Creation
- Water Reporting in Oil and Gas Operations
  - > What are we doing well?
  - > Where can we improve?
- Case Study – Industry Partnering With a State to Reduce Fresh Water Demand



WHO WE ARE



- *2nd largest US Natural Gas Producer*
- *13th largest US Crude Oil Producer*

Data taken from 2017 CHK Annual Report

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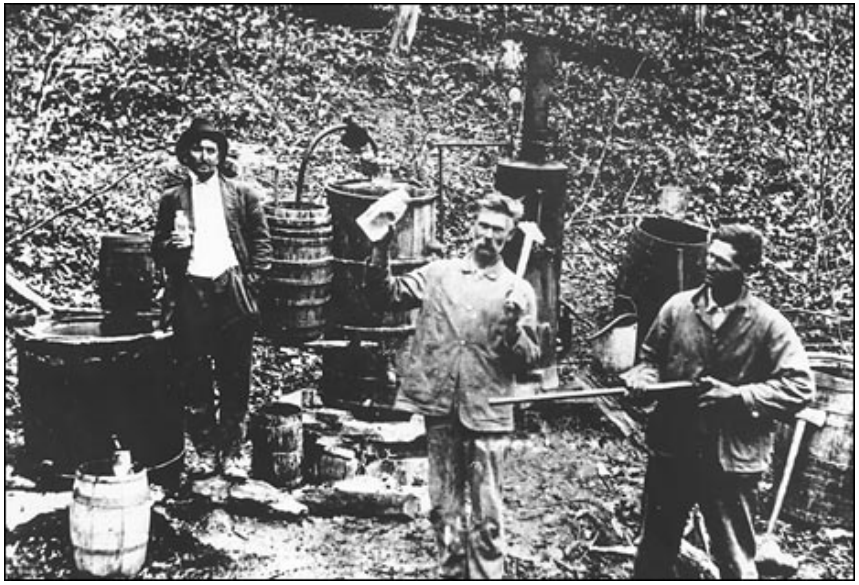
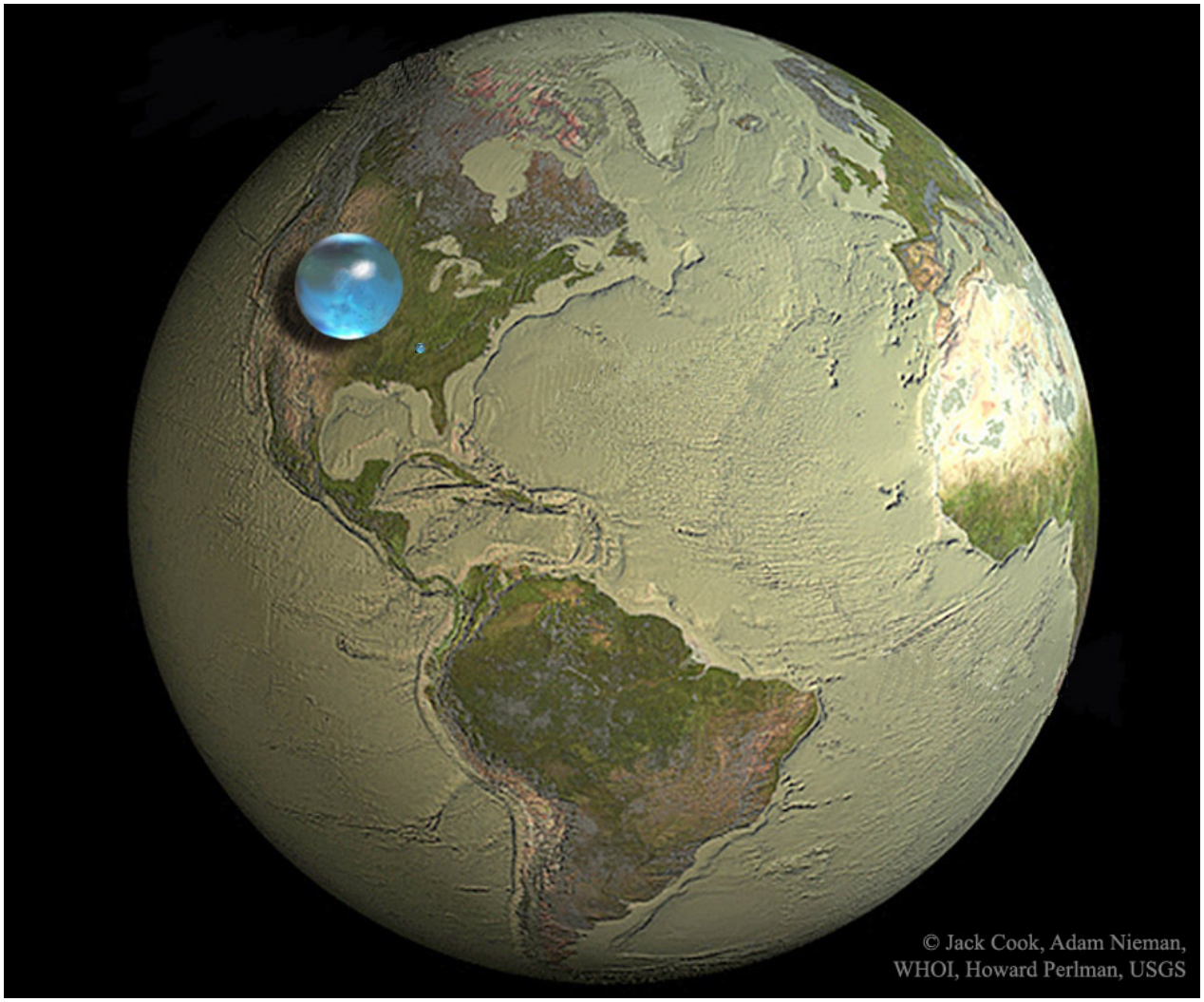
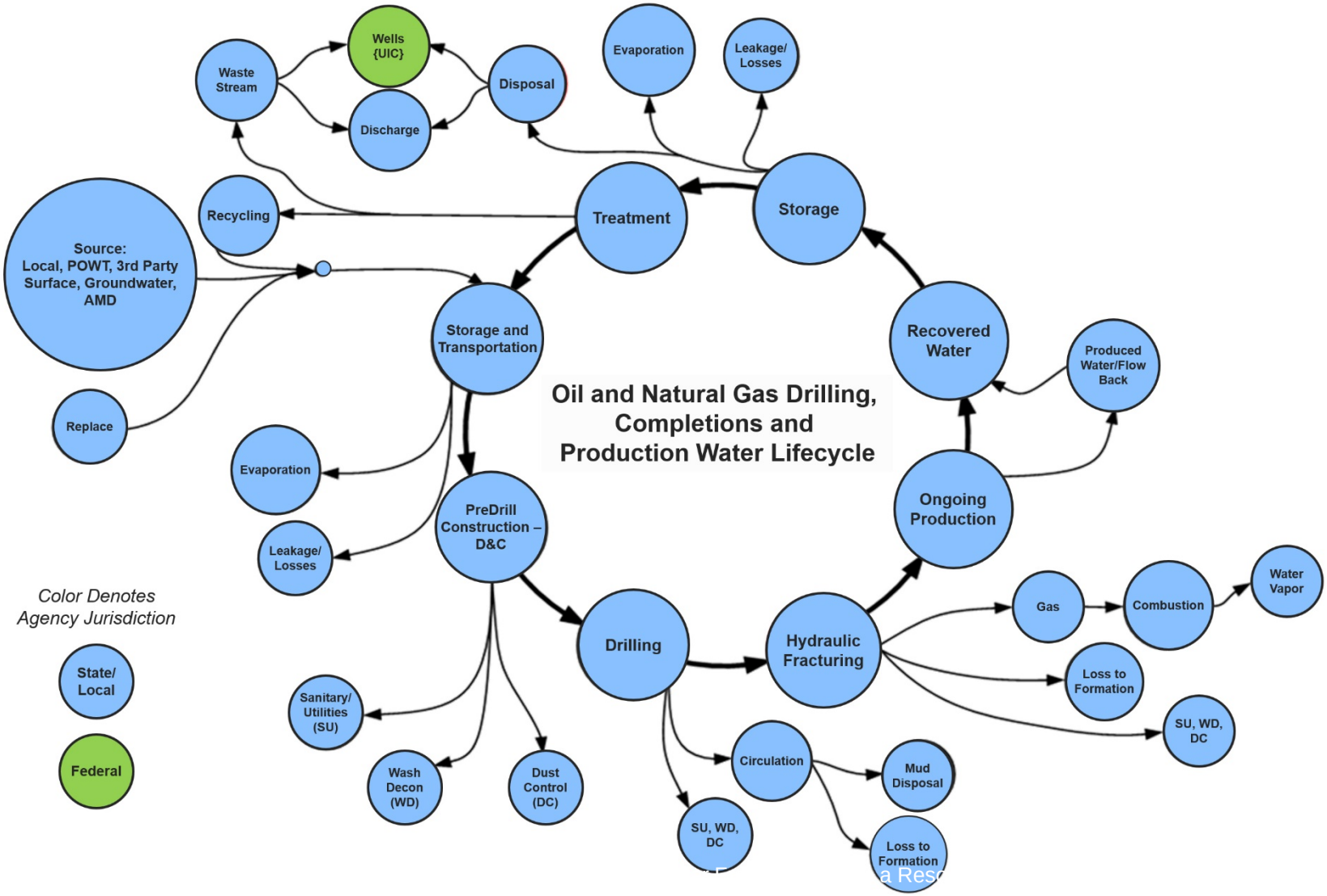


FRESH WATER

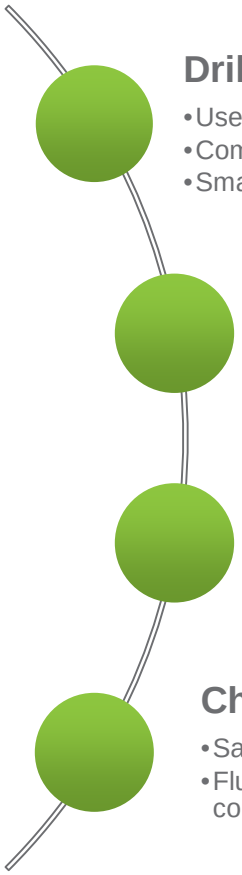


CHESAPEAKE ENERGY

LIFE CYCLE OF WATER: OIL & GAS OPERATIONS



COMMON WATER USE AREAS IN OIL AND GAS OPERATIONS



Drilling

- Used as a base fluid for drilling mud
- Common volume is 1 barrel (42 US gal) per foot of well depth
- Smaller volumes use for cleaning rigs and dust suppression

Hydraulic Fracturing

- Single largest usage
  - 8-10 years ago – common usage was 3-5 million gallons per well
  - Current longer laterals, denser completions are requiring 5-15 million gallons per well

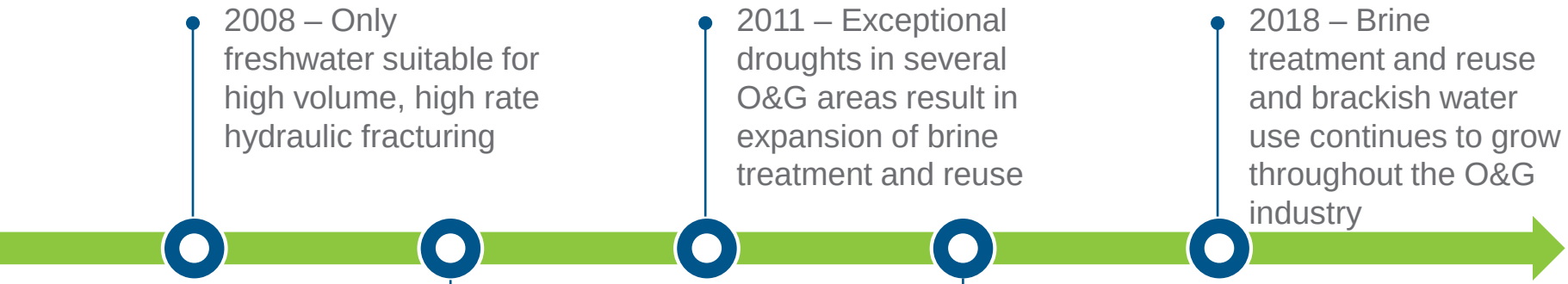
Other Operations

- Well workovers, Drill outs
- Displacement fluid in remedial operations such as acidizing

Chemical Treatments

- Salt removal in wells prone to salting
- Flush for regularly scheduled batch treatments such as application of corrosion inhibitors

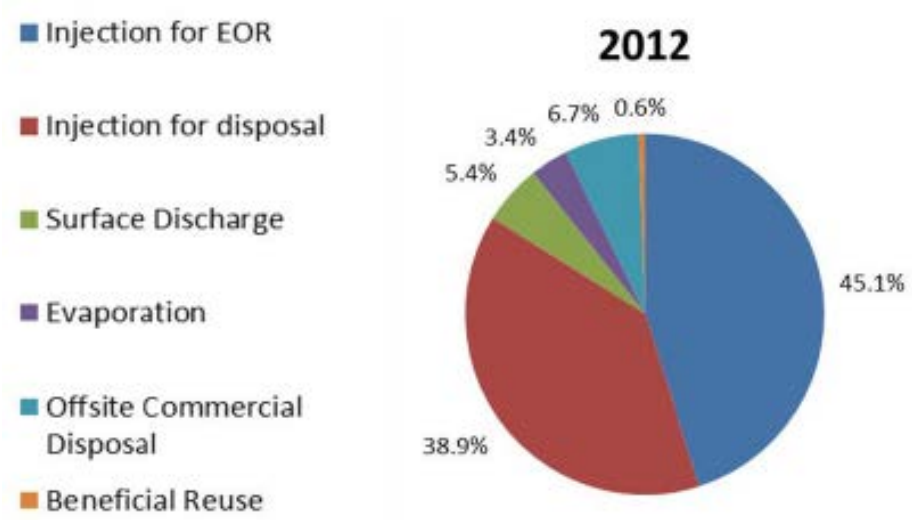
RECENT EVOLUTION OF WATER USE IN HYDRAULIC FRACTURING



CHESAPEAKE ENERGY

PRODUCED WATER IN THE U.S.

- Data from John Veil, April 2015, “U.S. Produced Water Volumes and Management Practices in 2012”
- In 2012, onshore and offshore U.S. oil and gas wells produced 21,180,646,000 barrels of water.



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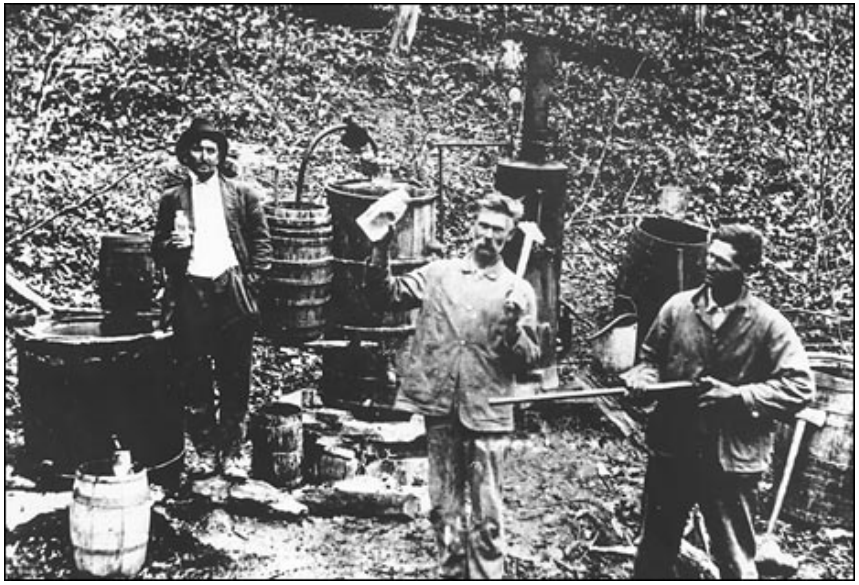

BEST PRACTICES

- Efficient Use of Water
  - > High rate hydraulic fracturing in horizontal wells can be water intensive
  - > Ten years ago volumes per well were in the 3-5 million gallons range
  - > With longer laterals denser completion profiles, we are now seeing 5-15 million gallons per well
  - > However, water efficiency (gal/mmbtu) is staying flat or improving on a gallon of water per million British Thermal Units of energy standpoint

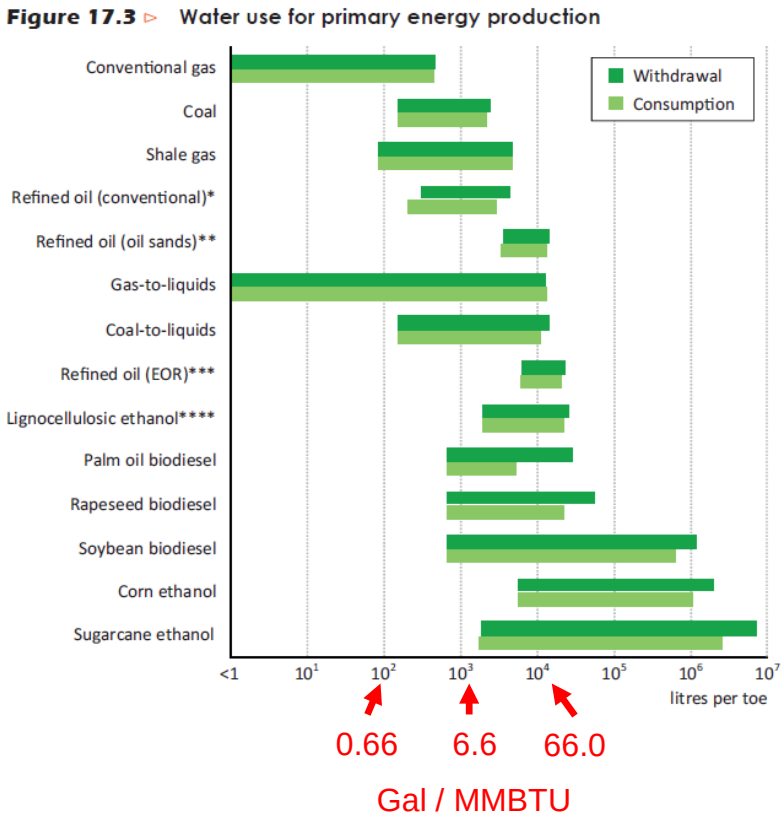

Chart: http://www.worldenergyoutlook.org/media/weowebsite/2012/WEO_2012_Water_Excerpt.pdf

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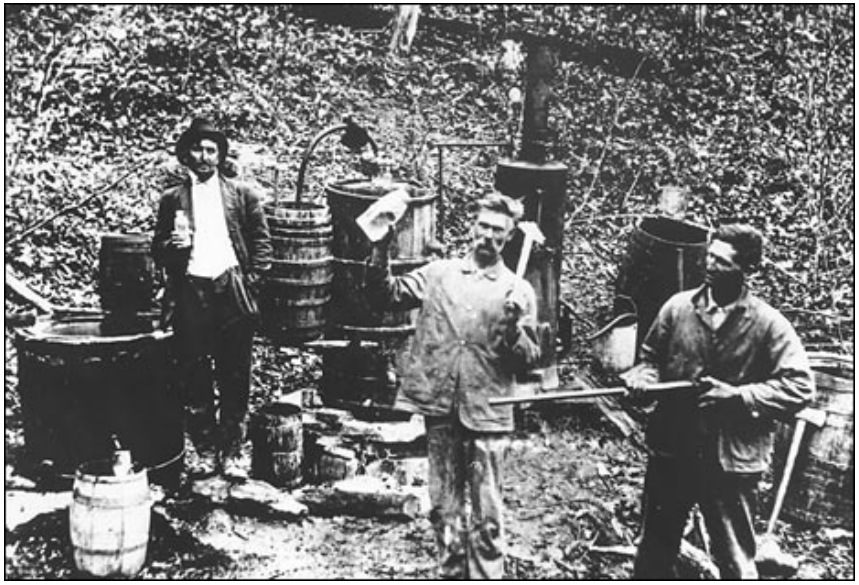
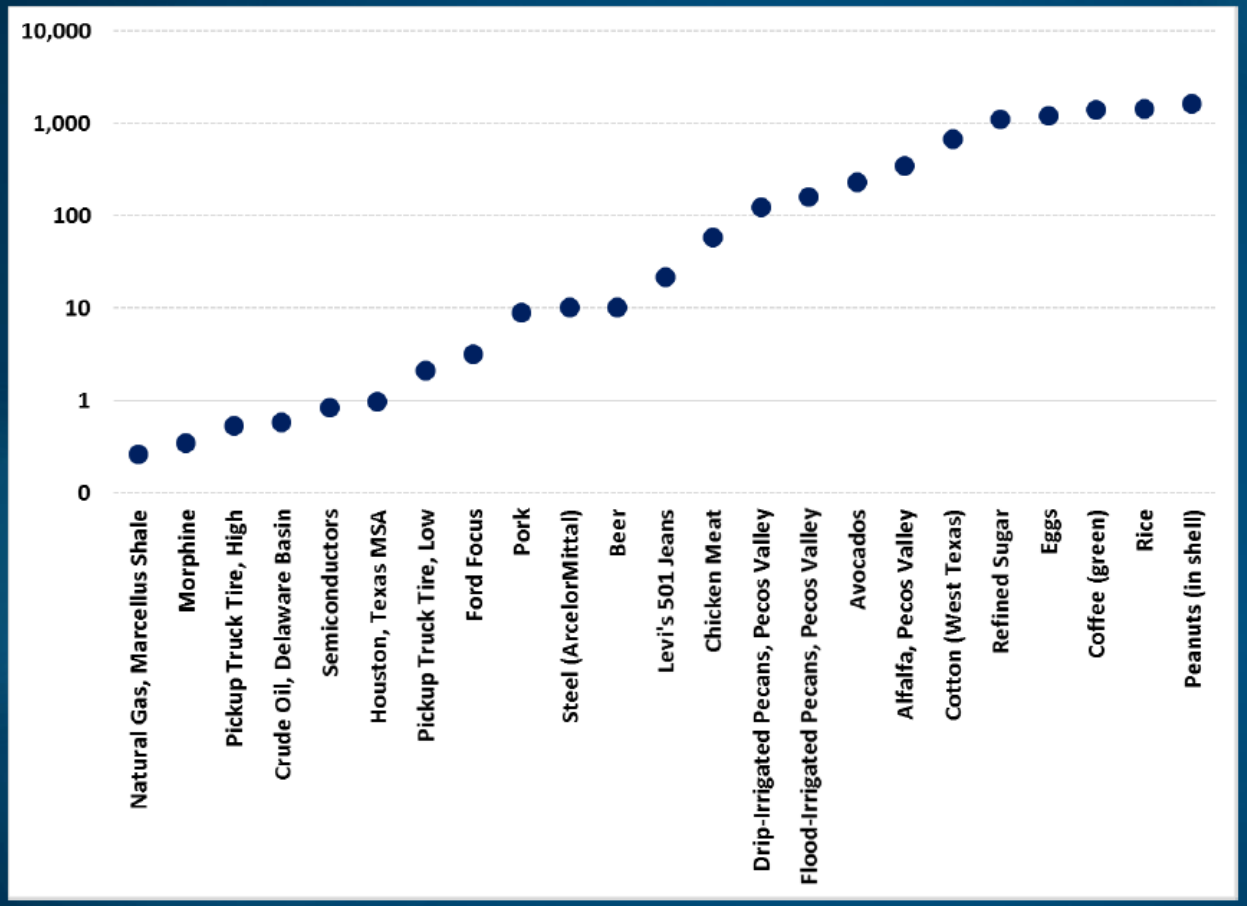


Gallons of Water per Dollar of Economic Value Generated: Orders of Magnitude



Source: Company Reports, EIA, FracFocus, Hoekstra & Mekonnen, Journal Articles, TWDB, USDA

Gabrielle Collins, J.D., Baker Institute for Public Policy, Rice University, "How Much Water Does It Take To Produce a Billion Dollars of Economic output?"

	Direct economic value generated per gallon of water used	Gallons of water needed to create $1 in direct economic value	AF of Water Consumed Per Billion USD in Economic Value Created	Depth of Coverage Over City of Houston's Physical Area, Inches
Natural Gas, Marcellus Shale	$3.804	0.3	807	0.02
Morphine	$2.847	0.4	1,078	0.03
Pickup Truck Tire, High	$1.845	0.5	1,663	0.05
Crude Oil, Delaware Basin	$1.692	0.6	1,814	0.05
Semiconductors	$1.170	0.9	2,623	0.08
Houston, Texas MSA	$1.008	1.0	3,045	0.09
Pickup Truck Tire, Low	$0.465	2.2	6,604	0.19
Ford Focus	$0.313	3.2	9,808	0.28
Pork	$0.111	9.0	27,578	0.79
Steel (ArcelorMittal)	$0.098	10.2	31,359	0.90
Beer	$0.097	10.3	31,577	0.90
Levi's 501 Jeans	$0.046	22.0	67,447	1.93
Chicken Meat	$0.017	58.5	179,422	5.14
Drip-Irrigated Pecans, Pecos Valley	$0.008	123.9	380,275	10.89
Flood-Irrigated Pecans, Pecos	$0.006	160.8	493,488	14.13
Avocados	$0.004	232.6	713,695	20.43
Alfalfa, Pecos Valley	$0.003	348.5	1,069,458	30.61
Cotton (West Texas)	$0.001	678.8	2,083,168	59.63
Refined Sugar	$0.001	1111.1	3,409,875	97.61
Eggs	$0.001	1207.6	3,706,080	106.09
Coffee (green)	$0.001	1428.6	4,384,125	125.50
Rice	$0.001	1434.4	4,401,954	126.01
Peanuts (in shell)	$0.001	1666.7	5,114,812	146.42

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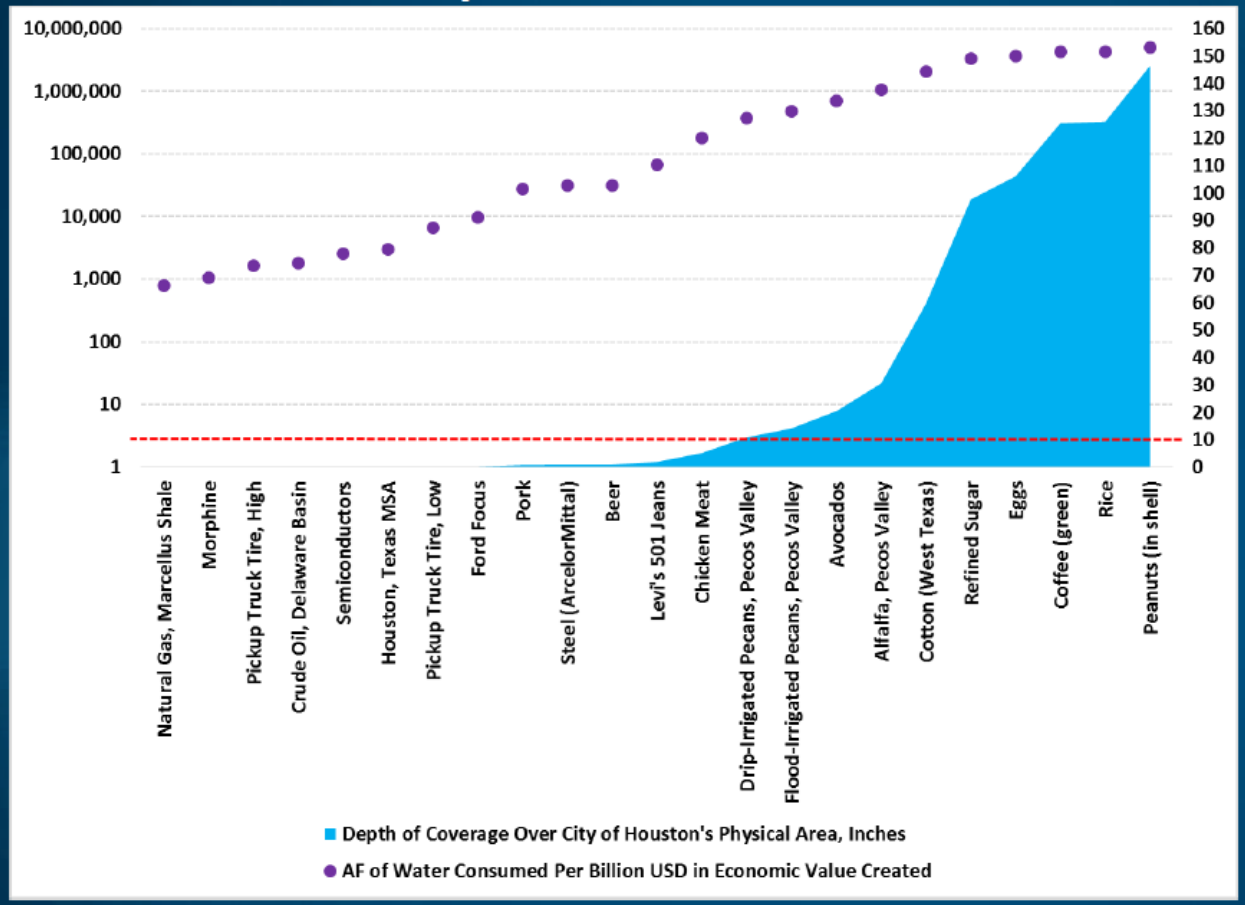
Acre-Feet of Water per Billion Dollars of Economic Value Generated



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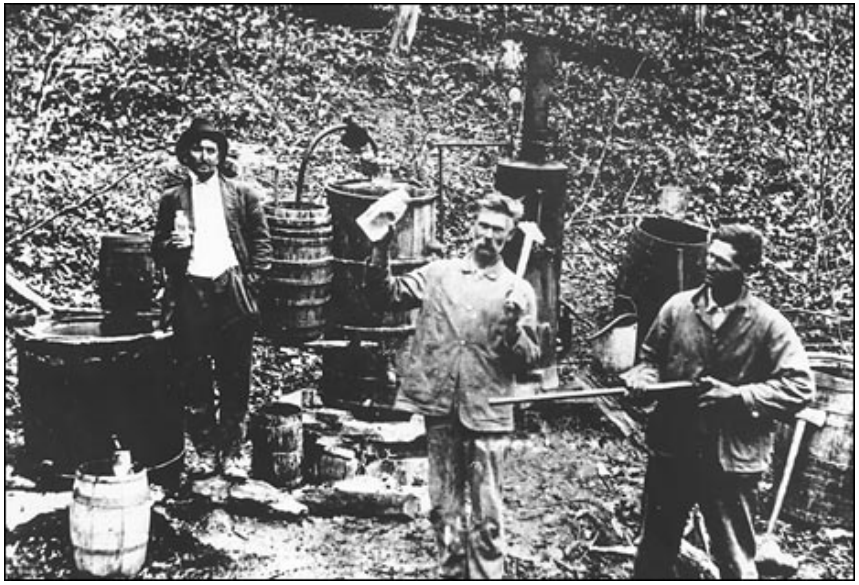

WHAT ARE WE DOING WELL?

- Water Usage on Hydraulic Fracturing Activities
  - > Usually Required by States or BLM
- FracFocus™
  - > Created and maintained by GWPC
  - > Initially, voluntary submissions by Operators but many States now mandate its use
  - > Data submitted includes
    - Water volume for completion
    - Sand (proppant) volume
    - Chemical composition and quantity for each HF additive

FracFocus
Chemical Disclosure Registry

www.fracfocus.org

Photo courtesy of BJ Services Company

WHAT CAN WE IMPROVE?

- More Transparency in Base Fluid for Completions
  - > Produced water
  - > Brackish groundwater
  - > Municipal effluent streams
  - > Industrial wastewater
  - > FracFocus reporting
  - > States request

WHAT CAN WE IMPROVE?

- Spill Reporting
  - > Required by States and BLM
  - > Reporting requirements vary
  - > Many Operators track more stringently
    - You cant improve what you don't track!
  - > Industry discussion in incubation phase regarding a universally acceptable, more robust method

Photo property of Alaska Department of Environmental Quality

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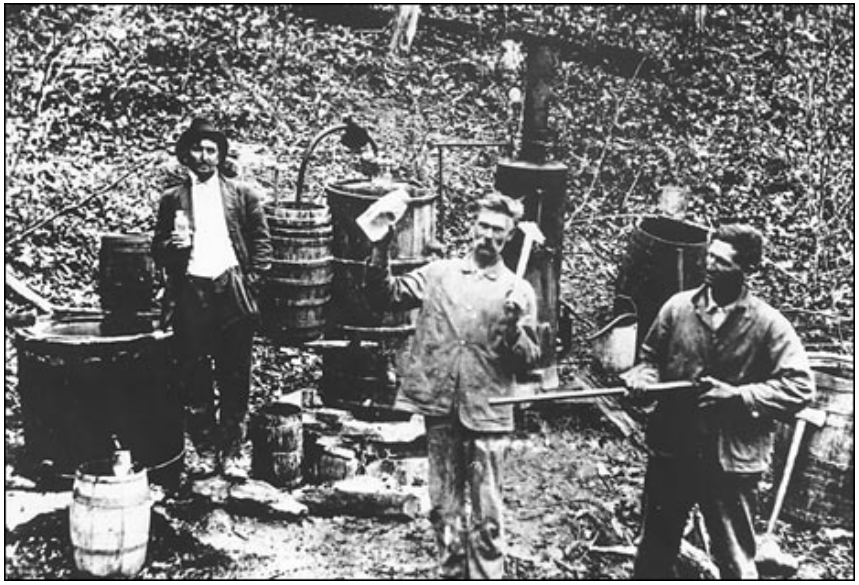
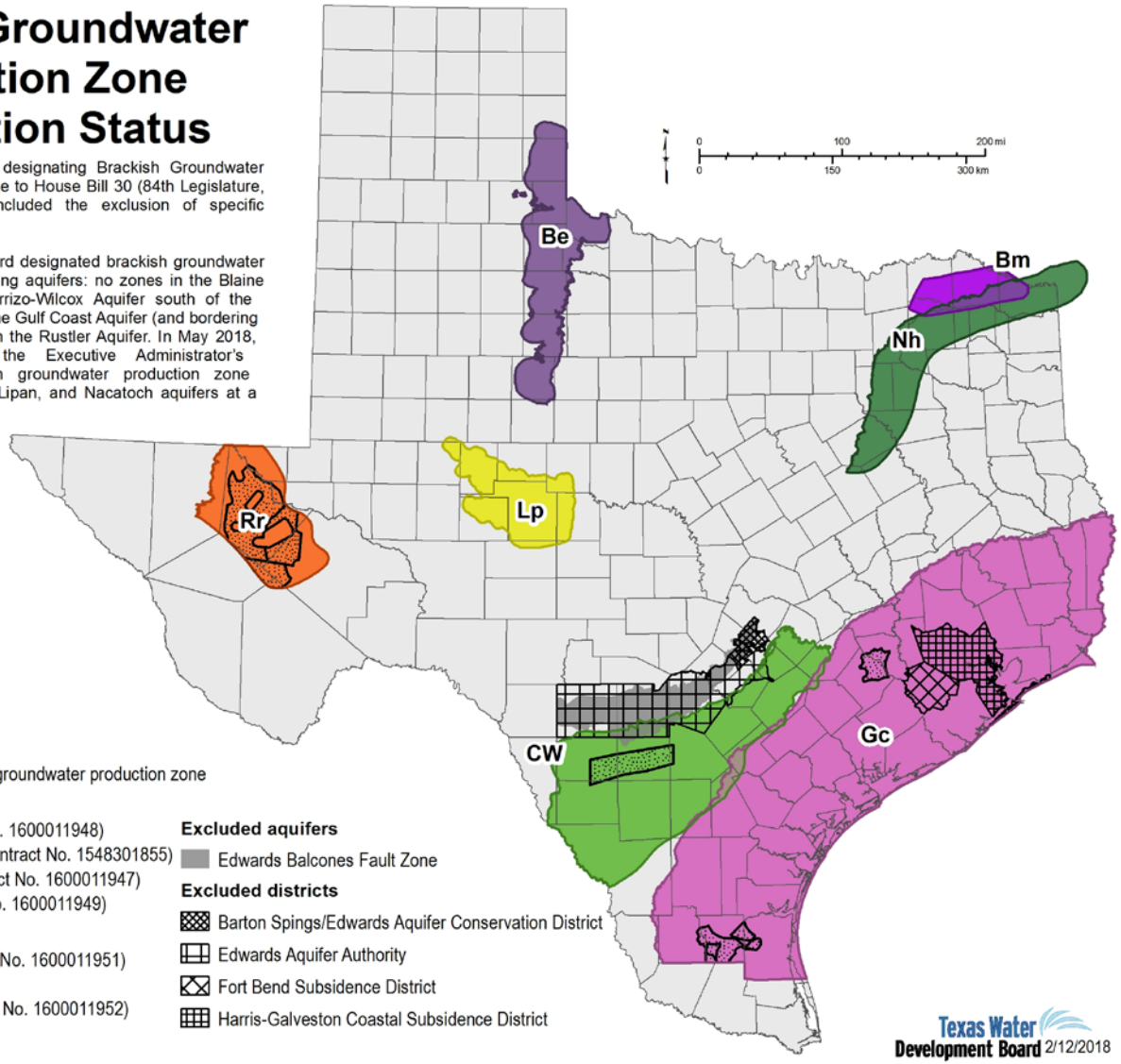


TEXAS WATER DEVELOPMENT BOARD
BRACKISH AQUIFER CHARACTERIZATION SYSTEM (BRACS)

Brackish Groundwater Production Zone Designation Status

The effort of identifying and designating Brackish Groundwater Production Zones is in response to House Bill 30 (84th Legislature, 2015) requirements which included the exclusion of specific aquifers and districts.

On October 20, 2016, the Board designated brackish groundwater production zones in the following aquifers: no zones in the Blaine Aquifer, one zone in the Carrizo-Wilcox Aquifer south of the Colorado River, four zones in the Gulf Coast Aquifer (and bordering sediments), and three zones in the Rustler Aquifer. In May 2018, the Board will consider the Executive Administrator's recommendation for brackish groundwater production zone designations in the Blossom, Lipan, and Nacatoch aquifers at a TWDB Board meeting.



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