NEMC

Stone Soup

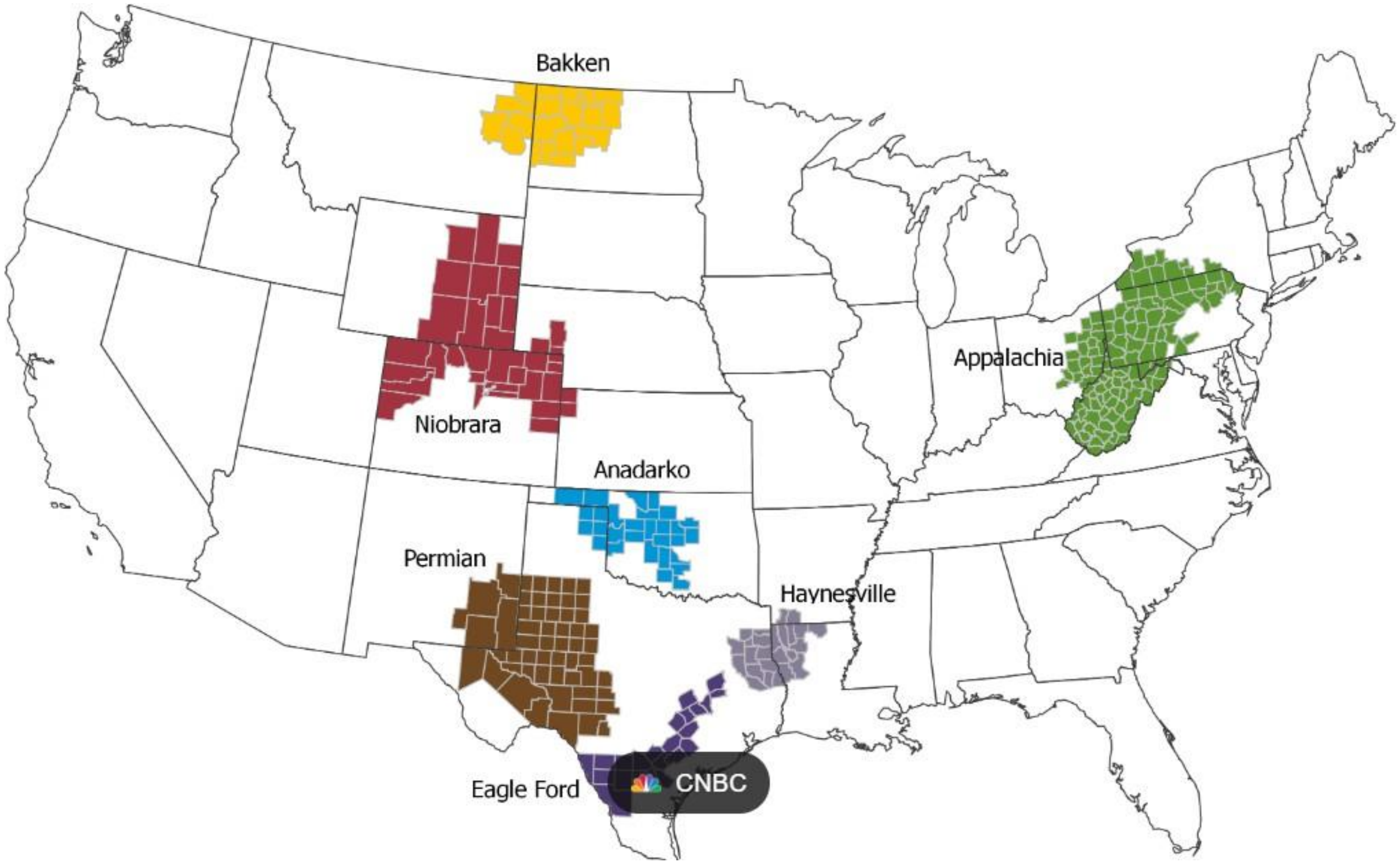
Friday August 5th, 2022

Energy Partners LP

Outline

Produced Water Background
Defining the Problem
Present Efforts
Strategic Opportunities
Baseline Analysis
End State

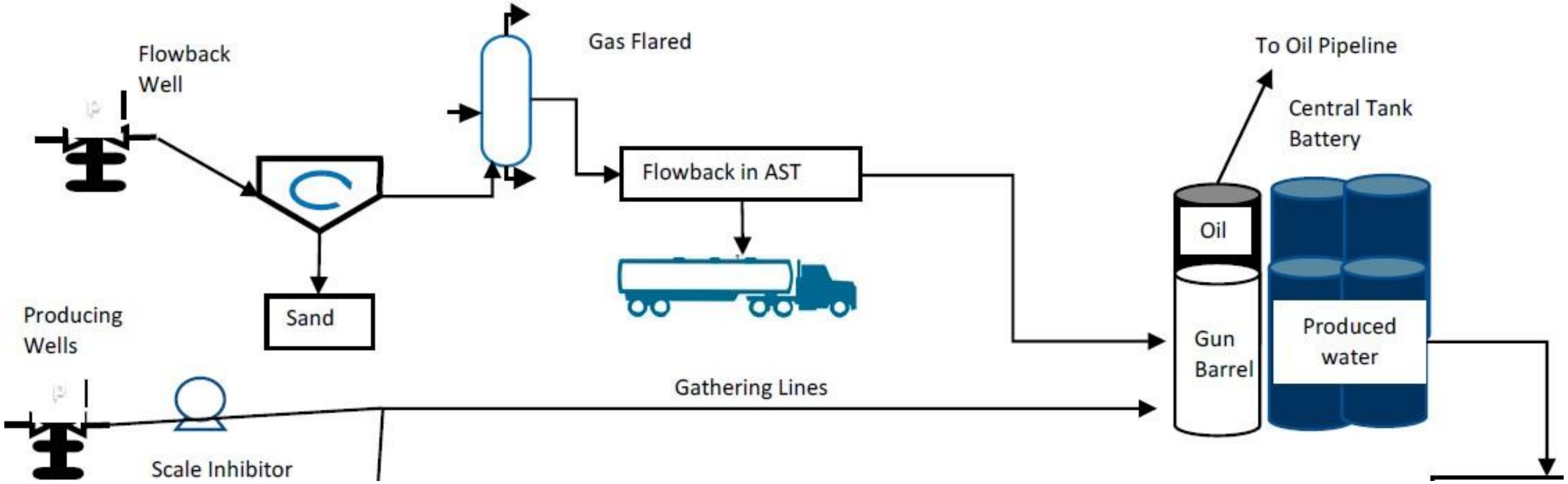
Produced Water Background



Major US Shale Plays

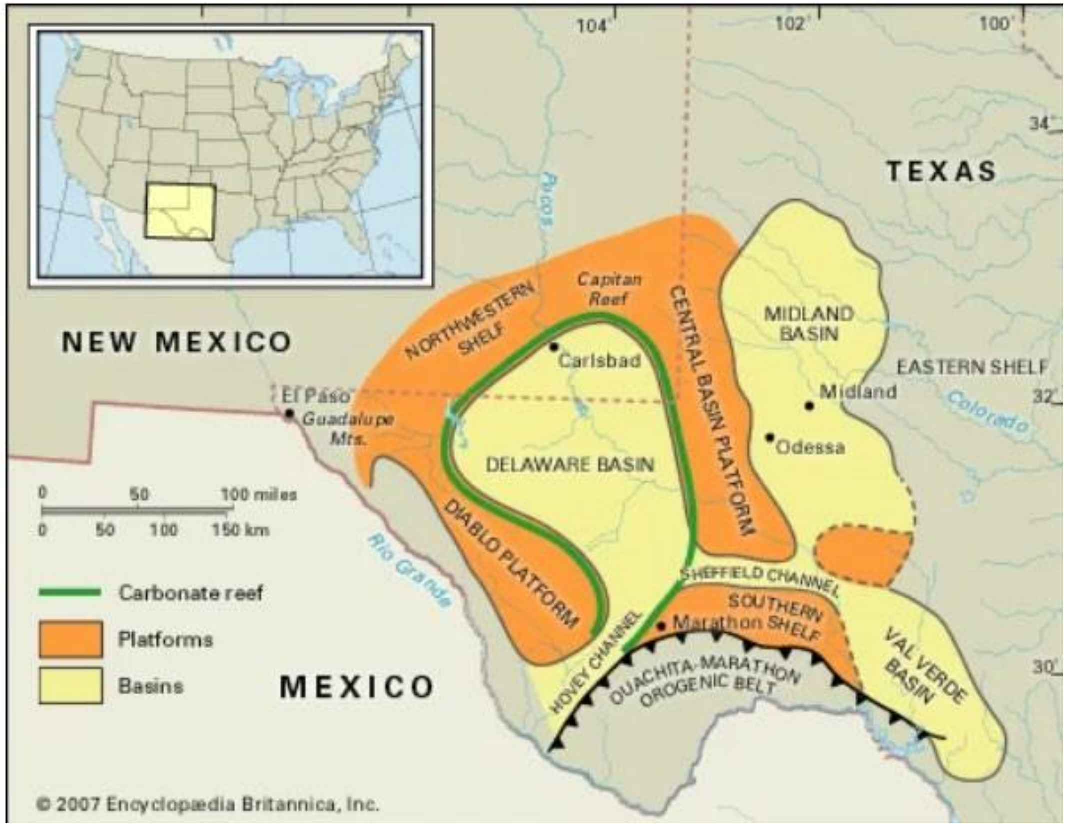
Shales are drilled into and fractured
Oil, gas and produced water come to surface
Produced water varies
by quality (TDS)
by quantity

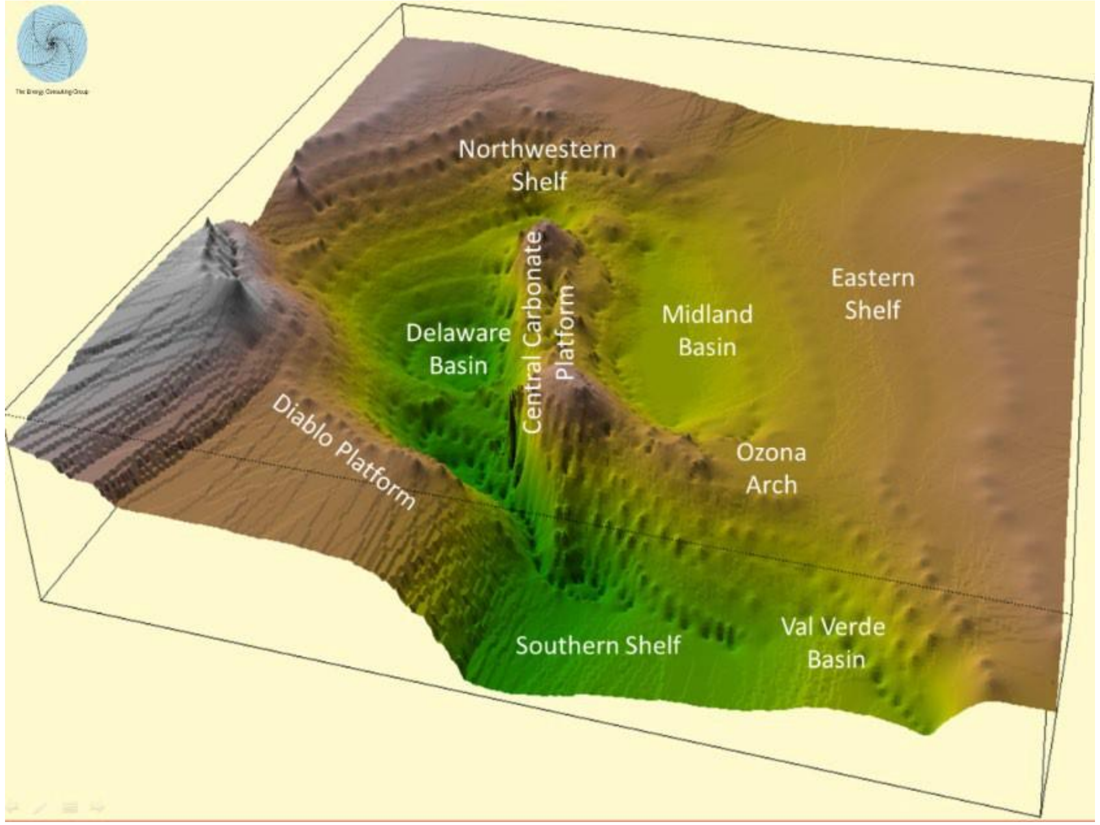
Produced Water Background



Produced Water Background

Permian Basin Detail





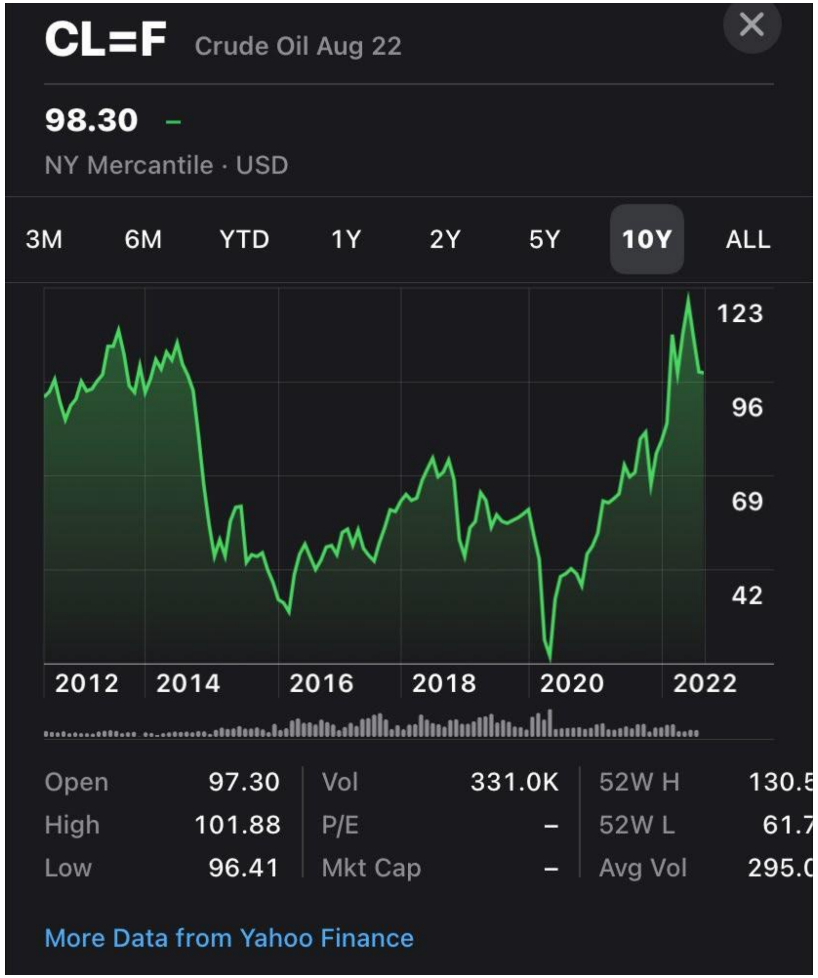
Defining the Problem-Near

ENVIRONMENT & CLIMATE CHANGE | GOV & POLITICS

Rise in New Mexico earthquakes likely triggered by oil industry

Wastewater injection wells are believed to be behind the significant increase in seismic activity

BY: **JERRY REDFERN, CAPITAL & MAIN** - 7:13 AM



SMART NEWS

Rio Grande Runs Dry in Albuquerque

The river is an important water source for central New Mexico, and it's also home to the endangered silvery minnow

Margaret Osborne

Energy Partners LP

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Defining the Problem-and Far

U.S. Government Accountability Office

FOR CON

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Critical Mineral Shortages Could Disrupt Global Supply Chains

Posted on June 21, 2022

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World's Top Producer of Ammonia, a Key Component in Fertilizer, Slashes Production Amid German Energy Crisis

By Neil Campbell
Neil lives in Canada and writes about society and politics.

Published: July 29, 2022

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Present Efforts-NM

Our Mission:

The mission of the Consortium is to advance scientific research and technology development required to guide future statewide produced water reuse policy.

Our Goals:

1) Fill scientific and technical knowledge gaps necessary to establish regulations and policies for fit-for-purpose treatment and reuse of produced water, and
2) Accelerate technology and process research, development, and implementation for environmentally sound, safe, and cost-effective reuse of produced water for industrial, construction, agricultural, rangeland, livestock, municipal, aquifer storage, surface water, and/or other applications.

The Process:

More info at
http://nmpwrc.nmsu.edu

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Present Efforts-TX

EPA Approves Texas NPDES Oil and Gas Program Authorization

On January 15, 2021, the US Environmental Protection Agency (the EPA) announced that it approved an application from the State of Texas to administer the National Pollutant Discharge Elimination System (NPDES) program for discharges into waters of the State from oil and gas operations. The specific discharges addressed by this action include produced water, hydrostatic test water and gas plant effluent.

The EPA, the State of Texas and proponents of the program transfer believe it promotes environmental protection and regulatory efficiency. In comments addressed by the EPA in the **Federal Register**, opponents to the change expressed a general distrust of the State's regulation of the oil and gas industry.

This federal action, which took effect during the final week of the Trump administration, provides for the Texas Commission on Environmental Quality (the TCEQ) to take over responsibility for permitting authority for such discharges from oil and gas activities, pipelines and natural gas processing plants that were previously under the jurisdiction of the Texas Railroad Commission (RRC).

The State's request for this change required several legislative and regulatory steps. On June 14, 2019, Texas Governor Greg Abbott signed Texas House Bill (HB) 2771 directing the TCEQ to seek NPDES program authority. HB 2771 also ordered the transfer of permitting authority for these discharges from the RRC to the TCEQ upon approval of program authorization, and the transfer of program authority from the EPA to the TCEQ. On October 12, 2020, Texas formally submitted to the EPA a request for NPDES program authorization for oil and gas discharges.

WATER MANAGEMENT

Texas Tech Heads Collaboration to Study Impact, Technology for Recycling Produced Water

The Texas Produced Water Consortium will bring together industry, stakeholders and university expertise to grow understanding and formulate research for produced water management in Texas.

Hart Energy staff Thu, 07/08/2021 - 01:36 PM

The Texas Produced Water Consortium, introduced to the Texas Legislature by state Sen. Charles Perry and signed by Gov. Greg Abbott in June, will bring together diverse stakeholders, experts and key information resources to study the economic impact of and technology needed to reuse produced water, including environmental and public health considerations.

Strategic Opportunities

Very rarely in life are there silver bullet solutions that can solve multiple complex problems. We have one before us at this time.

Problems

-Induced Seismicity
-Aquifer Depletion
-Critical Mineral Shortage
-Water Scarcity
-Lack of Regional Economic Diversity
-Bridge to Energy 2.0

Solution

Advanced treatment and utilization of produced water

Baseline Analysis

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Research Paper

Characterization of produced water and surrounding surface water in the Permian Basin, the United States

Wenbin Jiang[a], Xuesong Xu[a], Ryan Hall[b], Yanyan Zhang[a], Kenneth C. Carroll[c], Frank Ramos[d], Mark A. Engle[e], Lu Lin[a], Huiyao Wang[a], Matthias Sayer[b], Pei Xu[a,*]

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Table 1
Statistical results of general quality parameters of the total 46 PW samples.

		Mean	Max	Min	25th percentile	50th percentile	75th percentile
Alkalinity	mg/L as $CaCO_3$	272	870	100	128	207	336
Ammonia	mg/L	432	750	320	330	400	495
COD	mg/L	1626	3100	930	1250	1400	1950
pH	SU	6.6	8.1	3.9	6.3	6.7	7.0
TDS	mg/L	128,641	201,474	100,830	113,441	122,280	134,525
TOC	mg/L	103.5	248.1	2.4	28	90.6	173.3
TSS	mg/L	342.9	790	85	142.5	375	422.5
Turbidity	NTU	116.4	200	23	36	110	200
MBAS	mg/L	1.10	2.1	0.047	0.92	0.97	1.33

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Baseline Analysis

Statistical results of comprehensive elements analyses of the 46 PW samples.

		Mean	Max	Min	25th percentile	50th percentile	75th percentile
Cations							
Aluminum	mg/L	1.09	3.95	0.37	0.63	0.76	1.25
Arsenic	mg/L	3.17	6.04	1.62	1.74	2.64	4.61
Barium	mg/L	2.21	12.00	0.10	0.45	1.69	3.00
Beryllium	mg/L	0.03	0.04	0.01	0.01	0.03	0.04
Bismuth	mg/L	1.02	1.77	0.71	0.72	0.81	1.55
Boron	mg/L	42.34	76.50	17.20	33.29	40.65	51.03
Cadmium	mg/L	0.47	0.81	0.04	0.08	0.63	0.77
Calcium	mg/L	3821	8186	880	1705	3531	5744
Chromium	μg/L	1.7	2.2	1.3	1.3	1.6	2.2
Cobalt	μg/L	7.7	7.8	7.5	7.5	7.7	7.8
Copper	mg/L	0.65	1.46	0.24	0.24	0.45	1.26
Ferrous iron	mg/L	3.09	6.70	0.57	0.73	3.00	5.50
Iron	mg/L	19.35	65.20	0.50	4.60	14.00	25.70
Lithium	mg/L	22.39	52.28	11.74	20.00	21.02	23.40
Magnesium	mg/L	745.0	1877	295.3	472.7	621.3	959.1
Manganese	μg/L	488	1239	10	116	427	781
Molybdenum	mg/L	0.21	0.38	0.10	0.11	0.18	0.35
Potassium	mg/L	923	3637	222	449	808	1171
Selenium	mg/L	2.5	2.5	2.5	n/a	2.5	n/a
Silica	mg/L	107.7	195.4	4.0	29.2	115.7	178.2
Sodium	mg/L	40,896	68,985	25,080	37,000	39,673	42,967
Strontium	mg/L	449.9	1404	28.9	116.4	325.3	816.5
Thallium	mg/L	0.83	0.84	0.82	n/a	0.83	n/a
Thorium	mg/L	0.048	0.054	0.035	0.035	0.054	0.054
Uranium	mg/L	0.303	0.5	0.19	0.19	0.22	0.5
Vanadium	μg/L	79.6	94.5	61.4	61.4	83.0	94.5
Zinc	mg/L	1.14	1.81	0.17	0.17	1.45	1.81
Anions							
Sulfate	mg/L	496	965	151	243	510	690
Phosphorus as P	mg/L	8.5	36.0	1.7	2.5	6.4	8.9
Nitrite as N	mg/L	n/a	16	n/a	n/a	n/a	n/a
Iodide	mg/L	88	94	77	82	90	94
Chloride	mg/L	78,648	120,200	57,543	69,269	75,658	86,979
Bromide	mg/L	431	960	95	238	289	608
Radionuclides							
Gross Alpha	pCi/L	1105.6	1630	660	745	863	1630
Gross Beta	pCi/L	874.6	1230	456	748	889	1050
Radium-226	pCi/L	237.6	970.0	0.7	19.1	72.8	415.5
Radium-228	pCi/L	231.7	576.0	2.6	137.5	273.0	285.0
Uranium-234	pCi/L	0.33	0.76	0.20	0.24	0.24	0.24
Uranium-238	pCi/L	0.17	0.17	0.17	n/a	n/a	n/a
Thorium-228	pCi/L	21.5	52.1	3.4	3.7	21.5	30.5
Thorium-230	pCi/L	0.22	0.39	0.09	0.17	0.21	0.24
Polonium-210	pCi/L	3.28	5.38	1.75	2.24	2.72	4.05
Plutonium-238	pCi/L	0.17	0.17	0.17	n/a	n/a	n/a

Note: n/a: not available.

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Baseline Analysis

Statistical results of the detected organic compounds in the ten PW NM SWD samples.

		Mean	Max	Min	25th percentile	50th percentile	75th percentile
VOC							
Benzene	μg/L	2611.1	4900	1900	2200	2200	2600
Ethylbenzene	μg/L	112.2	160	72	93	110	130
Toluene	μg/L	2533	3700	1700	2000	2400	2900
Xylenes, Total	μg/L	1185.6	1600	710	1100	1300	1400
SVOC - General							
1,1′-Biphenyl	μg/L	5.9	8.5	3.8	4.6	5.2	7.2
1,4-Dioxane	μg/L	n/a	21	ND	n/a	n/a	n/a
1-Methylnaphthalene	μg/L	22.7	36	15	18	21	26
2-Methylnaphthalene	μg/L	38.3	65	26	29	36	45
2-Methylphenol	μg/L	81.8	98	68	77	80	85
2,4-Dimethylphenol	μg/L	34.1	42	29	31.5	33	36
Ethylene glycol	mg/L	n/a	27	ND	n/a	27	n/a
Ethanol	mg/L	0.51	0.98	0.14	0.21	0.57	0.67
Methanol	mg/L	24.5	52	5.6	12	26	27
Methylphenol, 3 & 4	μg/L	90.4	110	72	85	91	96
Phenol	μg/L	203.3	250	170	170	210	220
Pyridine	μg/L	237.5	300	120	235	240	260
Pesticides/Herbicides							
alpha-BHC (benzene hexachloride)	μg/L	0.018	0.027	0.009	n/a	n/a	n/a
Endosulfan I	μg/L	0.855	0.98	0.73	n/a	n/a	n/a
Endrin	μg/L	n/a	0.004	ND	n/a	0.004	n/a
Organic Acids							
Acetic acid	mg/L	n/a	89	n/a	n/a	n/a	n/a
Butyric acid	mg/L	n/a	7.1	n/a	n/a	7.1	n/a
Propionic acid	mg/L	n/a	5.7	n/a	n/a	5.7	n/a
SVOC-PAH							
Anthracene	μg/L	n/a	1.1	ND	n/a	n/a	n/a
Naphthalene	μg/L	15	24	11	12	16	16
Phenanthrene	μg/L	3.76	6.6	2.7	3.18	3.4	4.03
Fluorene	μg/L	4.35	5.6	3.1	n/a	4.7	n/a
Carbonyl Compounds							
Formaldehyde	mg/L	0.14	0.21	0.053	0.11	0.15	0.18
SVOC-TPH							
n-Decane	μg/L	556.7	890	340	390	530	610
Oil and Grease							
DRO (C10-C20)	mg/L	49	130	22	26	35	52
GRO (C6-C10)	mg/L	23.5	46	13	15	19.5	28
MRO (C20-C34)	mg/L	32.4	97	12	16	26	32
Tributyl phosphate	μg/L	34.6	74	3.3	12	30.5	53
Tentatively Identified Compounds (TIC)	μg/L	531.1	1000	280	320	350	840

= 130,000bbl skim oil in June

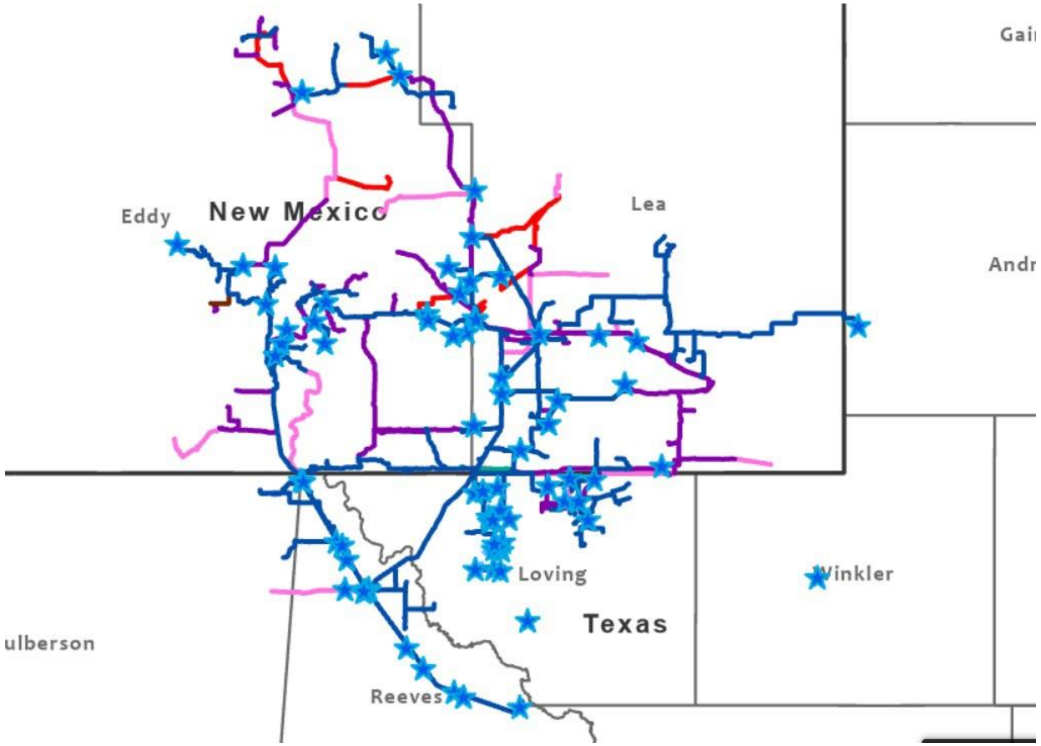
Baseline Analysis-BONUS!!

PFAS analyses results of a PW-NM-SWD and a Pecos RW-NM sample (unit: ng/L).

	PW/ Pecos	PW MDL/RL	Pecos MDL/RL		PW/ Pecos	PW MDL/RL	Pecos MDL/RL
PFBS	0.17 J/2.0	0.15/1.5	0.16/1.6	PFNS	ND/ND	0.12/1.5	0.13/1.6
PFBA	0.31 J B/ 1.3 J B	0.25/1.5	0.28/1.6	PFNA	ND/ND	0.2/1.5	0.21/1.6
PFDS	ND/ND	0.23/1.5	0.25/1.6	FOSA	ND/ 0.54 J B	0.25/1.5	0.28/1.6
PFDA	ND/ND	0.23/1.5	0.24/1.6	PFOS	ND/1.2 J	0.39/1.5	0.42/1.6
PFDoS	ND/ND	0.33/1.6	0.35/1.6	PFOA	ND/1.0 J	0.62/1.5	0.67/1.6
PFDoA	ND/ND	0.4/1.6	0.43/1.6	PFPeS	ND/0.24 J	0.22/1.5	0.24/1.6
PFHpS	ND/ND	0.14/1.6	0.15/1.6	PFPeA	ND/1.8	0.36/1.5	0.39/1.6
PFHpA	ND/0.35 J	0.18/1.5	0.2/1.6	PFTeA	0.24 J/ND	0.21/1.5	0.23/1.6
PFHxS	0.25 J B/ 1.0 J B	0.12/1.5	0.13/1.6	PFTriA	ND/ND	0.94/1.5	1/1.6
PFHxA	ND /1.2 J	0.42/1.5	0.46/1.6	PFUnA	ND/ND	0.8/1.5	0.87/1.6
NEtFOSA	ND/ND	0.63/1.5	0.68/1.6	NMeFOSA	ND/ND	0.31/1.5	0.34/1.6
NEtFOSE	0.98 J/ND	0.62/1.5	0.67/1.6	NMeFOSAA	ND/ND	2.3/15	2.4/16
NEtFOSAA	ND/ND	1.4/15	1.5/16	NMeFOSE	ND/ND	1/2.9	1.1/3.1
4:2 FTS	ND/ND	3.8/15	4.1/16	6:2 FTS	ND/ND	1.5/15	1.6/16
8:2 FTS	ND/ND	1.5/15	1.6/16	10:2 FTS	ND/ND	0.14/1.5	0.15/1.6
DONA	ND/ND	0.13/1.5	0.14/1.6	HFPO-DA (GenX)	ND/ND	1.1/2.9	1.2/3.0
F-53B Major	ND/ND	0.17/1.5	0.19/1.6	F-53B Minor	ND/ND	0.23/1.5	0.25/1.6

PFAS detected at low levels in both sources, FW about 5X PW

End State



<u>NGL Stats</u>

Most PW in US at over 2MM BBL/Day

Long Term **<u>Dedications</u>**

Over 130 Class II UICs

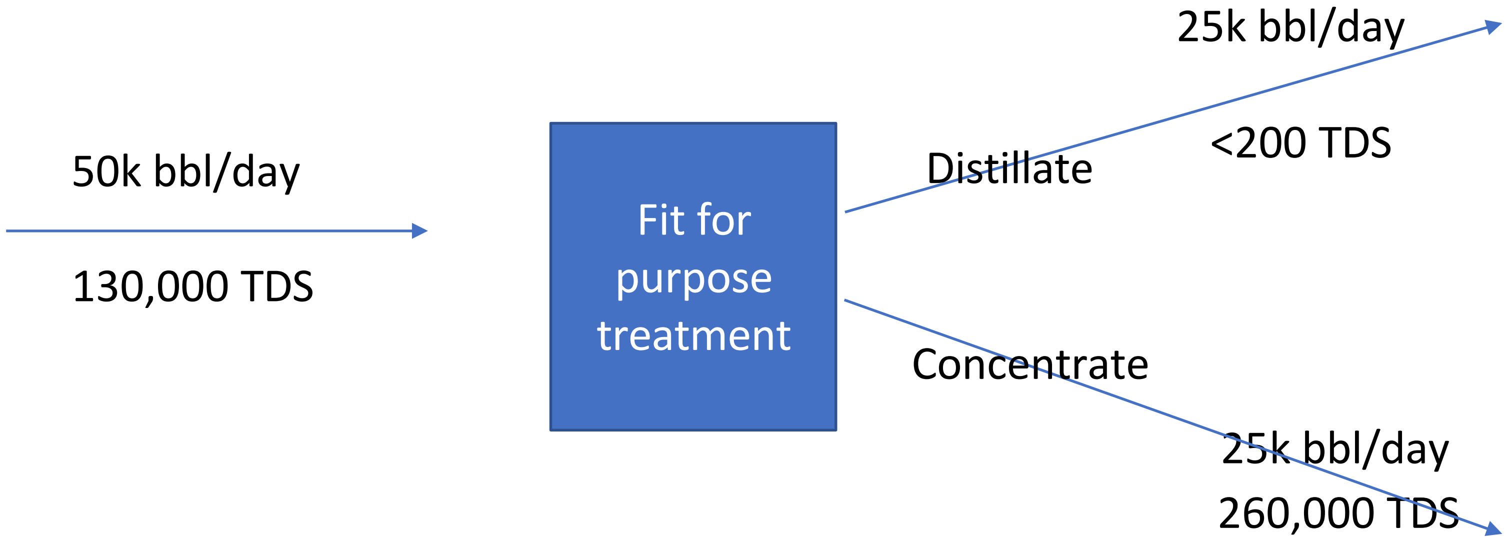
Average > 25K BBL/day

Over 600 miles LD pipeline

End State

<u>Consider 1 50k BBL/day facility</u>

Used in H2 generation
Non Consumptive Ag.
Consumptive Ag.
Aquifer Recharge



Chloralkaline process
Li , I, REE
Ammonia
Reduced volume Class II UIC injection

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End State

Consider 1 50k BBL/day facility

25k BBL/day distillate= 383MM gal/yr

= 1176 acre feet/yr

= enough for 320 tons of cotton/yr

= enough for 17,000 people

= enough for 437,500kg green H/day

25k BBL/day concentrate

= 689t/yr Ammonium

=39t/yr Li

=127t/yr I