

EUREKA RESOURCES, LLC

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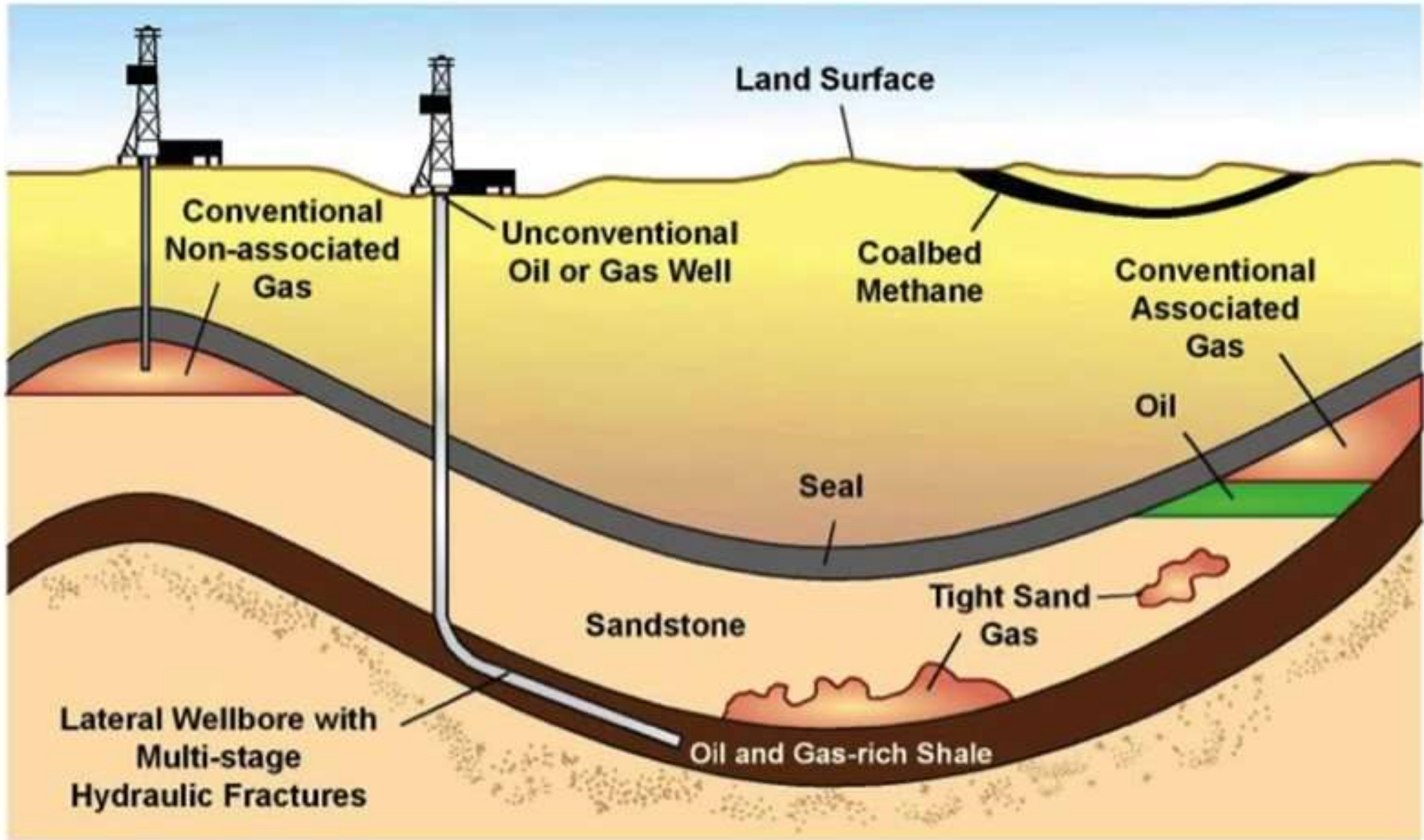
*Managing Engineer
C&S Engineers*



**A Sustainable
Choice for
Unconventional Oil
& Gas Wastewater
Management and
Co-Product
Recovery**

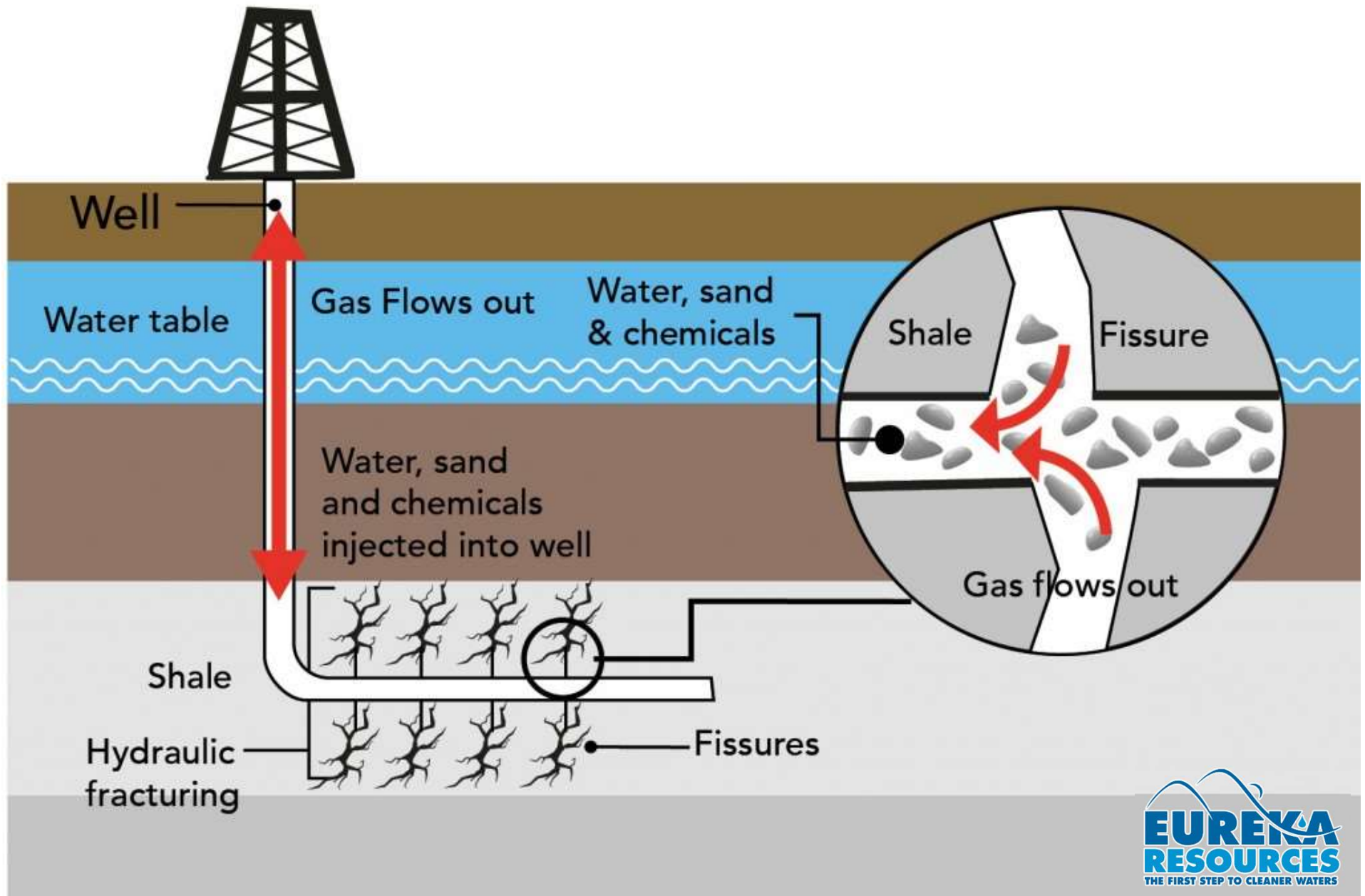


What is Unconventional Oil & Gas Wastewater?



Source: EIA

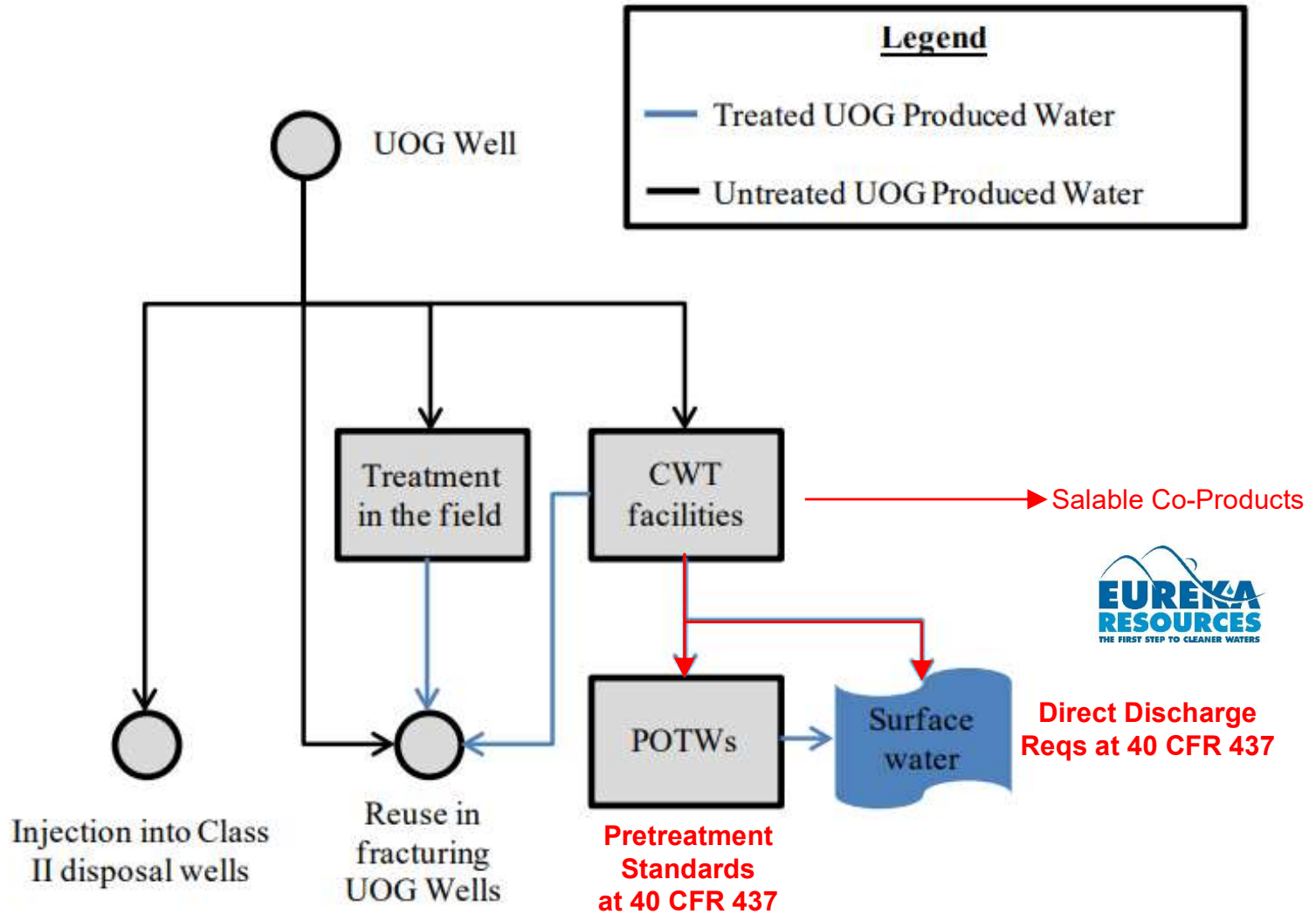
Shale gas extraction



Wastewater Characteristics Comparison

Parameter (mg/L)	Municipal Wastewater, Typ. (M&E)	Marcellus (PA - Eureka)
TS	<700	100,000 – 600,000
TDS	<500	250,000 – 400,000
Metals	<150	>25,000 (individual)
Chlorides	<50	140,000 – 150,000
Sodium	40-70	50,000 – 60,000
TENORM (μR/hr)	BG	BG – BG+250
COD	260 - 900	20,000 – 30,000
Total N	<40	200 – 600

Primary Management Methods



Source, USEPA, June 2016.

Background and Philosophy

- Eureka is a pioneer and leader in development of innovative, cost-effective, and environmentally-responsible solutions for treatment and management of unconventional oil and gas wastewater.
- Permit/design/build/operation of robust, centralized oil and gas wastewater treatment facilities with the following goals and objectives:
 - **Level-of-treatment optionality:**
 - Pretreated Wastewater - water treated to reduce the suspended solids; some dissolved solids.
 - Distilled Wastewater - water treated to remove dissolved solids
 - Concentrated CaCl₂ Brine - heavy (over 10.5 pounds per gallon) water that is very high in dissolved solids
 - De-Wasted (Fresh) Water - water that meets freshwater standards – WMGR123 Appendix A Limits.
 - **Disposal-level treatment:**
Ability to convert complex residual waste into freshwater.
 - **Turning residual waste into commercial-grade usable co-products:**
Maximizing recovery and beneficial reuse of recoverable co-products – MeOH, NaCl, Ca₂Cl, LiCl.
 - Approaching **TRUE** Zero Liquid Discharge (ZLD).

Existing Treatment Facilities

Second Street Facility, Williamsport, PA

- 8,000 to 10,000 BPD pre-treat capacity
- 2,400 to 4,800 BPD distillation capacity
- Discharge permit for disposal to WSA POTW (only one in the entire state of PA)
- Robust Solids-handling & Oil Recovery Systems
- Methanol Rectification Column



Reach Road Facility, Williamsport, PA

- Truck unloading / treatment / storage
- Future rail access
- Fully permitted site with potential discharge capability

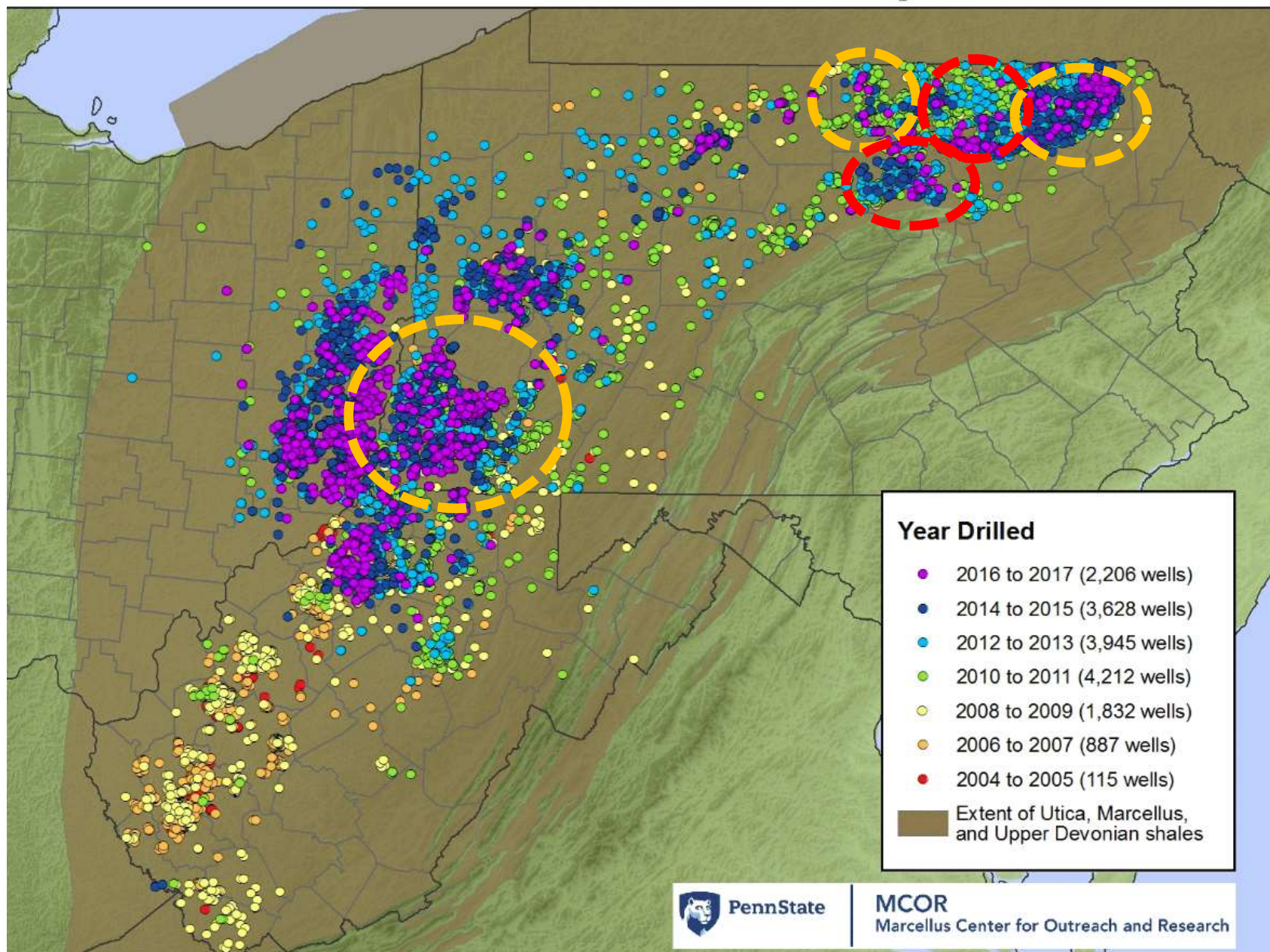


Standing Stone, PA Facility

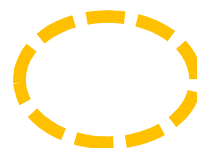
- 6,000 to 8,000 BPD pre-treat capacity
- 5,000 BPD crystallization
- Eureka patented “dewaste” process
- Discharge permit to Susquehanna River (only operating Marcellus discharge in state of PA)
- Commercial salt drying and packaging line.
- Ability to process low and high TDS waters.



Unconventional Wells Drilled by Year

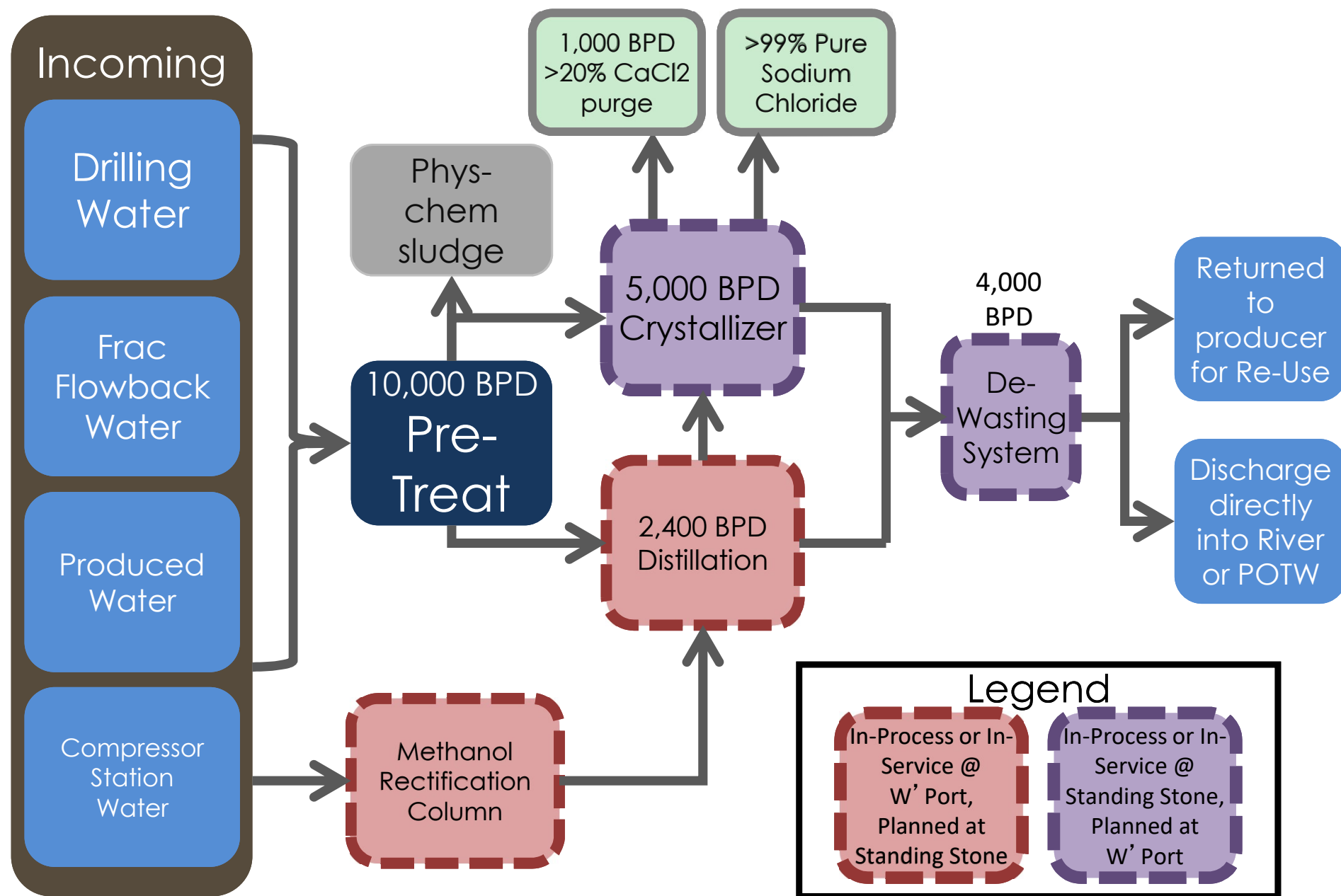


Existing plants and
approximate watersheds
served



Proposed facilities and
approximate watersheds
to be served

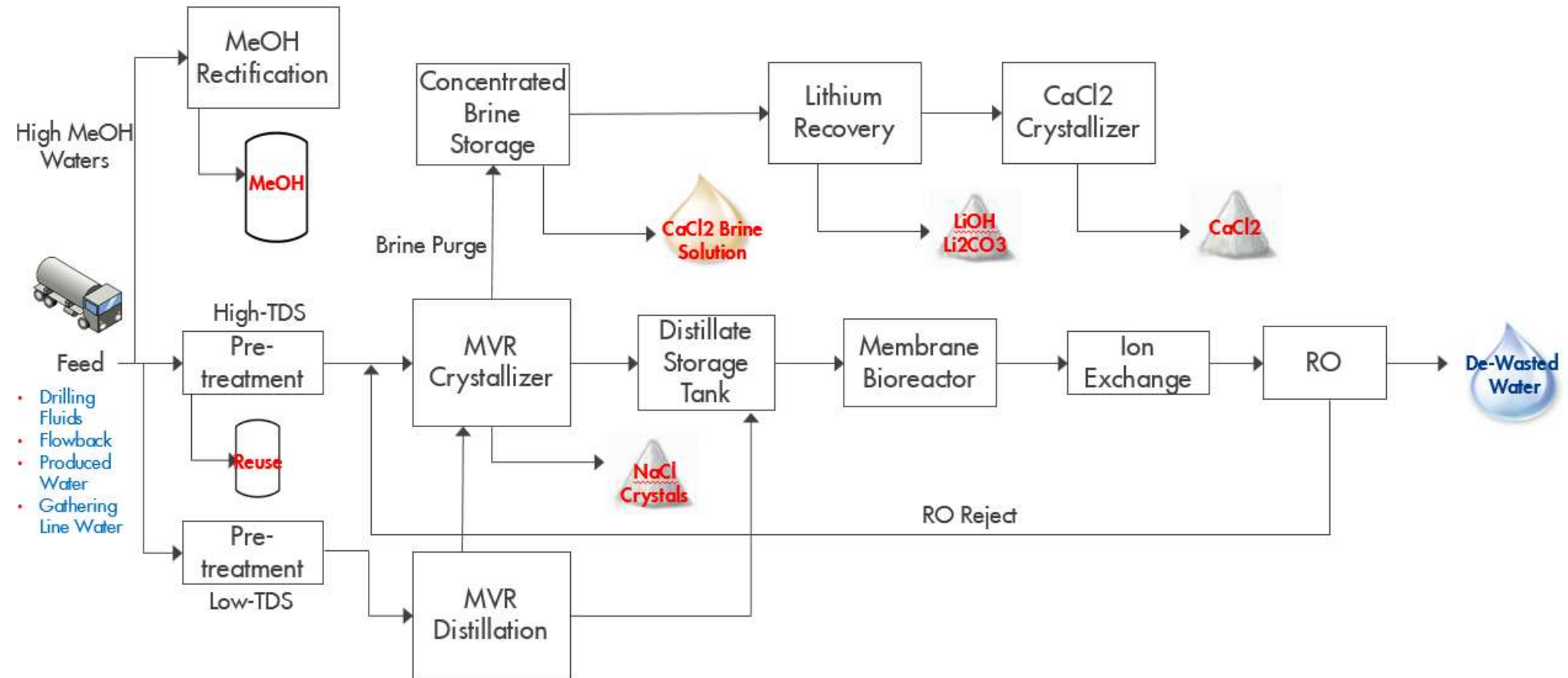
Patented Process Overview



Eureka Resources

Patented Treatment and Resource Recovery

Process Overview



The Water Conditioning Salt Success Story – From O&G Wastewater... to Big Box Store Shelves @ Walmart and Lowes

- Multi-year deal in hand with biggest distributor of sodium chloride in North America (Scotwood Industries).
- Capital investment in salt drying and bagging processes (20 t/hr nameplate capacity).
- Currently generating 100 – 125 pallets/day of bagged product.



Final Effluent Quality – Williamsport Facility

Indirect Discharge to Municipal POTW

Parameter	Effluent Limit – Monthly Ave. (mg/L)	Long Term Ave Effluent Quality (mg/L)
COD (Load – PPD)	1,688	550
CBOD (Load – PPD)	1,298	363
TSS	Monitor	<5
Chloride	125	2.37
Barium	2.0	0.13
TDS	250	<25
Ammonia	Monitor	<45
Ra-226, Ra-228 (pCi/L)	Monitor	<1

- Federal CWT ELGs in Organics Treatment and Recovery Subpart (40 CFR 437, Subpart C)
- 25 Pa Code Chapter 95
- WSA Regulations

Final Effluent Quality – Standing Stone Facility

Direct Discharge to Susquehanna River

Parameter	Effluent Limit – Monthly Ave. (mg/L)	Long Term Ave Effluent Quality (mg/L)
BOD ₅	53	<2
TSS	61.3	<5
TDS	500	<20
NH ₃	10	<1 - 6
Barium	10	<0.01
Chloride	250	<1 - 3

- Federal CWT ELGs in Organics Treatment and Recovery Subpart (40 CFR 437, Subpart C)
- 25 Pa Code Chapter 95

Nearest Public Water Supply Intake:

Danville, PA – 127 miles downstream

De-Wasting Demonstration

PADEP WMGR123 Appendix A

- Sampling Plan based on WMGR123 Appendix A General Permit Requirements
- Conducted sample collection (MBR/IX/RO effluent) for the initial demonstration from July 21 through September 19, 2014:
 - Daily flow-proportional composite samples
 - Weekly flow-proportional composite samples
 - Grab samples
- Analytical results confirmed that concentrations of all parameters as required by Part C.22.b of the WMGR123 permit were **lower than, equal to, or otherwise not detected** when compared to the de-wasting limits included in Appendix A for all samples
- **De-Wasting demonstration approved by PADEP on 11/24/14**

Parameter	Standard (mg/L)
Metals	1.2 ug/L – 25 mg/L
Chloride	25
NH3	2
Bromide	0.1
COD	15
Ethylene Glycol	13 ug/L
Gross Alpha, Beta	15 – 1000 pCi/L
MBAs	0.5
Alcohols	0.7 – 3.5
O&G	ND
Nitrate-Nitrite	2
pH	6.5 – 8.5
Ra-226 + Ra-228	5 pCi/L
Sulfate	25
Toluene	0.33
TDS	500
TSS	45
Uranium	30 ug/L

Effluent Characterization for Center for Responsible Shale Development (CRSD) Certification



CRSD Effluent Characterization Approach and Results

- De-Wasting System (MBR/IX/RO) effluent samples
- Five sampling events over three weeks
- Parameter list developed by CSSD based on potential chemical constituents in produced and flow back wastewater within Appalachia Basin
- Wastewater Effluent Toxicity (WET) testing also performed
- **Eureka is 'Best Available Technology' basis for CRSD shale wastewater effluent surface water performance standard**

Analysis	Method
TOC	EPA 415.1
Aldehydes	SW-846 8315
VOCs	SW-846 8260B with 20 non-interpretive TICs
SVOCs	SW-846 8270C with 25 non-interpretive TICs
Pentanoic and Hexanoic Acids	8270C-TLS (Library Search)
Organic Acids	SW-846 8015B (mod)
Alcohols	SW-846 8015B (mod)
Glycols	LC/MS/MS 8321AMOD
TPH C8-C40	SW-846 8015B (TPH)
30 ICP Metals	SW-846 6010B
Anions - Sulfate, Chloride, Fluoride, Bromide	EPA 300
Ammonia	EPA 350.2
TDS	SM 2540D
Ra 226 and Ra 228, dissolved, insoluble	EPA 903.1 and 904
Acrylamide	EPA 603
MBAS	Method SM 5540 C-2000
Mercury	Cold Vapor Method EPA 245.7
Nonylphenol	WS-MS-0010
Nitrite	SW-846 9056/A

Advantages to Eureka's Philosophy

- Valuable freshwater returned back to the hydrologic cycle; disposal-level solution; very valuable as play shifts towards production phase and creates water imbalance.
- No adverse to downstream public water intakes.
- Lower risk profile compared with other management alternatives, such as:
 - Storage and reuse without treatment and/or minimal level of treatment
 - UIC disposal; where logistics are favorable, centralized treatment are cost competitive
- Breaks the cycle of continual accumulation of dangerous contaminants in, or emission to, the environment; provides best opportunity to CAPTURE AND RECOVER contaminants (e.g., VOCs, HAPs, TENORM, salts) – a TRUE SINK for contaminants.
- Reduction of the long-term costs associated with continual cycle of treatment and recycling of oil and gas wastewaters
 - Field storage and transport of dangerous residual waste
 - Reduced EURs and well fouling
 - Complexity of drilling and completion fluids engineering
 - UIC impacts (*seismic? aquifer contamination? over-pressurized producing zones?*)
- **Complete revision of public perceptions!!!** The technology and expertise IS out there to manage unconventional O&G brines!