DOE Projects to Advance Environmental Science and Technology

Nine Unconventional Natural Gas Projects Address Water Resource and Management Issues

Washington, D.C. — The U.S. Department of Energy's (DOE) Office of Fossil Energy's, National Energy Technology Laboratory's (NETL) primary goal is to enhance the responsible development of domestic natural gas and oil resources that supply the country's energy. A specific objective is to accelerate the development and demonstration of technologies that will aid our country's independent producers in dealing with use and treatment of water related to natural gas and oil production.

Project DE-FE0000833 titled, "*An Integrated Water Treatment Technology Solution for Sustainable Water Resource Management in the Marcellus Shale"* attained its goals. During nine continuous months of operation, the AltelaRain® system placed adjacent to a natural gas well treated 77 percent of the frac flowback and production wastewater on -site, providing distilled water as the product. See Final Scientific/Technical Report: http://www.netl.doe.gov/technologies/oil-gas/publications/ENVreports/fe0000833-final-report.pdf

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PA DEP Water Analytical Report - November 2009
AltelaRain® ARS-4000 System - Butler County, PA

	DESCRIPTION	11/24/09 RAW RESULTS	11/24/09 CON RESULTS	11/24/09 DISTILLED RESULTS
1	Chloride - IC	10416.0 mg/L	66205. mg/L	51.0 mg/L
2	Osmotic Pres	542 MOSM	2350 MOSM	18 MOSM
3	Bromide	106.0 mg/L	631.0 mg/L	< 0.2 mg/L
4	Amonia-N T	33.47 mg/L	99.34 mg/L	Cancelled
5	Selenium T	< 70.0 ug/L	70.2 ug/L	< 7 ug/L
6	Thallium T	< 20.0 ug/L	< 20.0 ug/L	< 2 ug/L
7	Arsenic T	< 30.0 ug/L	< 30.0 ug/L	< 3.0 ug/L
8	Arsenic D	< 30.0 ug/L	< 30.0 ug/L	Cancelled
9	Lead T	< 10.0 ug/L	66.0 ug/L	< 1.0 ug/L
10	Lead D	< 10.0 ug/L	72.4 ug/L	Cancelled
11	Antimony T	< 20.0 ug/L	35.2 ug/L	< 2.0 ug/L
12	Antimony D	< 20.0 ug/L	36.6 ug/L	Cancelled
13	Selenium D	< 70.0 ug/L	< 70.0 ug/L	Cancelled
14	Thallium D	< 20.0 ug/L	< 20.0 ug/L	Cancelled
15	Silver D	10.0 ug/L	10.0 ug/L	Cancelled
16	Cadmium D	10.0 ug/L	10.0 ug/L	Cancelled
17	Chromium T	50.0 ug/L	50.0 ug/L	< 50.0 ug/L
18	Copper T	10.0 ug/L	320.0 ug/L	13.0 ug/L
19	Potassium D	59.8 mg/L	365.0 mg/L	Cancelled
20	Lithium D	13200.00 ug/L	79300.0 ug/L	Cancelled
21	Magnesium T	85.60 mg/L	564.0 mg/L	0.664 mg/L
22	Manganese T	800.0 ug/L	3990.0 ug/L	169.0 ug/L
23	Manganese D	720.0 ug/L	3740.0 ug/L	Cancelled
24	Silver T	10.0 ug/L	10.0 ug/L	< 10.0 ug/L
25	Aluminum T	200.0 ug/L	200.0 ug/L	< 200.0 ug/L
26	Aluminum D	200.0 ug/L	200.0 ug/L	Cancelled
27	Barium T	5530.0 ug/L	32000.0 ug/L	338.0 ug/L
28	Barium D	6220.0 ug/L	29900.0 ug/L	Cancelled
29	Beryllium T	1.0 ug/L	1.0 ug/L	< 1.0 ug/L
30	Beryllium D	1.0 ug/L	1.0 ug/L	Cancelled
31	Calcium D	780.0 mg/L	5080.0 mg/L	Cancelled
32	Calcium T	895.0 mg/L	5730.0 mg/L	6.52 mg/L
33	Cadmium T	10.0 ug/L	10.0 ug/L	< 10.0 ug/L
34	Chromium D	50.0 ug/L	50.0 ug/L	Cancelled
35	Copper D	10.0 ug/L	300 ug/L	Cancelled
36	Iron D	11800.0 ug/L	18500.0 ug/L	Cancelled
37	Iron T	13800.0 ug/L	20200.0 ug/L	526.0 ug/L
38	Potassium T	66.0 mg/L	404.0 mg/L	< 1.0 mg/L
39	Lithium T	14700.0 ug/L	84500.0 ug/L	70.0 ug/L
40	Magnesium D	77.1 mg/L	504.0 mg/L	Cancelled
41	Sodium T	5770.0 mg/L	34500.0 mg/L	24.4 mg/L
42	Sodium D	4930.0 mg/L	30100.0 mg/L	Cancelled
43	Nickel T	50.0 ug/L	50.0 ug/L	< 50 ug/L
44	Nickel D	50.0 ug/L	50.0 ug/L	Cancelled
45	Zinc T	10.0 ug/L	1120.0 ug/L	62.0 ug/L
46	Zinc D	10.0 ug/L	1020.0 ug/L	Cancelled
47	Hardness T	2590 mg/L	16649 mg/L	19 mg/L
48	Hot Acidity	4.8 mg/L	-88.80 mg/L	-12.8 mg/L
49	pH	6.2 pH units	6.3 pH units	7.0 pH units
50	SPC @ 25.0 C	29100.00 umhos/cm	> 111900.0 umhos/cm	276.0 umhos/cm
51	Alkalinity	165.2 mg/L	434.8 mg/L	34.2 mg/L
52	TDS @ 105 C	23586. mg/L	136522. mg/L	122. mg/L
53	TSS Wash 3x	48 mg/L	84 mg/L	< 5 mg/L
54	Sulfate - IC	21.6 mg/L	< 5.0 mg/L	1.69 mg/L

SUSTAINABLE WATER TREATMENT, RECYCLING & DISPOSAL PRACTICES IN THE MARCELLUS SHALE BASIN

LANDFILL GAS TO ENERGY

Designed to beneficially use landfill gas ("LFG"), the CARES McKean Facility employs LFG fired boilers to generate steam for the AltelaRain® thermal distillation circuit.

The facility currently uses approximately 350 standard cubic feet per minute of landfill gas with an average methane content of approximately 52%. The methane gas is chilled prior to sending it in the transmission pipeline to the CARES facility using a multistage centrifugal blower. The landfill gas is regulated into either of two 9.8 million BTU low pressure steam boilers at roughly 2 psi. The boiler manifolds were modified to support beneficial use of the landfill gas.

NPDES DISCHARGE PERMIT PA01012288 (as amended)

Following PA DEP's recent Chapter 95 regulatory changes, the CARES McKean TRD facility employs technology capable of meeting the required discharge requirements including:

NPDES CONSTIUENTS	Final Outfall 001*	UNIT
CBOD (avg mo)	48.5	mg/L
AmoniaNitrogen (avg mo)		mg/L
" May 1-Oct 31 (avg mo)	2.1	
" Nov 1-Apr 30 (avg mo)	6.3	
Arsenic (avg mo)	0.0102	mg/L
Barium (avg mo)	10	mg/L
Bromide	Report	mg/L
Cadmium	0.0002	mg/L
Chloride (avg mo)	250	mg/L
Chromium (avg mo)	0.0522	mg/L
Copper (avg mo)	0.0092	mg/L
Gross Alpha	Report	pCi/L
Lead (avg mo)	0.0032	mg/L
Nickel (avg mo)	0.053	mg/L
Oil & Grease (avg mo)	15	mg/L
pH	9-Jun	SU
Radium-226 + 228	Report	pCi/L
Selenium (avg mo)	0.0051	mg/L
Silver (avg mo)	0.0024	mg/L
Strontium (avg mo)	10	mg/L
Tin (avg mo)	0.0367	mg/L
Titanium (avg mo)	0.00612	mg/L
TDS (avg mo)	818	mg/L

NPDES CONSTIUENTS	Final Outfall 001*	UNIT
TSS (avg mo)	11.3	mg/L
Uranium	Report	ug/L
Vanadium (avg mo)	0.0518	mg/L
Acetophenone (avg mo)	0.0562	mg/L
2-Butanone (avg mo)	1.85	mg/L
Carbazole (avg mo)	0.276	mg/L
Fluoranthene (avg mo)	0.0268	mg/L
o-Cresol (avg mo)	0.561	mg/L
n-Decane (avg mo)	0.437	mg/L
n-Octadecane (avg mo)	0.302	mg/L
Phenol (avg mo)	1.08	mg/L
Pyridine (avg mo)	0.182	mg/L
Osmotic Pressure (avg mo)	51.3	mOs/kg
2,4,6-Trichlorophenol (avg mo)	0.0018	mg/L
Acetone (avg mo)	3.5	mg/L
Total Antinomy (avg mo)	0.0057	mg/L
Bis(2-Ethylhexyl) Phthalate (avg mo)	0.0015	mg/L
Butyl Benzyl Phthalate (avg mo)	0.035	mg/L
Total Cobalt (avg mo)	0.0194	mg/L
Total Mercury (avg mo)	0.00005	mg/L
p-Cresol (avg mo)	0.164	mg/L
Zinc (avg mo)	0.078	mg/L

Casella-Altela Regional Environmental Services (CARES) is a joint venture partnership between Casella Waste Systems, Inc. and Altela, Inc. established to develop sustainable water treatment, recycling, disposal and transportation solutions for the oil and gas industry in Pennsylvania and New York State.

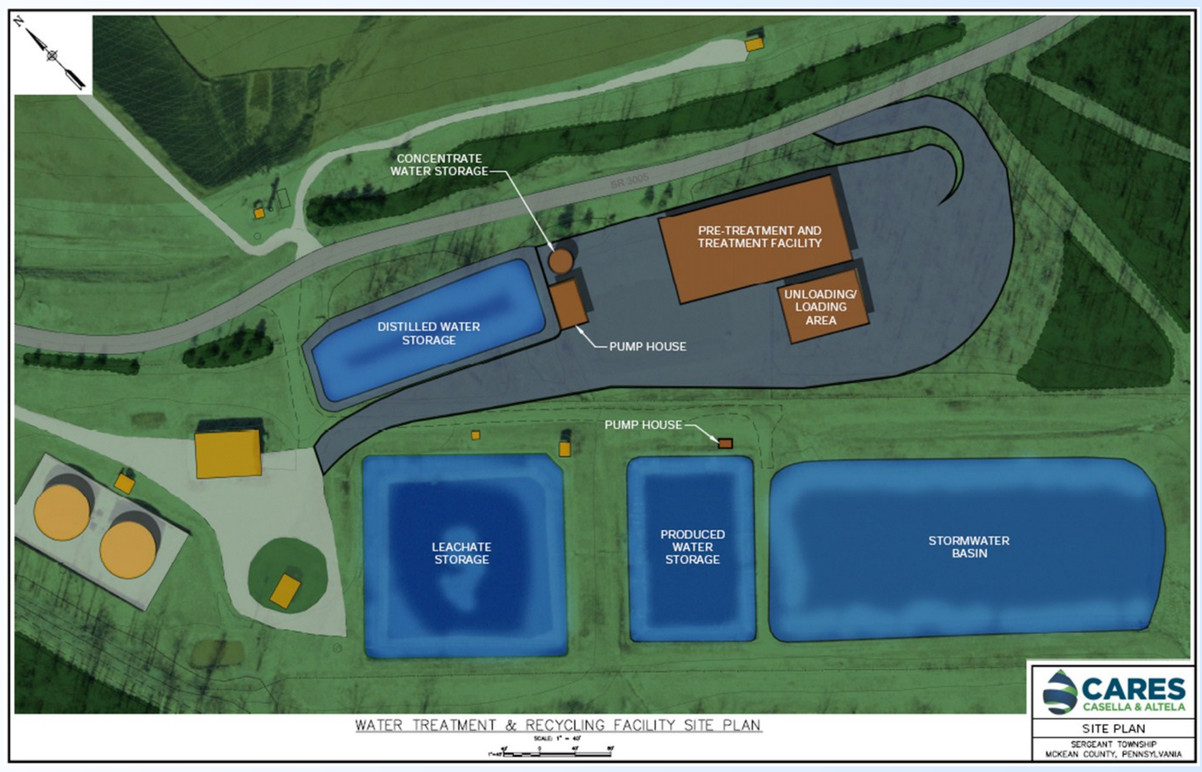
CAPABILITIES

***Water Recycling & Certified Frac Flowback Water:**
10,000 barrels per day capacity (Recycled frac water can be supplied with any level of customer-defined limits. Recycled water-based products offered to industry including recycled frac water for reuse in hydro-fracturing, clean distilled water and heavy brine for winterization

*** Separation and Solidification Services:**
Drill cutting management including solidification of concentrate water for disposal in the land-fill

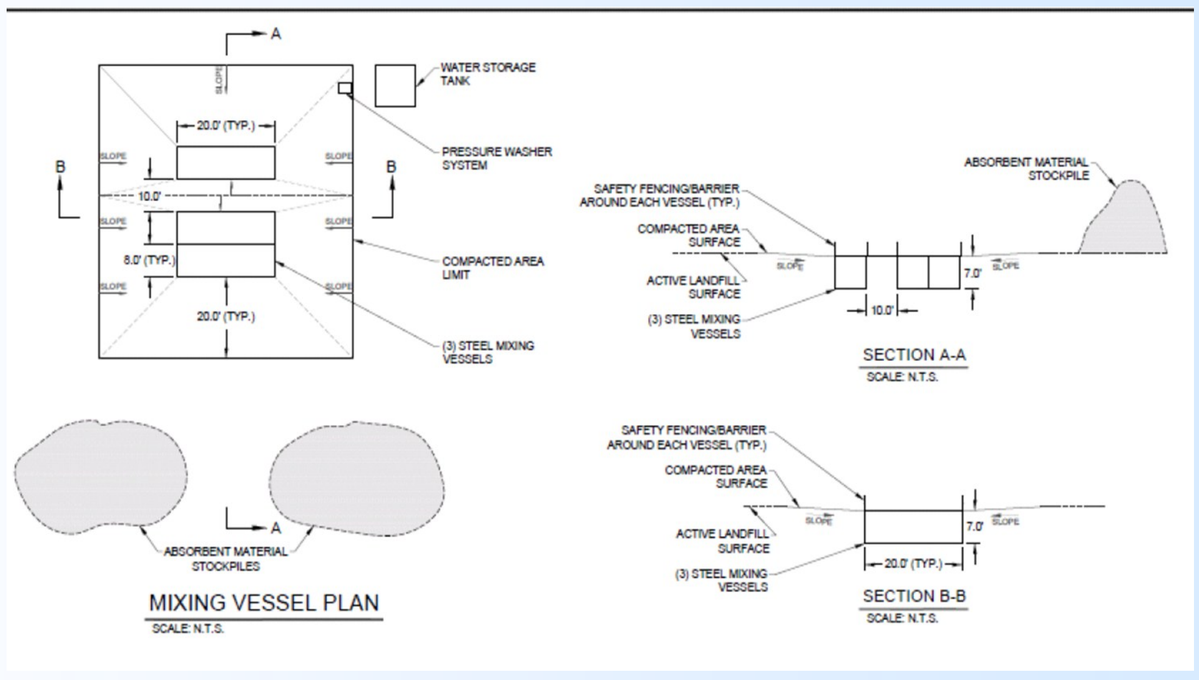
*** Material Sourcing:**
Frac sand supply, gravel for well-pad construction, and tanker cleaning

*** Storage & Transportation:**
Interim water storage, centralized transportation network-rail/over-the-road trucking, and storage areas for lay-down yards

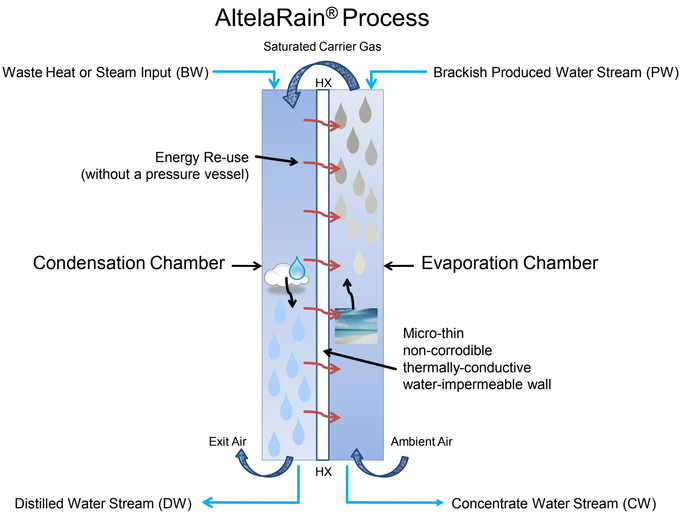


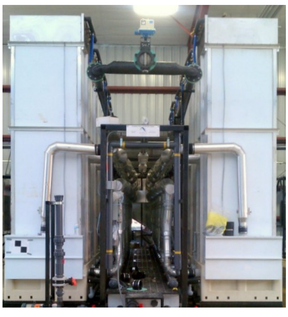
DRILL CUTTING & CONCENTRATE SOLIDIFICATION

Drill cutting management and disposal is available at the landfill. In addition, solidification of concentrate water, is available as needed.



Similar to nature's process for making rain, the AltelaRain® technology operates at low temperatures and low-grade steam. Ambient air flows up through brackish water in an evaporation chamber to strip contaminants into a concentrate. The air is then combined with steam and pushed down through a condensation chamber creating a clean distilled water product. The AltelaRain® technology does not require pressure which translates into lower OpEx and CapEx costs. The process can be driven by low-grade heat, waste heat or natural gas thereby making it suitable for "co-generation" applications to facilitate reduced energy costs.





Features

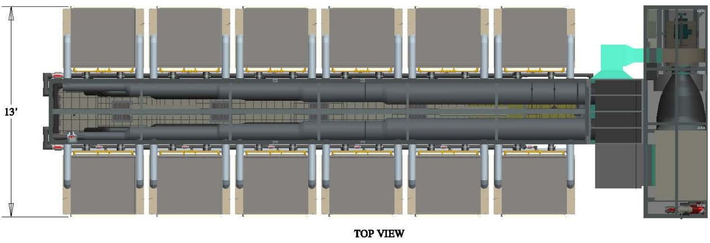
One AltelaRain® 750 Module consists of:

- **12 Towers /1,600 lbs. (725 kg) each (Dry)**
- **1 Center piping chase /7,500 lbs. (3,402 kg) (Dry)**
- **1 Heat exchanger chase /5,400 lbs. (2,450 kg)**
- **1 150 HP Steam Boiler (Can be supplied as an option)**
- **Misc. equipment /4,000 lbs. (1,815 kg)**

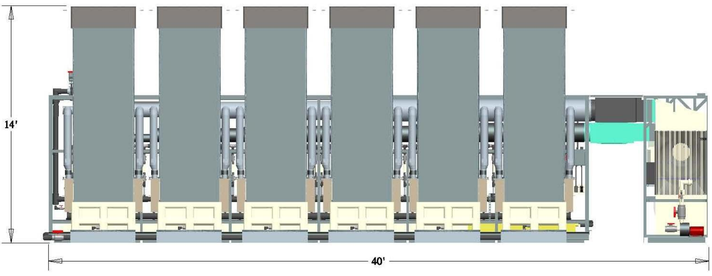
Shipping Weight: 36,000 lbs. (16,330 kg)

Dimensions: ~40' long x 13' wide x 14' tall

Footprint: 520 square feet (40' x 13') without boiler



TOP VIEW



FRONT VIEW