Testimony of

STW Resources

before the

Environmental Resources and Energy Committee

House of Representatives

Commonwealth of Pennsylvania

Harrisburg, Pennsylvania

April 15, 2009

Good afternoon. I am Judith Herschell, Managing Director of STW Resources and I am accompanied by Eric Pedersen–CEO, Gene Brock–President, and Marty Walter–Vice President of Operations, all of whom are available for your questions. First, I would like to thank Chairman George, Chairman Hutchinson and the entire Committee for the opportunity to provide testimony on the vital issue of water reclamation as it relates to flowback from drilling activities in the Marcellus Shale. We, at STW Resources, are pleased to offer information to clarify this issue as STW Resources' core business is treating flowback water from oil and gas drilling operations.

Pennsylvania is enormously fortunate to have the natural resources contained in the Marcellus Shale. It can significantly contribute to the economy as well as energy independence in the United States and our Commonwealth. We must access this resource responsibly and guard the quality of our land and watersheds, as the citizens of Pennsylvania and industries depend on water.

Governor Rendell and Acting DEP Secretary Hanger have made it clear that they welcome the tremendous economic opportunities the natural gas industry presents to Pennsylvania and they want the industry to be successful. But, there can be no compromise on the protection of our water resources and the environment. As a native Pennsylvanian, I am pleased to hear this level of support from the highest levels of our government. As a biologist and engineer with 25 years experience in water and wastewater treatment, I understand the challenges of treating water of the quality of flowback water and the risks of introducing this water into our environment. The variations in the quality and the chemicals used during the fracing process present a challenge. It is equally important to reclaim as much of our precious water resources as possible.

Drilling for natural gas, like all other forms of energy production, poses risks to the environment. Foremost, we must ensure we do not leave this era of Pennsylvania's history with a legacy burdened with environmental costs that could exceed the economic benefits that rapid development of the Marcellus Shale promises to bring to our Commonwealth.

Three methods of dealing with flowback are currently being discussed in Pennsylvania, and are as follows:

Disposal wells

While the safety and efficacy of disposal wells are subjects of debate, it is undisputed that the flowback water injected into these wells is lost to future use. In addition, a portion of the frac water injected into the drill site is lost to future consumptive use. The cumulative effect of water losses in the volumes typically used in frac operations presents a potential permanent damaging effect to our ecosystem.

Municipal wastewater treatment facilities

Municipal wastewater treatment facilities are not designed to address high levels of Total Dissolved Solids (TDS) found in flowback water. These facilities may remove some particulate matter, but the pollutants are simply diluted and released into our streams and rivers. Again, the cumulative effect of discharging pollutants into our rivers, lakes and streams will have disastrous effects in years to come.

Treatment plants specifically designed to treat flowback water

This type of treatment facility is fundamental to STW's business approach. We will present details of this approach, including frac water quality, STW treatment solutions and our partnership with General Electric, which manufactures the treatment equipment utilized in the STW solution. The Zero Liquid Discharge facilities fully address water treatment issues inherent to flowback water and facilitate total reclamation with no flowback water introduced into the environment.

Water reclamation is the most environmental friendly process to handle high TDS brines that return from Marcellus wells and other producing wells throughout the Commonwealth. Marcellus Shale wells utilize significantly higher water volumes than other production zones in Pennsylvania, especially in the "slick water" fracturing process. Typically less than 80,000 gallons of water are utilized in a Devonian Gas Well, whereas 500,000 to 3,500,000 gallons are utilized in Marcellus wells. Each well exhibits a different flowback characteristic. Anywhere from 10 to 100% of this fracture water flows back in the first few days to several weeks after fracture. STW has monitored many wells to evaluate TDS and flowback fluid constituents. A graph illustrating a recent fracture flowback in the Northern part of the state is provided in the

Appendix of our handout. These fluids contain significant salt concentrations dissolved from shale or other water contained zones. TDS levels will typically increase within a short time from the fresh water pumped in as flush for the fracture to as high as 240,000 mg/l or about 7 times ocean water salt content concentration. Of course, the volume of water from each well also declines from the fracture flowback until gas production.

The correct water reclamation for these fluids is a distillation process. In simple terms, it is desalination, or in other words, the use of a very cost effective, large volume "still." STW utilizes a three-step process from GE Water and Process Technology to reclaim the water and generate salts. Any chemical residuals left in the fluids would also be removed in this step. The residual solid waste from this pretreatment is properly processed and handled to disposal.

The second step is a brine concentrator or evaporator. This unit pumps incoming water through heat exchangers to preheat fluids with the exiting distilled water so minimal energy is lost throughout the process. The water enters the base section of the evaporator where temperature is maintained at 215°F, which is slightly above the boiling point of water so steam vapors arise above the liquid phase and are pulled through a vapor compressor where an enthalpy shift occurs. The compressed vapors are spread across a series of tubes at the top of the tower. Typically over 3,000 tubes are included in this area of the unit, manufactured from titanium for corrosion prevention. These vapors and liquids fall down the tubes as a thin film of liquids with vapors escapes. The vapors are collected and condensed as they exit through heat exchangers.

The product is distilled water in the <5 mg/l range. This is excellent water quality, more pure than bottled water. Its taste is unusual because the ions that provide taste have all been removed. This water could be utilized to recharge aquifers, processed further into drinking water or for agricultural use. This distillate can be recycled to the next well fracture or utilized by any firm that generates steam. It is an excellent boiler feed water and would lower operation costs for steam generation. Our focus is to locate nearby companies utilizing "waste coal" for generation of steam and electricity as optimal locations. STW has identified Pennsylvania locations that offer symbiotic water reclamation relationships. Each location has been identified to maintain lower operational costs and therefore, positively affect water reclamation costs. One other point, the residual brine from the evaporator is about 300,000 mg/l or 30% salt and could

be placed into salt water disposal wells to assist in lowering the costs. Depending on the incoming TDS to the evaporator, 50 to 90% distilled water could be recovered.

A mobile version of this evaporator has been engineered and is available. The unit is mounted on skids that can be transported to a well site via three semi-trailers, and can be placed at the well and recover from up to 90% of flowback water, with recovery dependent on incoming TDS. For example, at 75,000 mg/l or 7.5% salts in the water, about 75% of the brine would be converted to distilled water. This unit has been developed especially for use in the mountains where trucking costs to move the water in and out of the location are significant. The producers are building pads where 4 to 16 wells will be drilled on a directional basis. Typically, one fracture water containment is generated and all wells utilize this as a source for the drilling and fracturing process. The distillate from the mobile evaporator will be placed back into the containment for use in the next well. The residual concentrated brine will be transported to the central facility to be processed in the third step described next.

The third step in the process is to handle the residual brine from the evaporation step. The plant would be classified as a "Zero Liquid Discharge" ("ZLD") facility. The unit is called a crystallizer and operates with steam or electricity as energy source. This unit operates similar to the brine concentrator, only in the base unit the water is continuously evaporated until salt crystals are generated. The salt crystals are actually removed from the fluids continuously through a centrifuge.

In the crystallization process, two salts will be generated, calcium chloride and sodium chloride, in a fairly pure state. Both have market value to lower water reclamation costs. The sodium chloride portion would be further processed to make salt crystals similar to "rock salt" to meet PennDOT specifications for highway de-icing or public safety. PennDOT utilizes 600,000 tons of road salt during a mild winter, and a STW one million gallon per day water reclamation plant will generate approximately 235,000 tons per year of rock salt equivalent. With our plan to build, own and operate four plants in the short-term future, STW could provide a major portion of the de-icing salt required within the state.

The present practice of diluting fluids from oil and gas wells into rivers and streams has been accepted and performed for years. This has maintained rivers' TDS below 500 mg/l, even

with road salt finding its way to the rivers. By reclaiming salt from the oil and gas fluids, a critical public safety component is provided by eliminating the dissolved salts from the produced fluids entering the rivers.

Approximately 87% (assuming an average TDS of 130,000 mg/l to the plant) of trucks delivering water to a water reclamation plant should be full of fresh water on return to the field for use in the next well. This will minimize well site trucking by providing 2-way freight and thus will lower producers' overall costs of water reclamation. Our plant will generate sufficient water in one year to drill and fracture 91 horizontal Marcellus wells without any new withdrawal.

STW Resources is in the water reclamation business. We will build, own and operate these facilities. As part of our investigation for the proper sites, a multi-step process is undertaken to: understand the present and future drilling plans of all producers; understand flowback volumes and rates; understand water chemistry for each area; and then, to identify and maximize synergistic relationships. The central plants will be located across Pennsylvania. STW has pre-ordered equipment so a one million gallon per day evaporator can be operational in ten months, or by January 2010, with a fully operational crystallizer by August 2010. Other planned STW plants will require approximately nineteen months to commence operations.

STW Resources will provide water management for all producers through an outsource process. This minimizes the need for producers to develop expertise in water reclamation. This will free up manpower and capital for producers to focus on their core business, generating new Marcellus Shale producing wells. STW is the company to provide this outsource process. We know and understand the cash flow requirements. We have studied water chemistry across the Marcellus and fully understand how to properly and effectively reclaim at the lowest cost. We are prepared to provide capital with commitments from the producers. We have GE's support in the design specifications. We are the experts at water reclamation and have selected a Pennsylvania-based company, GE, to provide the appropriate technology for any/all waters.

The handout illustrates a ZLD facility with two evaporators (tall silver towers) and to the side is the crystallizer, and the far right in the blue bin is the salt manufactured at this site. Only 150 ZLD plants exist in the world, with 96% designed and built by GE. Also illustrated is a flow diagram of the process for fracture flowback and produced water for the Marcellus. A water

source is utilized to conduct the drilling and fracturing process. The flowback and produced water will be properly stored and will be processed through the 3-step process: pretreatment, evaporation and crystallization.

A special treatment will convert small granular salt to large crystals for use as a road de-icing salt. PennDOT also purchases a pure salt for use in making a salt solution to pretreat highways. The effluent from the evaporator may be a perfect fit for this brine. A secondary by-product of calcium chloride will also be generated for sale that will also affect the cost of water reclamation.

Pennsylvania's legislators must balance competing priorities involved with developing Pennsylvania's energy resources and economy. Development of our state's considerable natural gas resources involves: understanding challenges facing energy producers; effectively solving these challenges; and, promoting utilization of clean fuel sources. These issues interface with those developing the economy with a focus on activities that generate tax revenue and create permanent jobs. Additional concerns exist for our communities and elected officials for attracting infrastructure investment that result in economic growth. Water supplies available to support this growth must be maximized. Of course, environmental concerns are primary. These include protecting waters of our state and reducing carbon dioxide emissions and noise pollution while reducing wear on our roadways. All of these concerns must be balanced with the priorities of producers – protecting their investment in mineral rights, developing access to water supplies, dealing with disposal issues safely and economically, reducing community disruption, and maintaining a positive public opinion.

Water reclamation is a critical factor in bringing these competing priorities into unison, providing a win-win for all involved. It safeguards the environment and results in sustainable drilling operations. This allows energy producers to have access to water for fracing operations and for future operations, while minimizing truck traffic and maintaining the high quality of our water systems. A sustainable industry continues to attract investment and create jobs. The public will certainly have a positive view of an industry that presents such a sustainable scenario.

The first of several plants now in the planning stage for Pennsylvania is to be located in Curwensville. This $100 million facility will treat a capacity of 1 MGD using an evaporator,

crystallizer and salt re-granulizer. The facility is planned as a merchant business with multiple off-take parties. The facility is to be co-located with an ethanol facility under construction by Consus Ethanol, and will use waste coal to fire a co-generation facility. While there is a synergistic relationship between these facilities, the water reclamation facility is a standalone entity, scheduled to be operational in ten months.

This joint project offers solutions to many issues facing the natural gas industry. It is a sustainable solution to water treatment and water supply issues. It fosters Pennsylvania's leadership in clean energy solutions with natural gas and ethanol while solving an environmental problem of waste coal, a by-product of Pennsylvania's coal mining industry. This water treatment solution reduces truck traffic issues while creating well paying jobs.

The cycle of utilizing our precious water resources in the production of energy generates wastewater that is recycled to a recovered product of fresh water that reduces the volume of water used in the industry as a whole.

We respectfully recommend that the Environmental Resources and Energy Committee consider the treatment of wastewater as a primary, near-term solution for treating frac water, as this is the solution that benefits the economy of our Commonwealth, our ecosystems, the citizens of Pennsylvania, and the natural gas industry.

Chairman George, Chairman Hutchinson and members of the Committee, STW is most appreciative for your attention and for the opportunity to speak to you this afternoon. We are happy to address any questions you may now have. Alternatively, we would be happy to answer questions you may later have if you contact us at the numbers set forth below:

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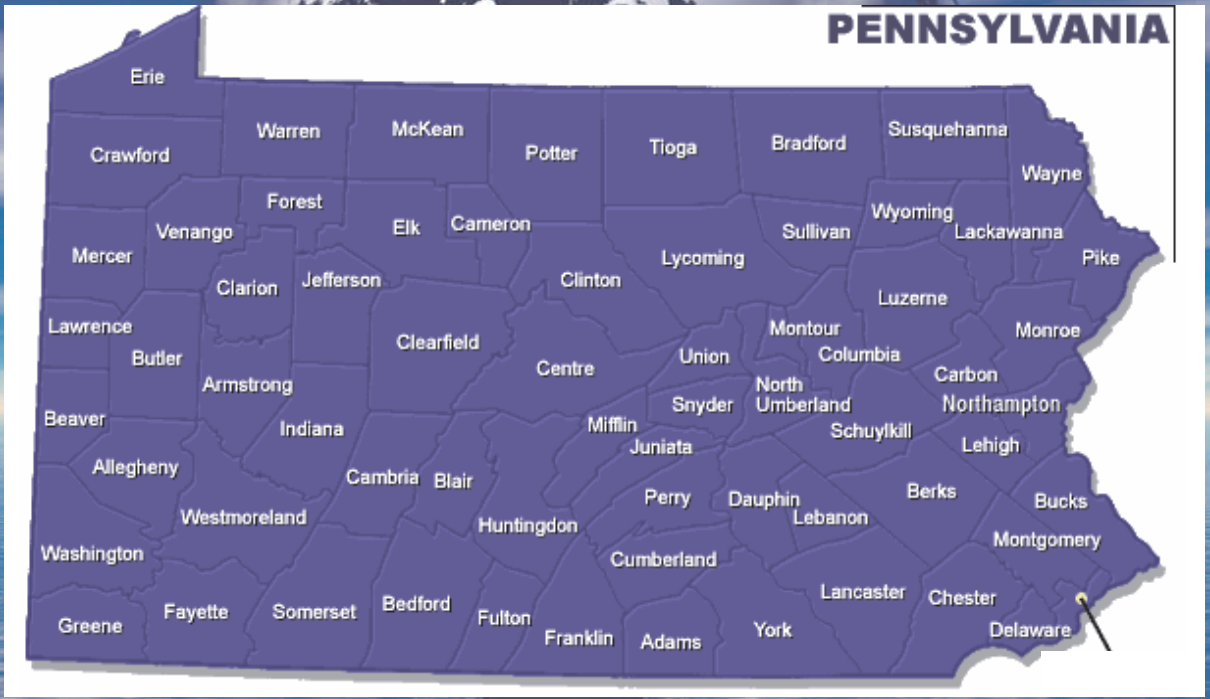
STW Resources, Inc.

Presentation To:

Pennsylvania Environmental Resource and Energy Committee



Water Reclamation using GE Innovation

imagination at work

STW Resources, Inc.

- Eric Pedersen – CEO
- Gene Brock – President
- Marty Walter – Vice President Operations
- Judith Herschell – Managing Director

Brine Concentrator – Crystallizer
Zero Liquid Discharge Facility

GE Water and Process Technology, Trevose Pa.

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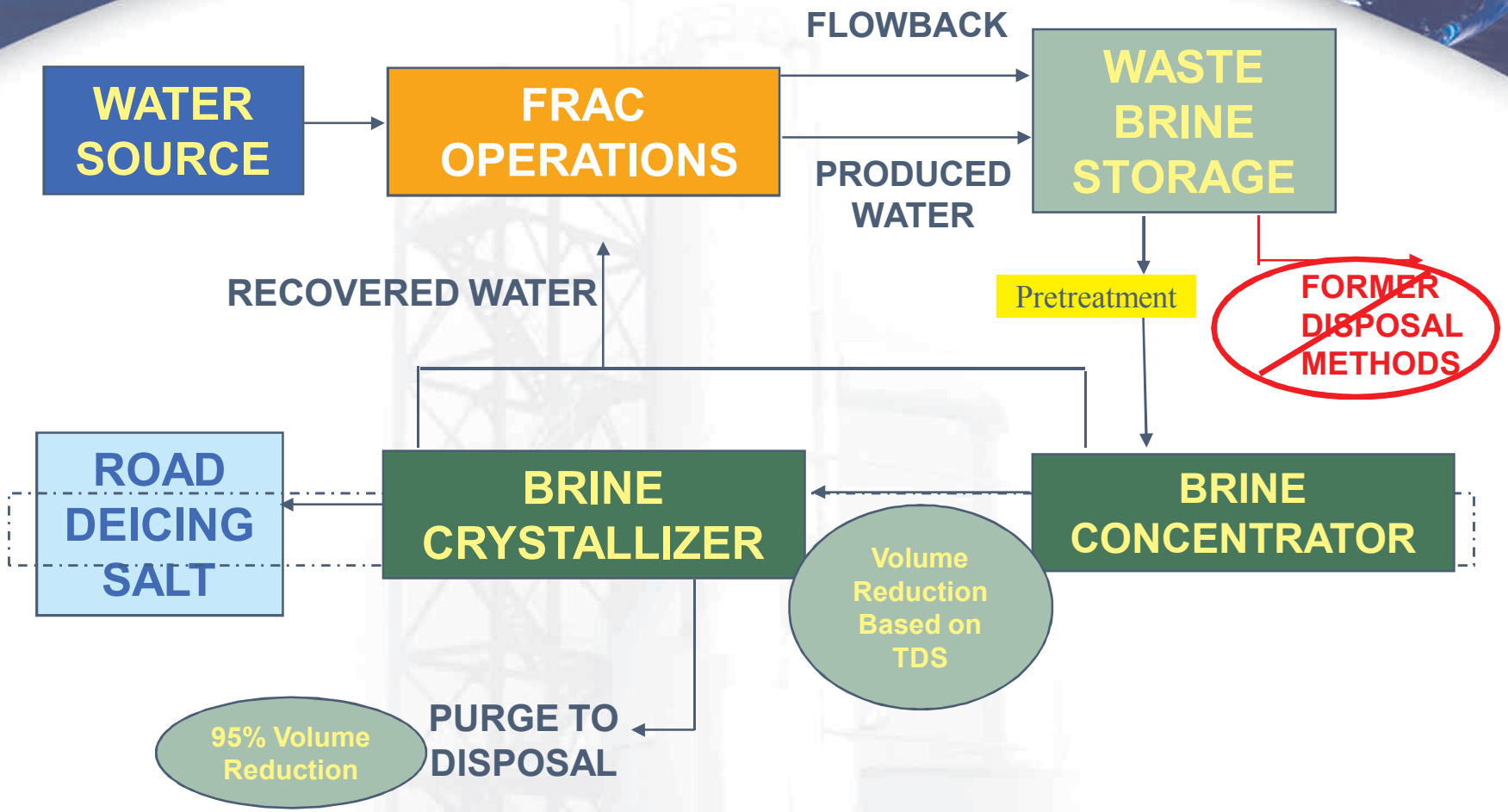
Water Reclamation using GE Innovation

Frac Water Treatment & Recycle



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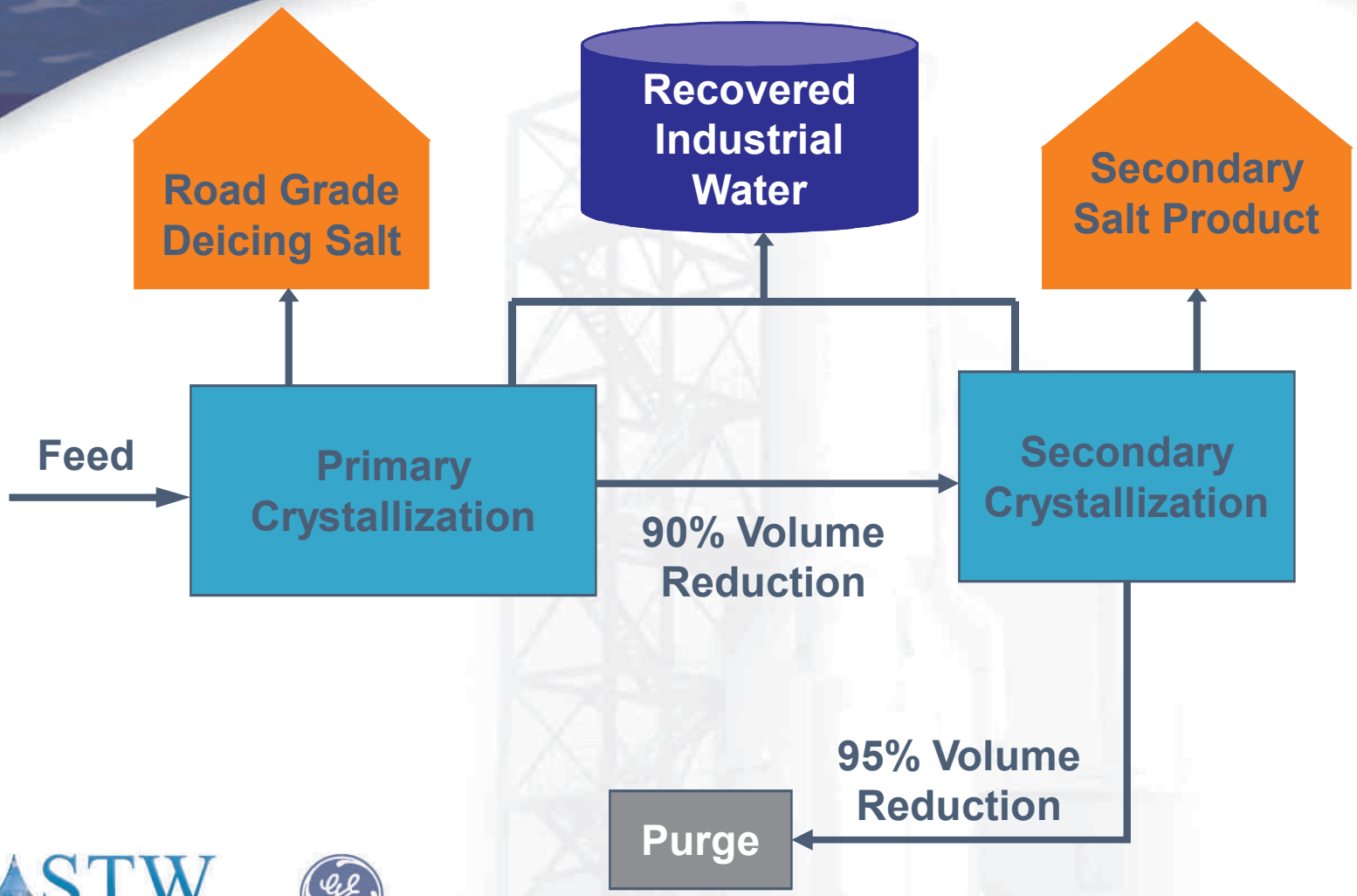
Overall Salt Production Process…



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Water Reclamation

Removal of Total Dissolved Solids

Water	Distilled Water	Produced		
pH:	7.3	6.3		
Cations	mg/L	mg/L	as:	
Calcium:	0	15000	Ca	Removal
Magnesium:	0	2204	Mg	Removal
Sodium:	1.3	61323	Na	Removal
Iron:	0	191	Fe	Removal
Barium:	0	864	Ba	Removal
Strontium:	0	5513	Sr	Removal
Manganese:	0	2.98	Mn	Removal
Anions	mg/L	mg/L	as:	
BiCarbonate	0	207	HCO3	Removal
Carbonate:	0	0	CO3	Removal
Sulfate:	0	1	SO4	Removal
Chloride:	2.3	117700	Cl	Removal
Total Dissolved Solids	4.7	202328	TDS	Removal

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Brine Concentrator - Evaporator

5 to 2,000 gpm
171 to 68,800 bpd

Recovery dependant on Inlet Water

TDS 75,000 = 75% recovery
TDS 120,000 = 60% Recovery
TDS 150,000 = 50% Recovery

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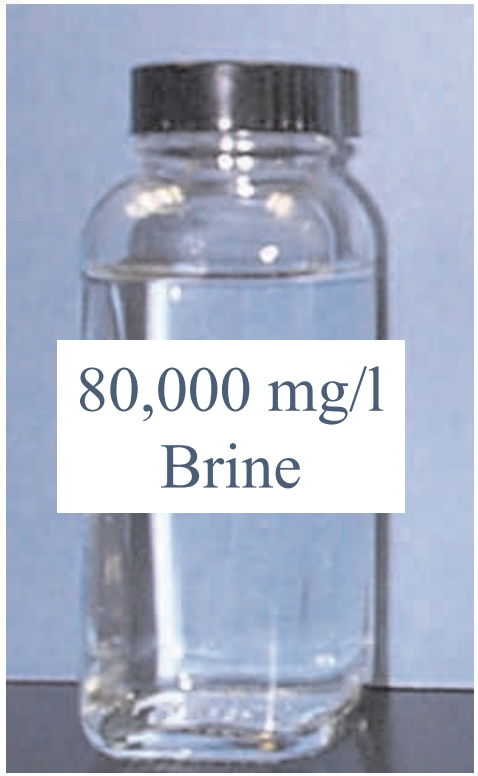
Water Reclamation using GE Innovation

Brine Concentrator - Evaporator



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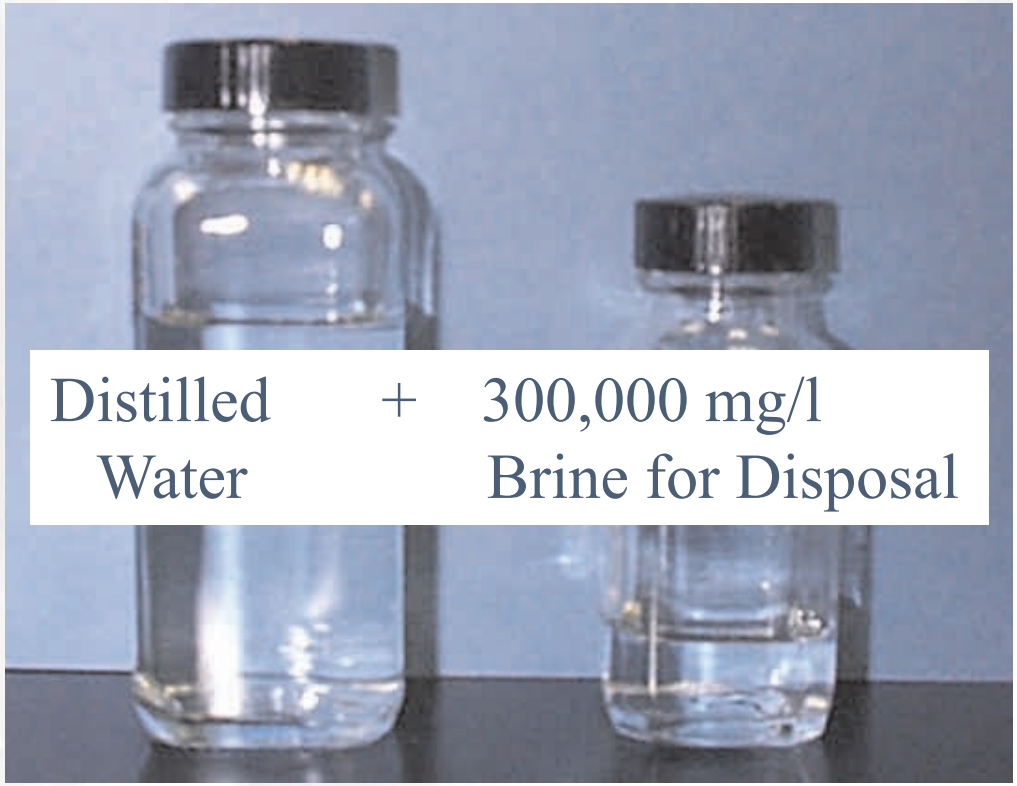

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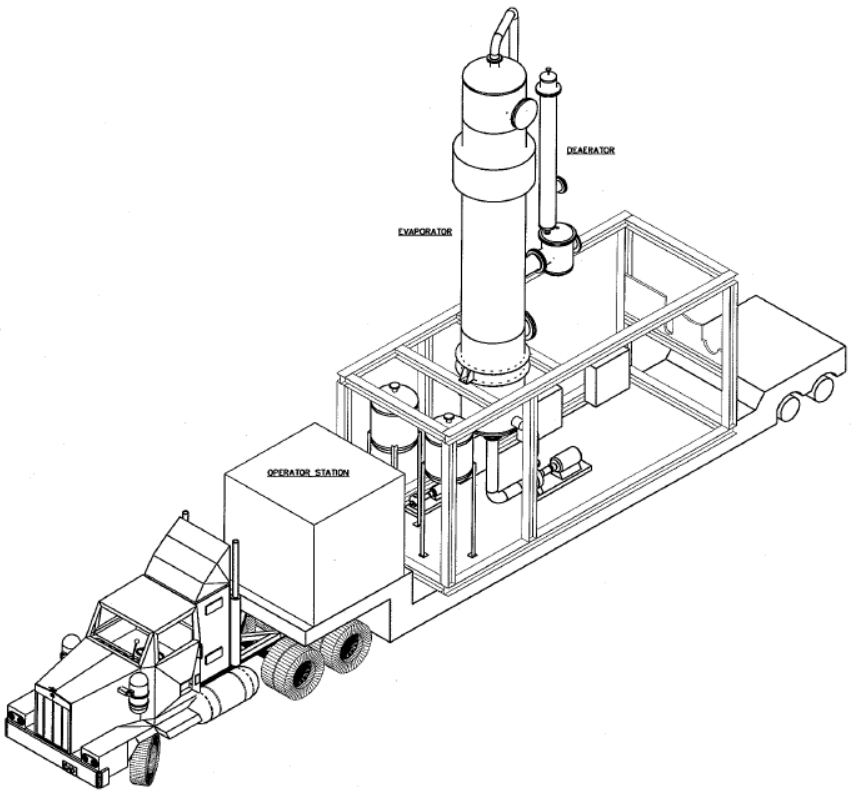
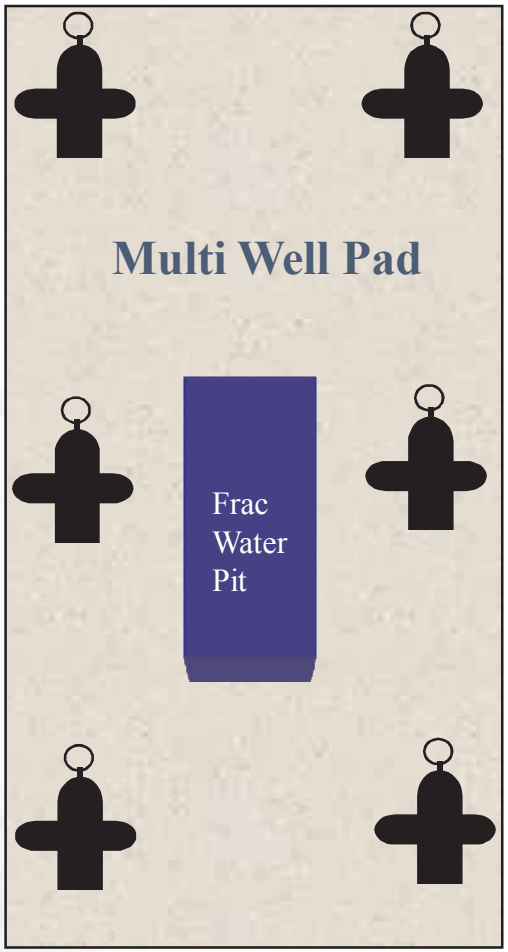
Can Process Up to above 150,000 mg/l
Recovery Percentage Adversely Effected

Mobile Water Reclamation





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Water Reclamation using GE Innovation

Crystallizer

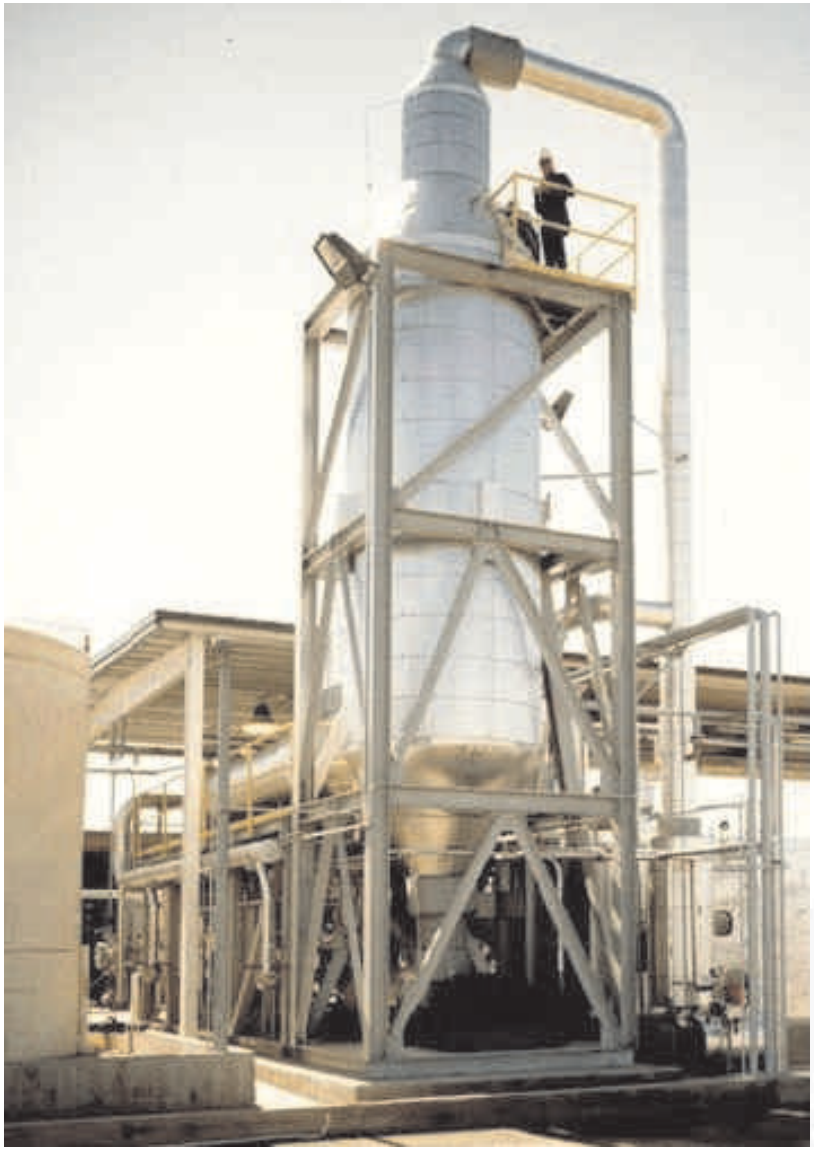
Zero Liquid Discharge

20 to 400 gpm

685 to 13570 bpd

Inlet 300,000 mg/l

Outlet Water/Salts



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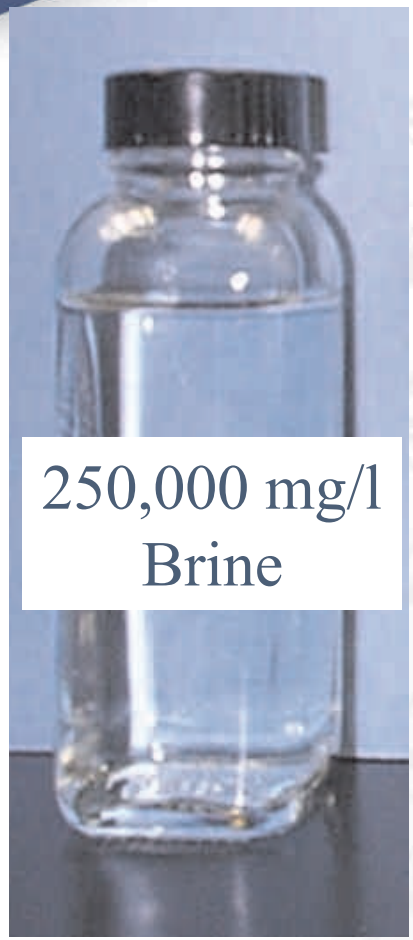
Water Reclamation using GE Innovation

Crystallizer



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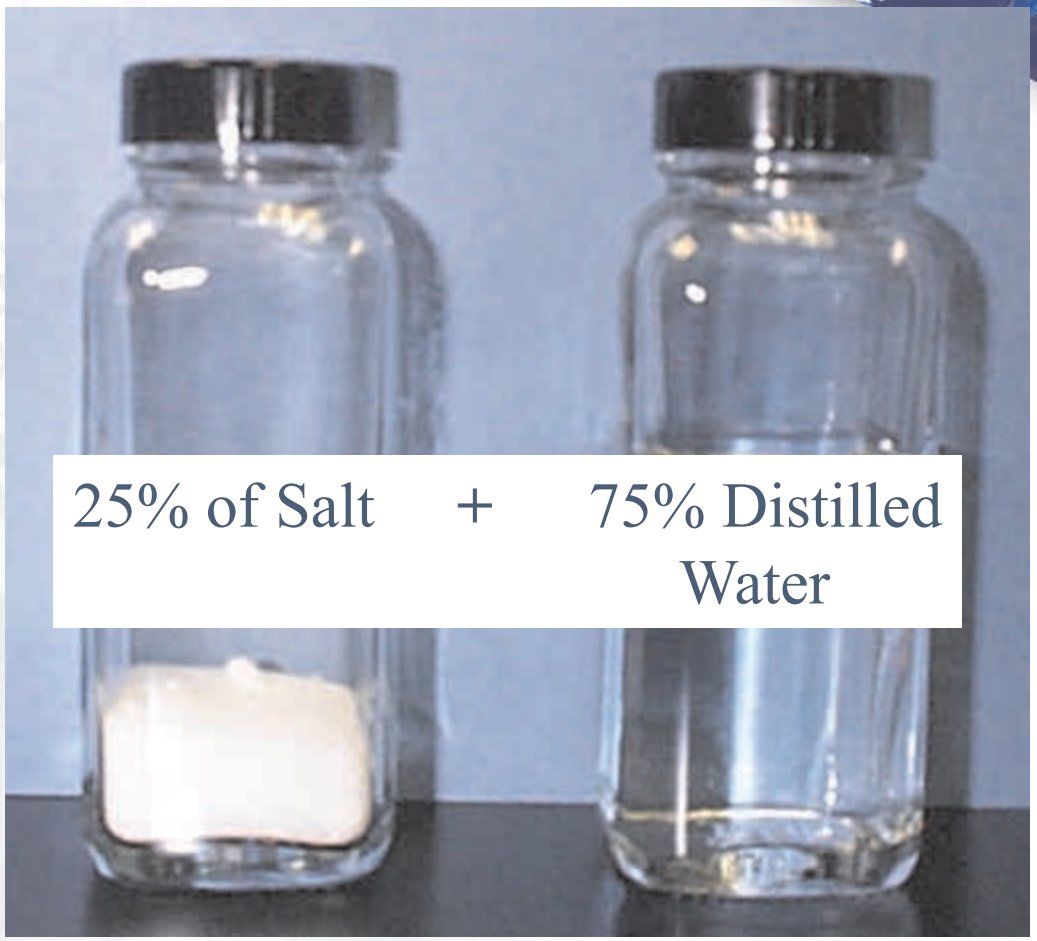

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Water Reclamation using GE Innovation

Outsource Benefits

The Producer Can Focus Capital/Manpower on Gas Production
STW handles the Water Management

	Capital	OUTSOURCE
Cash Outflow Timing	Variable	Predictable
Water Quality and Quantity	Unknown	Guaranteed
Cost per bbl Treated	Unknown	Optimal
Capital Investment	High	Low
Design Performance	Unknown	Guaranteed
System Operational Risk	Moderate	Low
Infrastructure Demand	Moderate	Moderate
Expertise Leveraging	Moderate	High
Technology Risk	Moderate	Low

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PA Must Balance Multiple Priorities

Energy Development	Economic Development	Environment/ Infrastructure	Working with Producers
• Develop the State's considerable natural gas resources • Provide effective solutions for challenges facing energy producers • Promote utilization of clean fuel sources • Waste coal solutions	• Promote economic activities that generate tax revenue • Create permanent job growth • Attract maximum infrastructure investment to promote economic growth • Maximize the use of our water supplies to support economic growth	• Protect surface water supplies – river systems • Protect ground water resources – minimize contamination • Reduce heavy vehicle emissions and noise • Reduce wear and tear on existing roadways	• Protect sizable investment in mineral rights • Develop access to sustainable water supply • Discharge waste streams safely and economically • Reduce community disruption from heavy vehicle transportation • Create favorable PR opportunities

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Water Reclamation using GE Innovation

A Win-Win for All Parties

Energy Development

- Promotes sustainable well completion activity
- Offers solutions to producer fluid issues
- Enhances Gas Play Development

Environment / Infrastructure

- Protects surface and ground water supplies
- Reduces roadway emissions, damage and noise
- Reduces salt to rivers

Water Reclamation

Economic Development

- Attracts investment in state
- Creates jobs
- Preserves economic water supplies

Producer Challenges

- Provides sustainable solutions to fracturing fluid challenges
- Provides positive community PR

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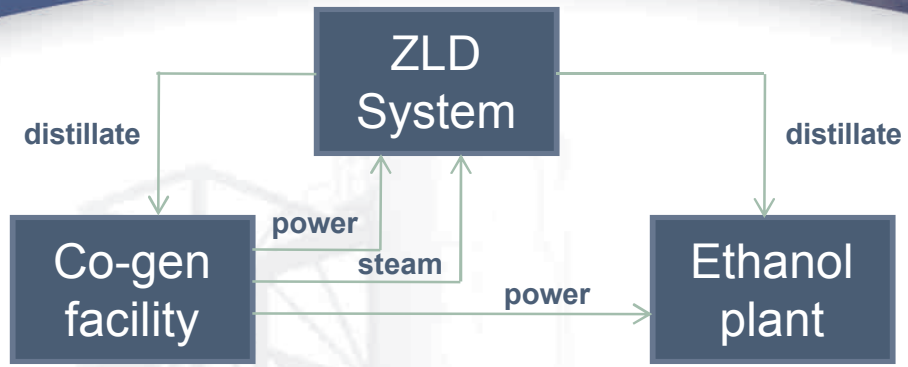
Water Reclamation using GE Innovation

Case Study: Curwensville Project



- $100 million water reclamation project located in Curwensville, PA
  - *1 MGD evaporator, crystallizer, salt re-granulizer*
  - *Likely merchant business – multiple off-take parties*
- Co-located with Consus Ethanol project
  - *Ethanol production facility*
  - *Agreement between STW and Consus Ethanol*

Project offers many positive attributes to Pennsylvania

- *Sustainable solution to producers' brine discharge and water supply problems*
- *Fosters PA's leadership in clean energy solutions: natural gas and ethanol*
- *Reduction in roadway wear & tear*
- *Job creation*

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Water Reclamation using GE Innovation

Curwensville Time Table
Evaporation – January 2010
Crystallizer – August 2010

Future Plants
19 Months from Date of Order
Additional Plants as Required

Turning Waste into Value

Reduce

Recover

Recycle

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Water Reclamation using GE Innovation

Water

The Only Natural Resource with NO Substitute

Water Reclamation Using GE Technology

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Water Reclamation using GE Innovation

imagination at work

Appendix

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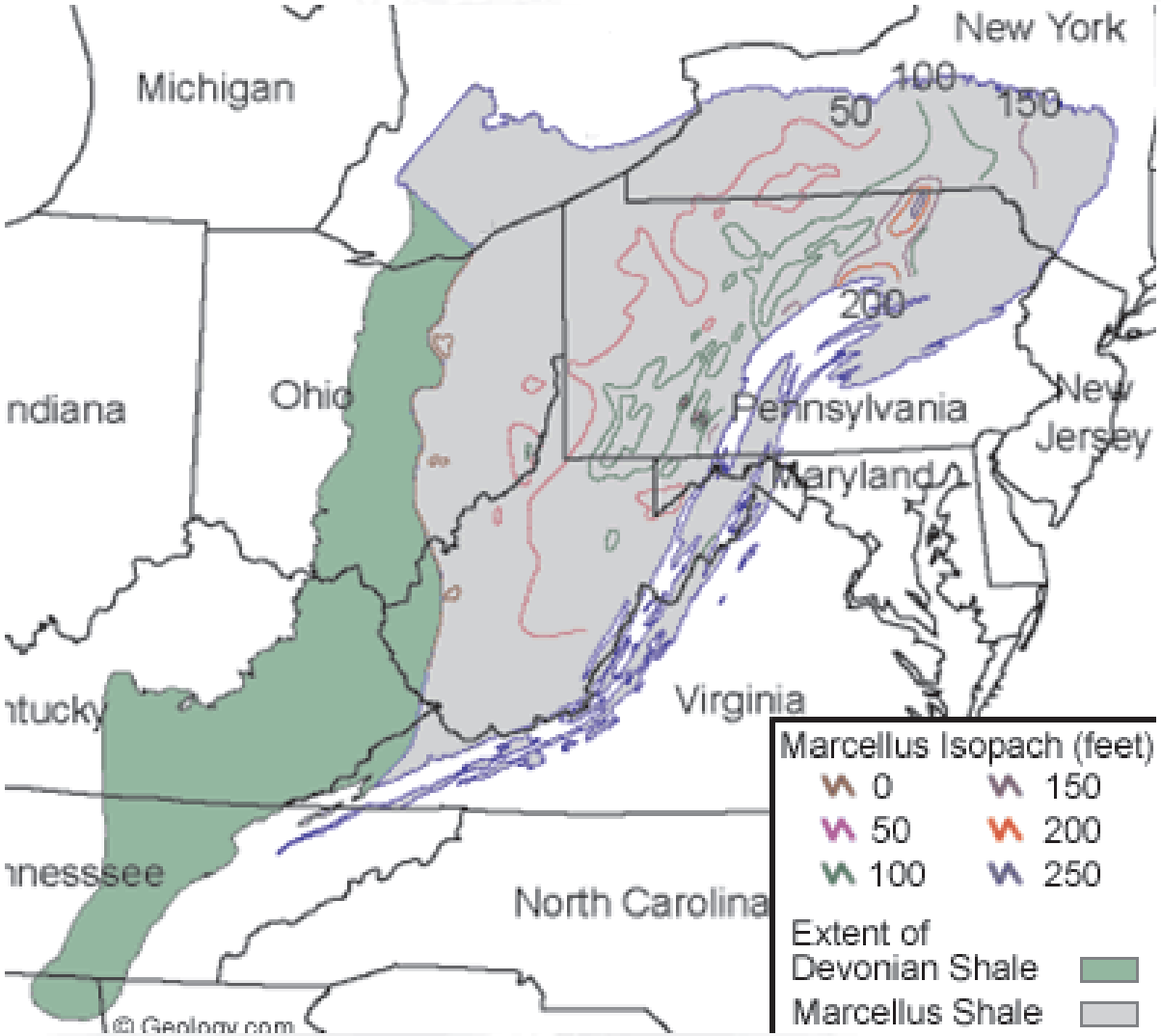
Water Reclamation using GE Innovation

Marcellus Shale



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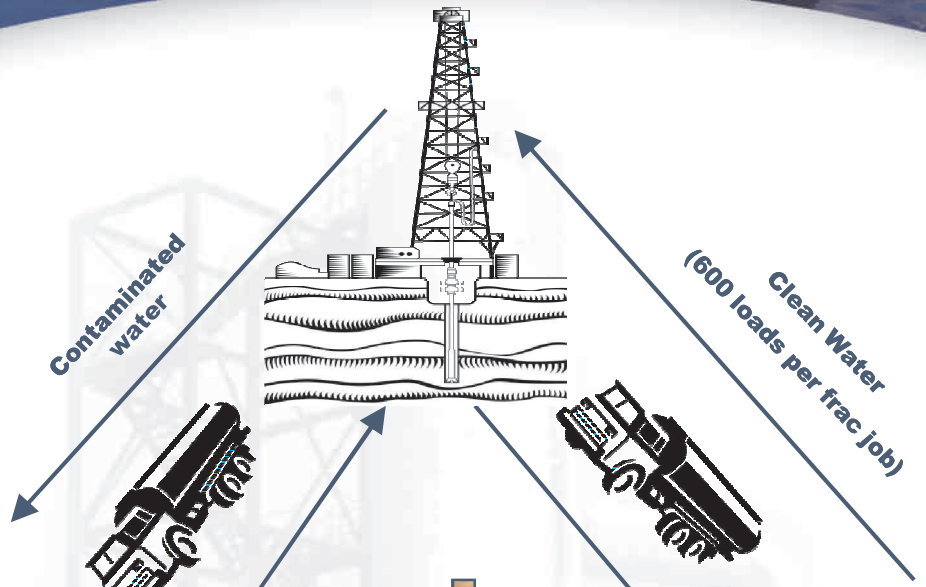
Current Water Disposal Cycle



- Trucks are empty when returning to a fracture job from offloading wastewater at a plant and diluted to the river..

- Trucks are empty when returning to a water source from offloading fresh water at a fracture job.

Fresh water supply

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Hydraulic Fracturing Shales
Focus for STW Resources

Volume for the Fracture
Flowback and Production – Contaminated Water
Volume Requiring Disposal
Disposal Lost Forever from the Ecosystem

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Fracture Source Water

Ohio River Water

TDS:	326
pH:	7.4
Cations	**mg/L**
Calcium:	33.02
Magnesium:	6.12
Sodium:	37
Iron:	0
Barium:	0.24
Strontium:	0.58
Manganese:	0
Anions	**mg/L**
Bicarbonate:	146
Carbonate:	0
Sulfate:	0
Chloride:	100
Gases:	**mg/L**
Carbon Dioxide:	0
Hydrogen Sulfide:	0

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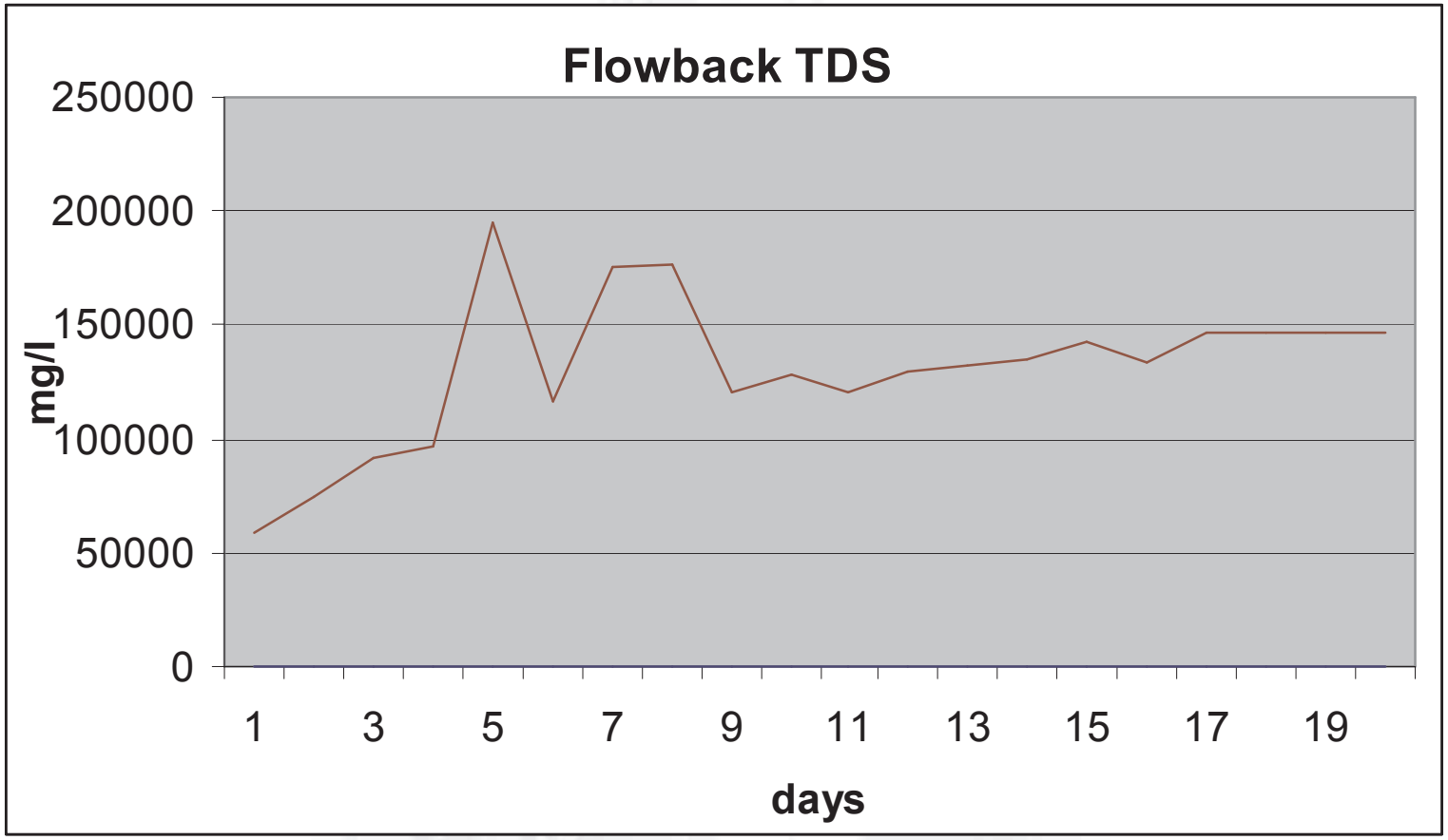
Water Reclamation using GE Innovation



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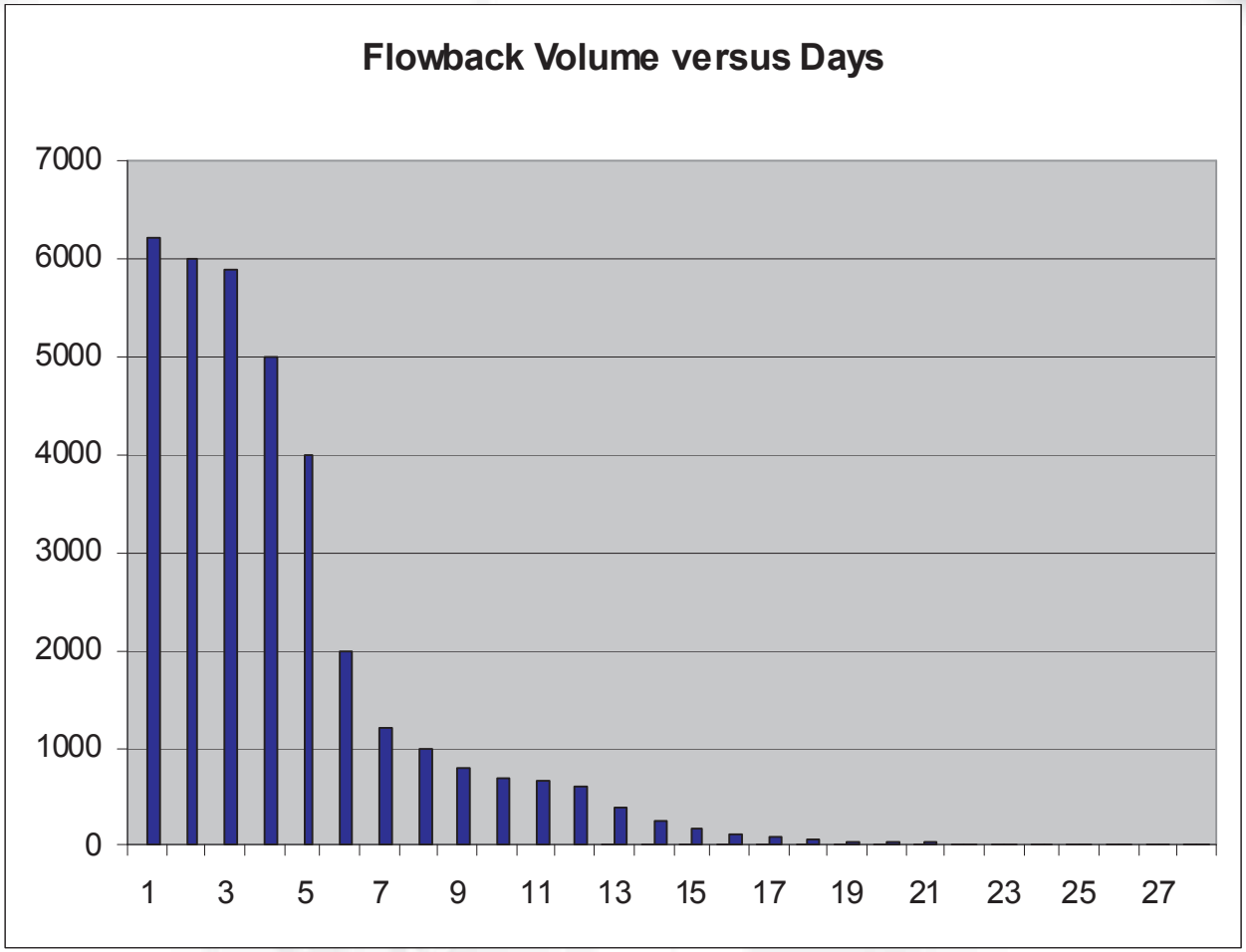
Water Reclamation using GE Innovation



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