Treatment of Produced Water to Discharge Quality

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VP, Business Development
Veolia designs and deploys solutions for **water**, **waste** and **energy** management, participating in the sustainable development of cities and industries.

**WATER**
Management of the global water cycle, from production and distribution of drinking water to the collect, treatment and recycling of wastewater.

**WASTE**
Liquid and solid non-hazardous and hazardous waste management
Our expertise covers the entire waste life cycle from collection to recycling, leading to the final recovery of waste as materials or energy.

**ENERGY**
Energy efficiency, efficient management of heating and cooling networks, green energy production, all unique expertise for a sustainable world.

$28 Billion in revenue
163,226 employees on 5 continents
Our Recent Success - Antero Resources

WORLD'S LARGEST CENTRALIZED SHALE GAS WATER TREATMENT FACILITY TO DISCHARGE QUALITY
Oklahoma
Oklahoma - Produced Water Generation

- Mississippian Lime Play
  - High Volumes of Water
  - TDS: 200,000 mg/l to 300,000 mg/l
  - Water Disposed by Deep Well Injection
  - Issues with Disposal of Produced Water

- STACK Play
  - Moderate Volumes of Water
  - TDS: 30,000 mg/l to 100,000 mg/l
  - Majority of the Water is Reused
  - Issues with Fresh Water Availability

- Woodford Shale Play
  - Low Volumes of Water
  - TDS: 10,000 to 25,000 mg/l
  - Water Disposal by Deep Well Injection
  - Issues with High Disposal Costs
Oklahoma - A Potential Solution

- High Volumes of Produced Water Generated in Mississippian Lime Basin
- Treatment to Mississippian Water to Discharge Quality (Fresh Water)
- Veolia’s proven CoLD™ Crystallization Technology for Treatment
- Centralized Treatment Facility on a Service Fee Approach ($/barrel)
- Transfer of Fresh Water to STACK Area (pipeline)
- Utilize Fresh Water for Fracking Operations
- Minimize Injection Volumes in Mississippian Lime Basin
- Addresses the fresh water limitation issue
CoLD® Crystallization Process

- **Process Goal**
  - TDS & Boron Removal
  - Zero Liquid Discharge

- **Forced Circ. Crystallizer**
  - Fitted with “Vacuum System”

- **Energy for Evaporation**
  - Steam or Indirect Heat Pump

- **Low Operating temperature**
  - Lowers the solubility of Salts
  - Crystallize at a lower concentration

- **Key Advantages**
  - Low Pretreatment Costs
  - No Calcium Removal in Pretreatment
  - Less Chemicals, Less Sludge
  - Lower Energy Requirement
  - Robust Treatment System
Merchant Facility - Commercial Structure

- Centralized water treatment
- Facility Owned by Veolia
- Design, Build, Operate by Veolia
- Service fee ($/barrel) approach
- Short term contract structure
- Designed to handle variability
- Title transfer at facility inlet
- Availability based on market
Merchant Facilities - Commercial Benefits

- No capital outlay required
- No long term volume commitments
- No risks with utility consumption (chemicals)
- Transfer risk & liability with disposal of produced water
- Economies of size - large centralized regional facility
- Speed to market - faster delivery permitting production increase
- One stop shop for disposal of prod. water /purchase fresh water
Merchant Facilities - Environmental Benefits

- Minimize Injection Volumes
- Minimize Seismicity induced due to Deep Well Injection
- Minimize dependency on Class-II Injection Wells
- Sustainable solution - enables reuse of produced water
- Generates fresh water from produced water
- Recovery of valuable by-products from produced water
- A reliable solution for disposal of produced water