

PARSONS

Oilfield Produced Water Management and Beneficial Reuse



Innovations for Any Oilfield Produced Water Challenge

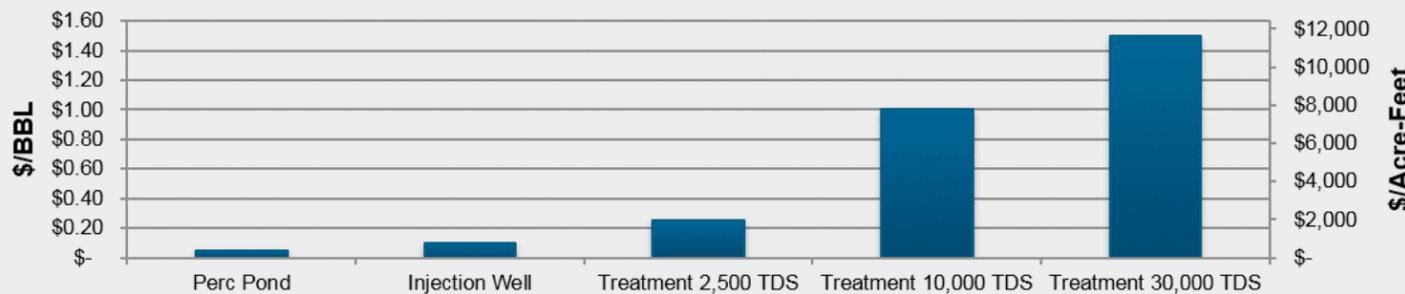
With oil production comes an abundance of produced water, a critical resource in today's increasingly limited water supply. For every barrel of oil produced, an additional 8 to 10 barrels of water typically accompanies it. Approximately half of the produced water gets put to use in the oilfield itself, still leaving a considerable quantity of produced water to manage.

As irrigators and water managers explore ways to supplement their limited water portfolios, they look to their neighboring oil producer for valuable water resources. Parsons works with both oil producers and water managers, offering decades of experience for water reuse strategies. Parsons has the design and construction management experience to meet any produced-water challenge. Our expertise designing, permitting, and building oilfield water and wastewater projects includes:

- De-oil and filtration for water flood and disposal
- Water softening for steam drives
- Desalination for beneficial reuse

Parsons has every available solution to guide our customers to the best business decision for managing their produced water. When we combine our permitting, environmental, and water treatment engineering capabilities, we're able to arrive at unique, differentiated, and optimized solutions. Optimization is important when it comes to produced water management. Water quality and end uses drive treatment methods—and costs—as illustrated in the chart below.

Oilfield Produced Water Management Options and Estimated Costs



First-of-a-Kind Solutions for Successfully Managing Oilfield Water

Parsons supports a broad range of customers in evaluating and providing solutions for water management – our services result in less volume of down-hole water disposal and waste and increased contributions to regional water supplies. Parsons' design contributions to the Chevron San Ardo and Arroyo Grande water reclamation plants are operating examples of produced water treatment innovations with successful track records of performance. These first-of-a-kind Parsons' projects are briefly described below.

CHEVRON SAN ARDO WATER PLANT

Parsons worked with Veolia North America in designing a reverse osmosis (RO) plant permitted for 50,000 barrels of water per day (BWPD) (2.1 million gallons per day), including oil and solids removal, degasification, warm lime softening, multi-media filtration, ion exchange softening, and sodium adsorption ratio adjustment steps in support of the reverse osmosis desalination process.

ARROYO GRANDE FIELD WATER RECLAMATION FACILITY

Parsons worked with Veolia North America in integrating the Freeport McMoRan Oil & Gas reverse osmosis plant permitted for 20,000 BWPD (0.84 million gallons per day), including oil and solids removal, degasification, warm lime softening, multi-media filtration, ion exchange softening, and sodium adsorption ratio adjustment steps in support of the RO desalination process. Parsons also designed on- and off-plot facilities and power systems in support of Freeport McMoRan Oil & Gas' Arroyo Grande field expansion.

Sustainability and Parsons' Water and Wastewater Practice

Sustainability is the cornerstone of Parsons' water and wastewater practice and also one of our core values. Our expertise in the oil and gas, energy, and chemical industries and our robust industrial and municipal water and wastewater practice allows us to provide a full complement of services for industrial water reuse to our valued oil and gas customers. Parsons' commitment to sustainability drives us to provide innovative solutions for our customers' produced water reuse strategies.

SUSTAINABLE WATER MANAGEMENT

Attributes of produced water compared to other supplemental water supplies include:

- Beneficial to both the oil producer and the irrigator
- Independent of state and federally operated systems
- Treatment systems are privately operated
- Water quality is tailored to end-user needs
- Reliability and free from prescriptive claims

Produced Water Services

- Planning services
- Concept design
- Cost estimation
- Permitting
- Preliminary design
- Front-end engineering
- Scoping
- Detailed engineering and design, including civil, structural, mechanical, electrical, process, and controls
- Off-plot piping
- Optimization studies
- Pilot plant design, construction, and operation
- Construction management
- Operations and maintenance
- Recharge basins
- Wetlands design



Produced Water Reuse Options

Innovative and practical options are available for our oil and gas customers:

- Agricultural and landscape irrigation
- Artificial lakes
- Boiler feed water
- Construction activities
- Concrete mixing
- Cooling tower makeup
- Dust control
- Golf course irrigation
- Groundwater recharge
- Industrial processes
- Public parks
- Riverbed replenishment
- Wetland enhancement/recharge



Industry-Leading Technologies

Parsons is employing state-of-the-art technologies to help our oil and gas and industrial customers implement their water reuse strategies.

PRETREATMENT FOR EMULSIFIED OIL AND FREE OIL

- Corrugated plate oil/water separation
- Coagulant aided gravity/corrugated plate/dissolved air flotation and dissolved nitrogen flotation separation
- Dissolved air/nitrogen flotation
- Gravity oil/water separation
- Thermal and pH emulsification breaking

PRETREATMENT FOR GROSS INORGANICS REMOVAL

- Air stripping/steam stripping for ammonia removal
- Coagulation/flocculation inorganics precipitation with gravity settling and/or fine filtration
- Ionic exchange for water softening or specific ionic species removal
- Electrocoagulation with gravity settling and/or fine filtration

ADVANCED TREATMENT TECHNOLOGIES

- Constructed wetlands (ammonia and/or organics polishing)
- Mechanical vapor recompression
- Microfiltration
- Nanofiltration
- Reverse osmosis
- Run-dry evaporation
- Thin film evaporation
- Ultrafiltration
- Vacuum distillation



Our Core Values



SAFETY

We maintain a safe and healthy environment in all of our offices and on each of our projects.



INTEGRITY

We uphold our reputation for integrity and provide an ethical work place. We do the right thing each time we face a tough decision.



INNOVATION

Through inventive processes and unique solutions, we provide unmatched value to our customers.



QUALITY

We provide high-quality services and products. We meet requirements the first time and strive for continuous improvement.



DIVERSITY

We actively pursue diversity in our workforce, markets, and services. Technical challenges require new perspectives and open minds.



SUSTAINABILITY

We are conscious of the impact our work has on the environment. We work with customers to provide clean, efficient, healthy, effective solutions on all projects.

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