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Managing Water in the West

Produced Water Reuse Case Studies

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EUCI: Produced Water Management in the West

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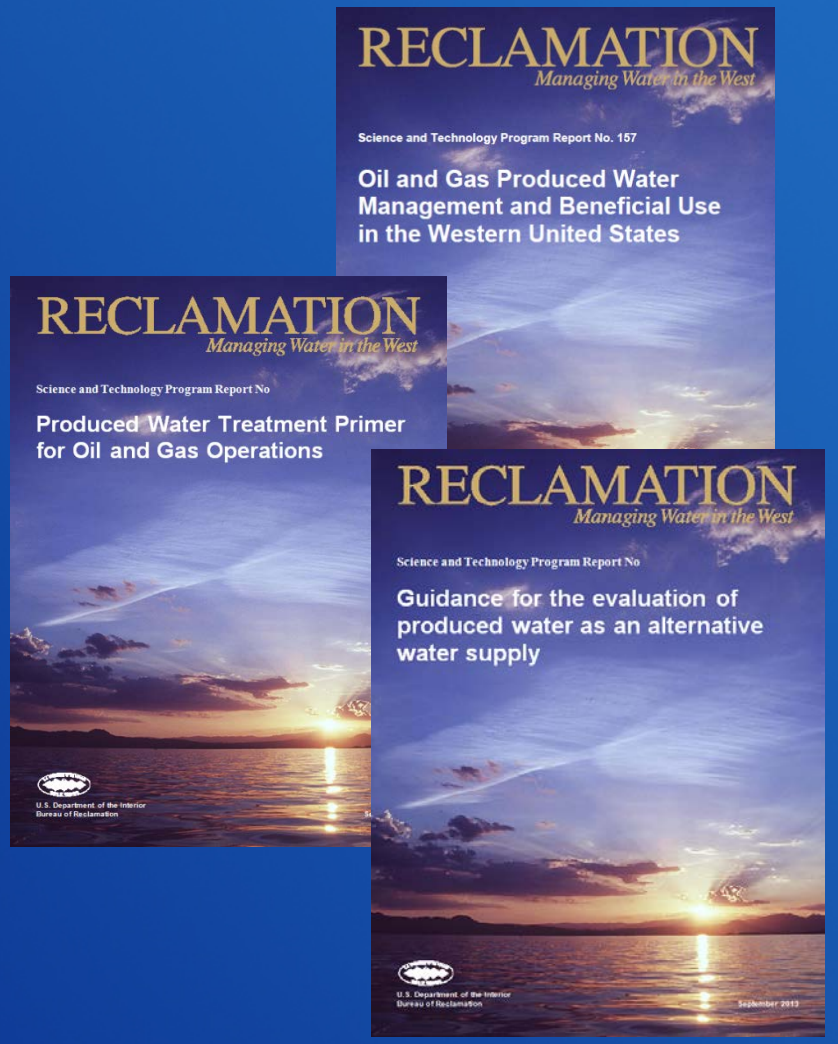
Water Management Reports

Presentation Outline

- Management options
  - Transportation
  - Natural Conveyance
  - Disposal
  - Beneficial Use
- Case studies
  - Alternate Sourcing
  - Onsite Reuse
  - Centralized Treatment
- Management consideration
- Value of water supply



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Water Management Options

Water Sourcing ⟷ Water Disposal

Transportation

Natural Conveyance

Disposal

Beneficial Use

Alternate Sources

Onsite Reuse

Centralized Treatment

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Transportation Options

- Trucking
  - Cost and logistics
  - Water storage
  - Environmental Impacts
- Piping
  - Permanent Installations
  - Temporary infrastructure
  - Co-locating with piping infrastructure
- Temporary storage

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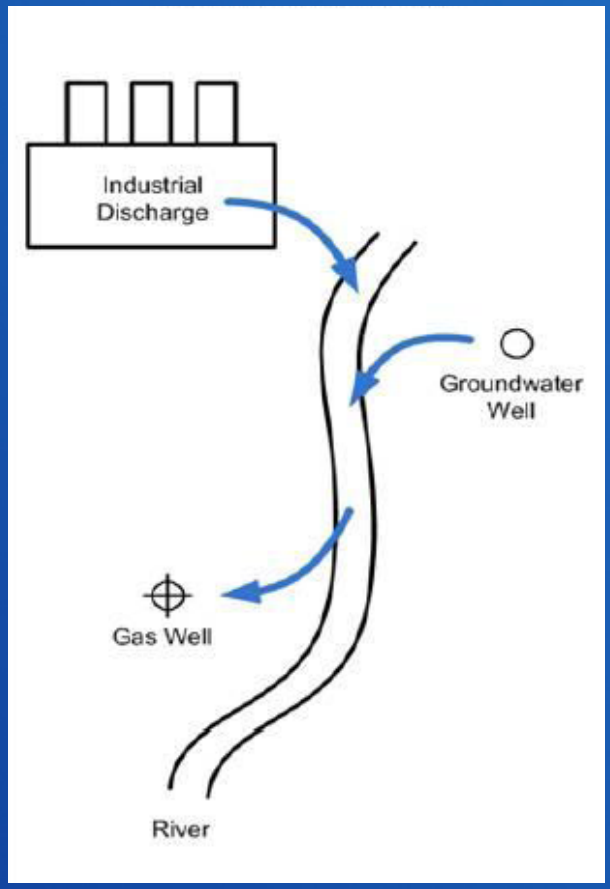
Natural Conveyance and Direct Onsite Reuse

Facilitating water reuse:

- Industrial/commercial reuse sources
  - Increased volume in water ways
  - Free/natural conveyance system
- Direct reuse of hydraulic fracturing flowback and produced water
  - Compatible with the producing formation
  - Available on-site (reduces transport cost)
  - Reduces disposal wells



Texas Bed and Banks Permit
Source: www.trinity.edu

Disposal

- Evaporation
  - Arid areas, evap rates
  - Land area and cost
  - Maintenance, solids disposal
- Injection
  - Nearby locations
  - Formation capacity
  - Environmental impacts

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Beneficial Use Options

Western water uses:

- Irrigation (sub-surface applications)
- Surface water augmentation
- Municipal drinking water
- Industrial uses (fire suppression, dust control)
- Habitat (salt marshes)

Produced water management in Powder River Basin, NETL

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Alternate Water Sources

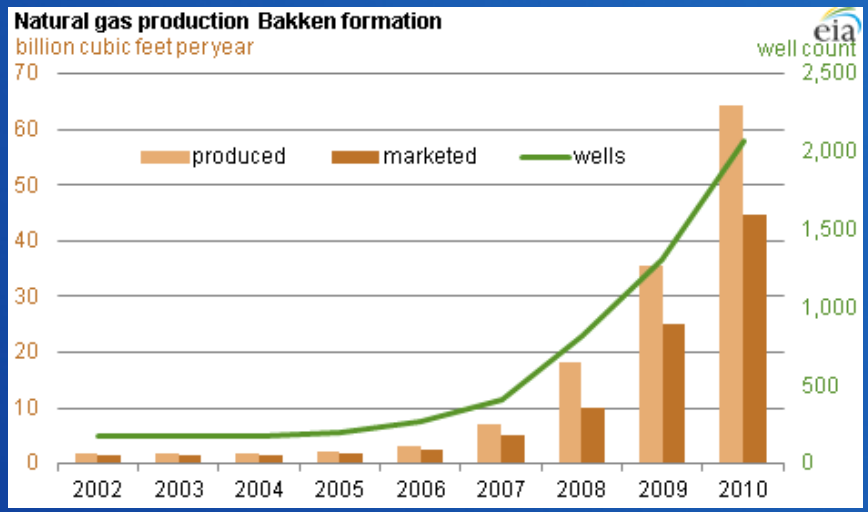
Concept:

- Treating alternate water sources, nearby to well drilling operations

Costs and Benefits:

- Requires treatment and infrastructure
- Reduces demand on fresh water supplies
- Potentially closer to the well field, limits transportation costs

Alternative Water Sources Case Study: Bakken, EERC



Background:

- Volume of water per well fracture ranges from ~ 0.5 million to 3 million gallons (10,000 bbls to 60,000 bbls)
- Cost to purchase raw water $0.25/bbl up to $1.75/bbl
- Water transportation $0.63/bbl up to ~ $5/bbl.
- Costs for deep well injection $0.50/bbl to $1.75/bbl.
- Transportation costs represent from 56% to 84% of the total water-handling costs

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Alternative Water Sources Case Study: Bakken, EERC

Site Description:

- Flowback water recovery: 15% - 50%
- Salinity levels as high as 220,000 mg/L
- Treatment unlikely cost-effective in most cases

Solution

- Near Tioga, North Dakota
- Existing brackish groundwater production well

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Alternative Water Sources Case Study: Bakken, EERC

Treatment:

- Reverse osmosis (RO) to treat brackish groundwater
- Total dissolved solids (TDS): ~9,000 - 11,000 mg/L
- Treated water is stored in a lined and covered pond
- On-site hauling station allows 4 trucks to fill in 20 minutes

Sandia National Laboratories

Source: Kurz, B. (2010) “Bakken Water Opportunities Assessment”. University of North Dakota’s Energy and Environmental Research Center (EERC)

Alternative Water Sources Case Study: Bakken, EERC

Keys to project success:

1. Alternative source (brackish groundwater) was available in the area
2. Existing infrastructure for the groundwater well was available and was not an incurred cost
3. Well was located at a reasonable distance from the drilling site
4. Technically and economically feasible to treat the alternate source

Onsite Reuse

Concept:

- Treating flowback and produced water onsite using a mobile treatment system to reuse water at the well field

Costs and Benefits:

- Requires mobile treatment equipment and water storage infrastructure
- Variable water quality returning from the well
- Reduces demand on fresh water supplies
- On-site location reduces transportation costs

Onsite Reuse
Case Study: Mobile Systems

Background:

- Numerous mobile systems are available from commercial vendors
- Most permanent installations have mobile equipment equivalent
- Reduces trucking and pipeline to have treatment onsite
- Equipment is available for purchase or rent and can be moved and reused at new site locations

Onsite Reuse
Case Study: Mobile Systems

Advantages:

- Modularity and maneuverability
- Flexibility
- Reduced transportation costs

Disadvantages

- Smaller components
- Exposure
- Power requirements

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Alternative Water Sources Case Study: Mobile Systems

Keys to project success:

1. No need exists for long term infrastructure
2. It is necessary to have a water treatment system that can be moved from site to site
3. Storage (permanent or temporary) for raw and treated water is available onsite
4. Power available onsite
5. Low to medium water volumes
6. Technically and economically feasible to treat the flowback and produced water quality
7. Need for water recycling due to water shortage or transportation costs

Centralized Treatment

Concept:

- Central collection facility to treat produced and flowback water from the region for reuse or discharge

Costs and Benefits:

- Requires permanent treatment infrastructure
- Economies of scale, plant can treat multiple producers, extends treatment over lifetime
- Plants designed for variable water quality
- Treated water can be used within the industry or outside the industry as a supply to offset costs
- Transportation or conveyance required

Centralized Treatment Case Study: San Ardo, CA

Background:

San Ardo treats produced water for the purposes of:

1. Discharge to recharge basins
2. Production of Once Through Steam Generator (OTSG) make-up water

San Ardo Facility, Source: Veolia

Complex feed water source

First membrane-based produced water desalination facility

Operated by Veolia Water for Chevron U.S.A.

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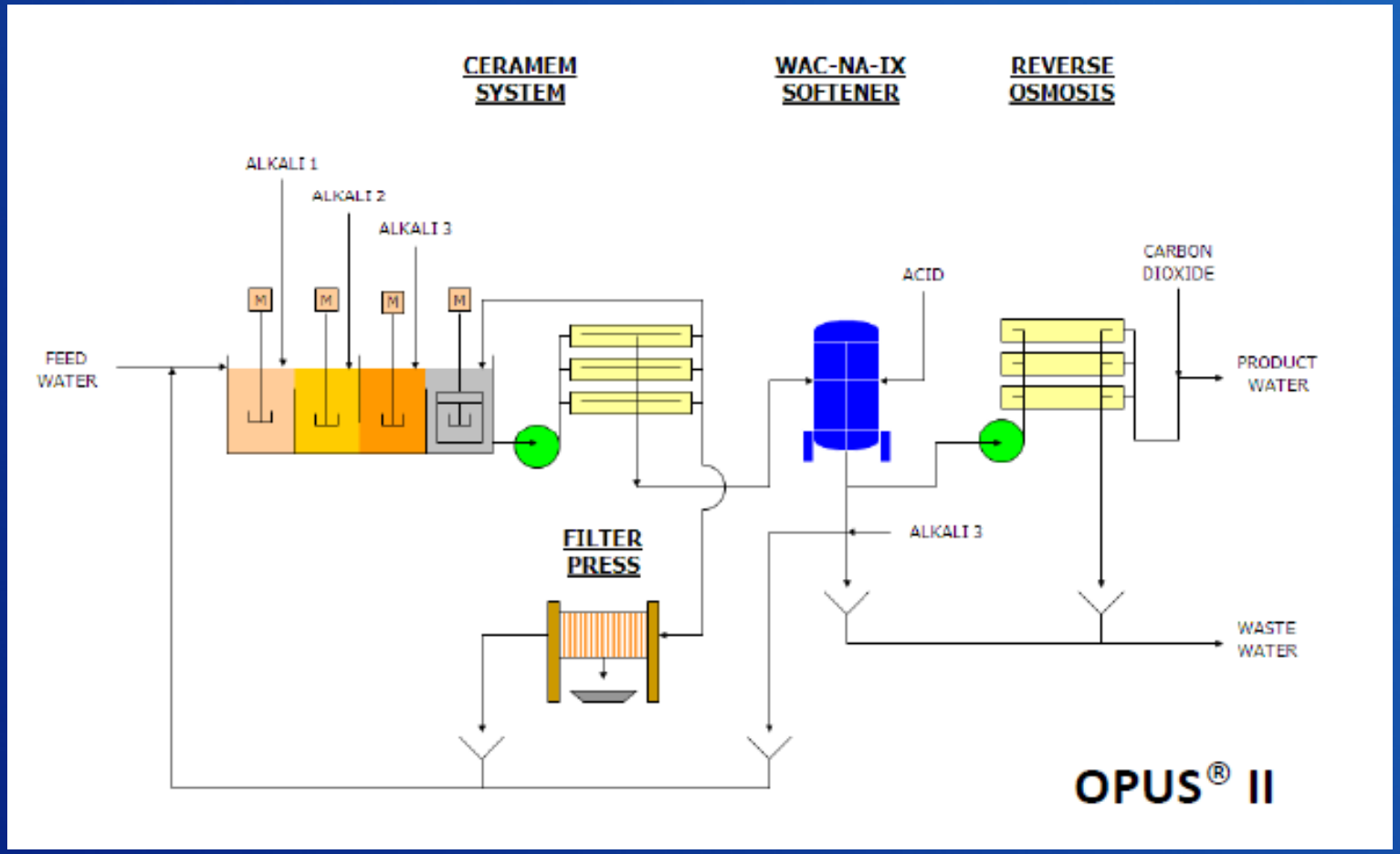
Centralized Treatment Case Study: San Ardo, CA



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Centralized Treatment Case Study: San Ardo, CA

Water Quality:

Temperature 200°F

Free oil 25 ppm

TOC 80 ppm

Silica 240 ppm

Boron 26 ppm

Hardness 240 ppm

TDS 6,500 ppm

Treated Water Quality:

TDS < 510 ppm

Boron < 0.64 ppm

Hardness < 2 ppm as $CaCO_3$

Water recovery, 75%

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Centralized Treatment Case Study: Wellington, CO

Background:

- Location - Town of Wellington and the north area of Larimer County
- Purpose - Create additional water supply from produced water
- Water is injected into a shallow groundwater well for recharge

Treatment:

- Dissolved air floatation
- Activated carbon
- Pre-treatment
- Ceramic microfiltration

Wellington Water Works, Source: Stewart Environmental Consultants, Inc.

End Use: Aquifer supplies water to a RO plant that provides drinking water to the Town of Wellington

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Centralized Treatment Case Study: Pinedale Anticline, WY

Background:

- Located in southwestern Wyoming
- Limitations on disposal injection
- Facility treats produced and flowback water
- Facility treats water from a collection of producers
- 75% of received water is treated and redelivered
- 25% of water is further treated and discharged to the river

Source: High Sierra Energy, LP

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Centralized Treatment
Case Study: Pinedale Anticline, WY

Facility:

- Water is returned to operators for fracture water or discharged
  - 60,000 bbls/day recycling
  - 20,000 bbls/day discharge
- Infrastructure
  - Treatment and recycle plant
  - 19 miles of pipeline for recycle delivery
  - 1 deep injection well
  - 3.5 MM bbls of water storage capacity

Source: High Sierra Energy, LP

Centralized Treatment
Case Study: Water Quality Options

Concept:

- Treating flowback and produced water at a centralized facility to various qualities for different end uses

Costs and Benefits:

- Requires a variety of treatment equipment (sometimes multiple process trains and/or stages) to create a variety of water qualities
- Allows for an alternative option of disposal through discharge to the environment
- Offers an alternative supply for industry use
- Offers a potential supply to users outside the oil and gas industry
- Offers multiple revenue streams to offset treatment facility costs

Existing Water Treatment Plants

Case Studies of Existing Hydraulic Fracturing Flowback and Produced Water Treatment Facilities

- Facility Description
- Location
- Feed Water
- Capacity
- Treatment Process
- Treated Water Use
- Concentrate Disposal
- Operational experience
- Performance data
- Permits

McKean County, PA

San Ardo, CA

Clarion County, PA

Wellington, CO

Pinedale, WY

Powder River Basin, WY

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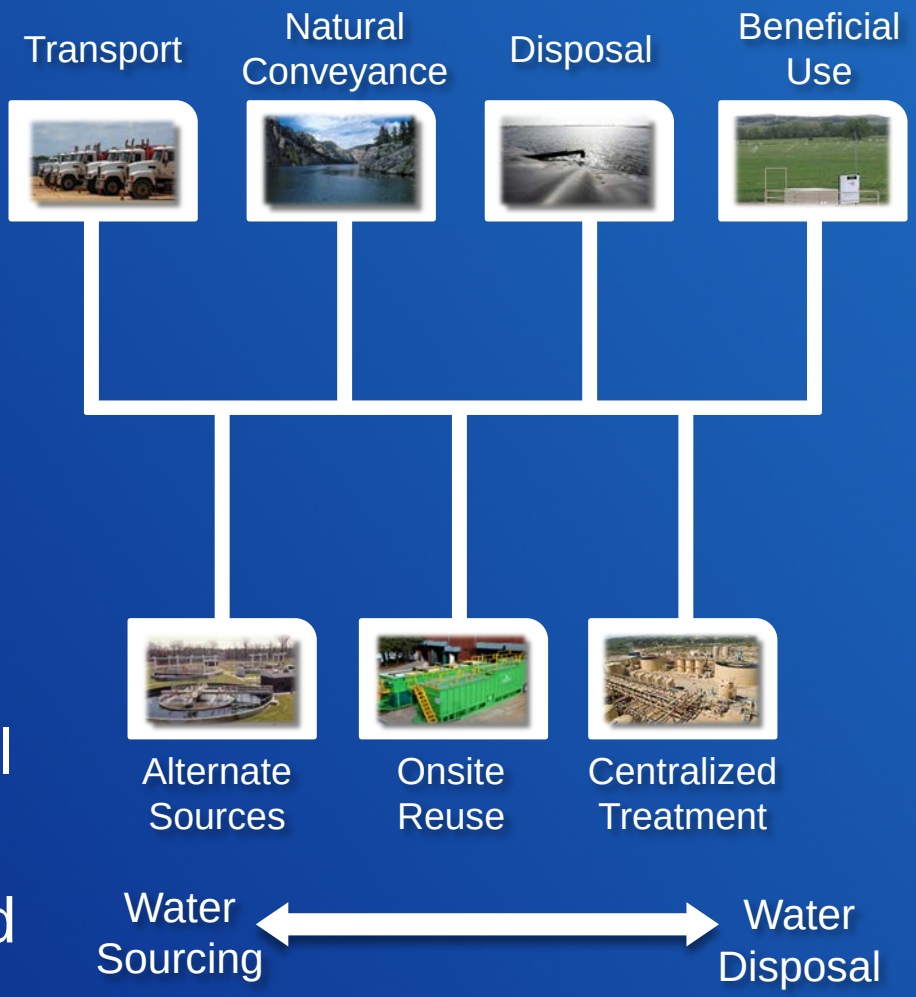
Centralized Treatment Case Studies

Keys to project success:

1. Need for long term infrastructure
2. Multiple producers contributing to the facility
3. The use of a third party to operate the treatment facility
4. High water volumes and consistent demand
5. Lack of disposal options
6. Need for treated water in the area
7. Alternate treated water use outside the industry

General Conclusions

- Case by case basis
- Range of water management options
  - Transport and Disposal
  - Onsite Reuse
  - Beneficial Use
- Water ownership options
- Economic, technical, social, and environmental considerations
- Inherent value associated with water



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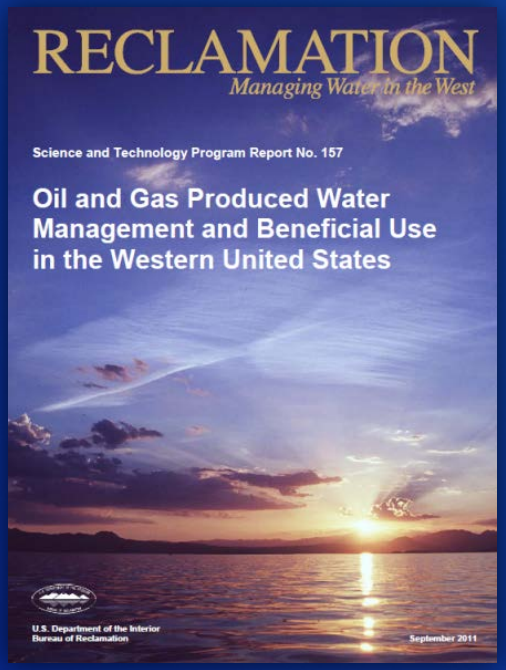
Additional Information

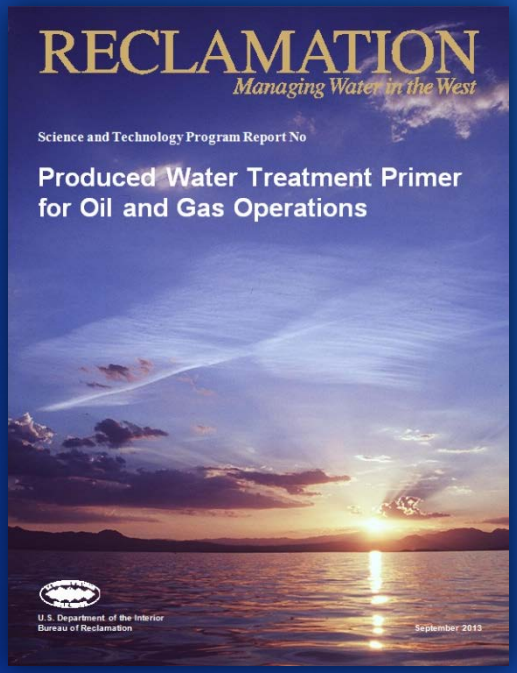
Research Project Websites:

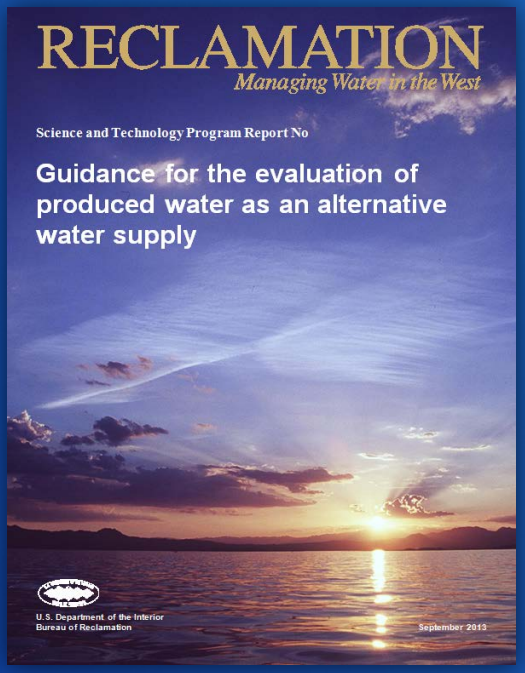
http://www.usbr.gov/research/projects/detail.cfm?id=1617

http://www.usbr.gov/research/projects/detail.cfm?id=3259

http://www.usbr.gov/research/AWT/reportpdfs/report157.pdf







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