Seawater Desalination in California: The Sand City Approach

West End Event - Green Lecture Series

August, 2011

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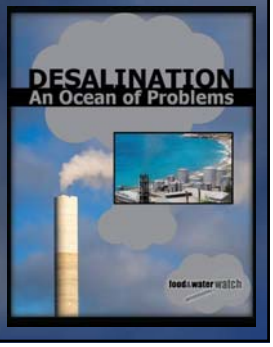
An Ocean of Concerns

"Desalination is a risky water supply option that actually creates more problems than it solves."

Food and Water Watch, February 2009

Key Problems sited:

1. **Too expensive**
2. **Environmental damage**
3. **Boron removal**
4. **Prohibitive energy costs**

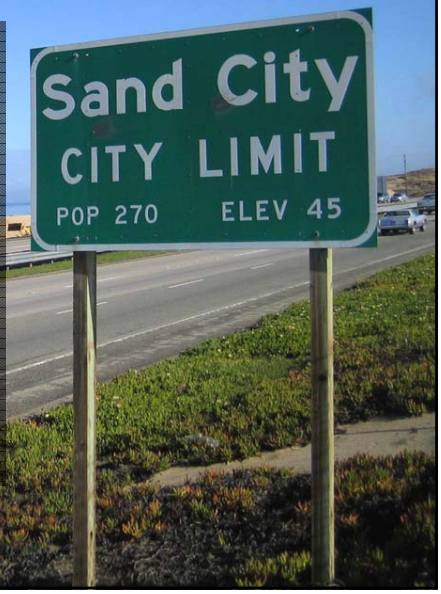


Outline

- Project Background
- Treatment Approach
- Environmental Permitting
- Health Department Permitting
- Sand City's SWRO process
- Summary

The City of Sand

- 300 acre city with 1.5 miles of coastline
- Home to 200 businesses, about 40,000 visitors during business hours
- No City annexations possible
- Purchases water from California American Water
- City's growth has been limited by water supply



Project History

- 1995 SWRCB Order 95-10 requires new water sources within CAW to first satisfy illegal pumping on Carmel River (1-for-1 rule).
- 1996 CCC allows limited development of resorts and commercial use along the coast. City considers desalination and withdrawal from CAW system to avoid 1-for-1 rule.
- October, 2002 Test well constructed at Bay street – testing begins.
- July, 2005 CCC Unanimously approves Sand City's Coastal Permit Application for 300AFY desalination facility.
- January, 2006 SWRCB determines that Sand City's project is exempt from 1-for-1 rule. Sand City seeks partnership with CAW.
- March, 2006 Sand City secures rights to brackish water within City Limits.
- October, 2007 Sand City signs resolution allowing CAW to operate the desalination facility, making 206 AFY initially available to reduce pumping on Carmel River, reducing to 94 AFY as Sand City reaches build out.
- December, 2007 Construction begins on desalination facilities.

Treatment Approach Selected for Simplified Permitting

- Beach wells minimize impact to environment
- Primary treatment process exceeds DPH regulations, minimizing energy use
  - Cartridge filters
  - SWRO
  - UV
  - Product stabilization
  - Sodium hypochlorite
- Subsurface brine discharge

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Health Department Permitting

Environmental Permitting

Department of Public Health Permitting

- First SWRO in California to complete DPH permitting under current drinking water regulations
- Approval process loosely established by pilots in West Basin and Carlsbad
- Sand City chose treatment approach to minimize DPH concerns
- Primary Concerns
  - Primary & secondary standards
  - Pathogens
  - UV validation
  - NSF approved materials


State of California—Health and Human Services Agency
California Department of Public Health

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State of California—Health and Human Services Agency
California Department of Public Health

Pathogen Removal

- Regulated as groundwater under direct surface water influence
- LT2 ESWTR not yet implemented in California
- Treated as impaired water source to simplify SWA and WSS

Pathogen	Removal Achieved				CDPH Requirement
	RO	UV	Chlorine	Total	
Viruses	> 2-log	--	> 4-log	> 6-log	6
Giardia	> 2-log	> 3-log	--	> 5-log	5
Cryptosporidium	> 2-log	> 3-log	--	> 5-log	4

UV Validation

- Selected UV system to deliver 40 mJ/cm² at 120% design flow and 95% UVT
- 22 mJ/cm² required for 4-log inactivation of *Cryptosporidium* and *Giardia*
- UV units certified under German DVGW guidelines
- Credit given for 3-log *Giardia* and *Cryptosporidium*

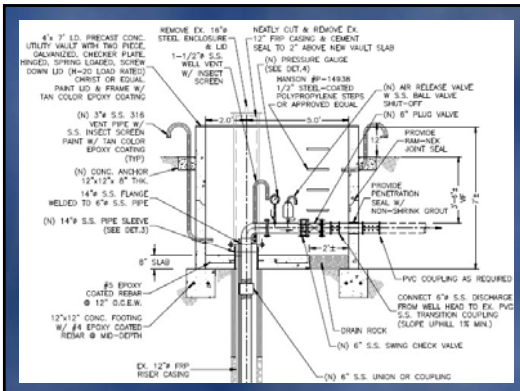
Environmental Permitting

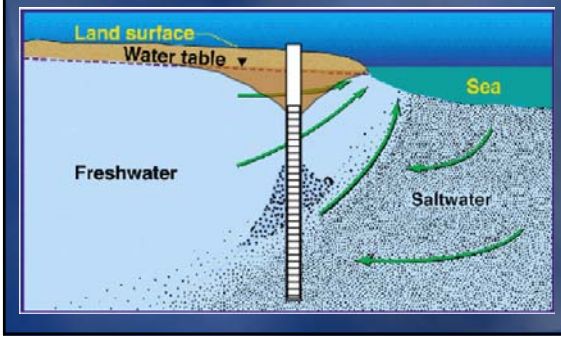
- Major obstacle delaying desalination projects in California
- Key issues tend to be intakes, brine, and energy use
- Carlsbad Coastal Development Permit took 2 years, rejected 4 times
- Sand City took conservative approach to achieve coastal commission approval in 4 months

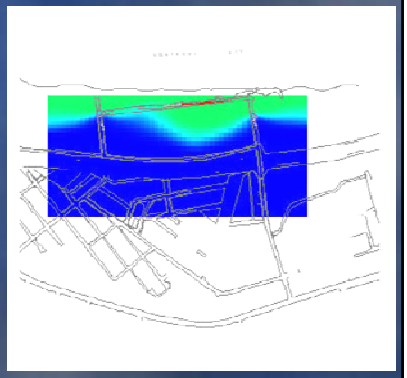
Intake Approach

- Four vertical feed wells with submersible pumps in vault
- Feed wells are 65-90 feet deep
- County Well Permit to withdraw water
- Coastal Commission primarily concerned with well construction
  - Mitigation work to counter impact of rig
  - Monitoring for endangered species – BLL, SBB, SP

Feed Water Source: Brackish Water from Subsurface Wells



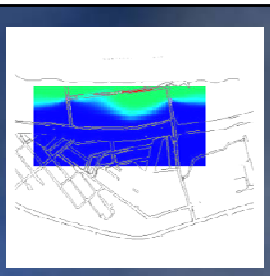


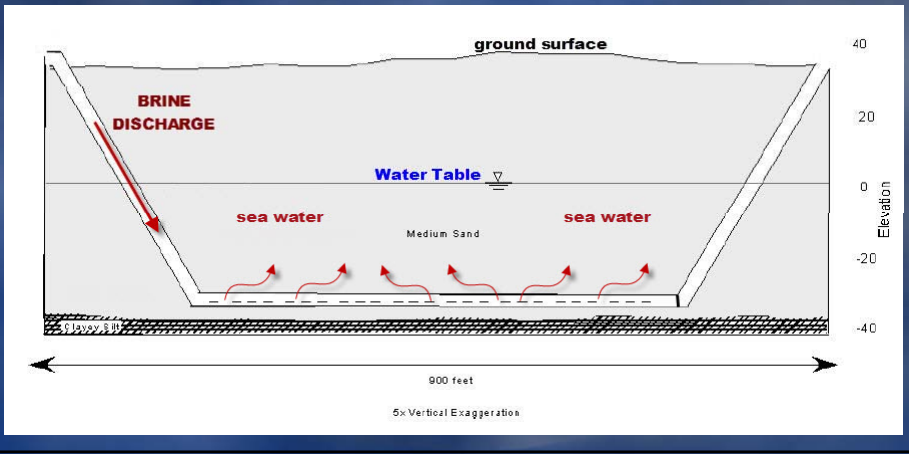


Brine Disposal Approach

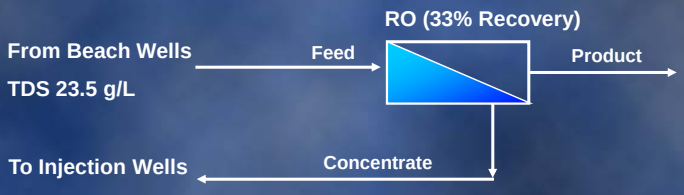
- Horizontal Discharge well
  - 6-inch diameter with slots set down 30-ft below seawater
  - 700-ft horizontal
- Waste discharge permit (NPDES) by RWQCB for brine wells
- Plant operated to maintain brine salinity below seawater (35 g/L)
- May require dilution with raw water when salinity high

Horizontal Discharge Well





Brine Outfall Approach



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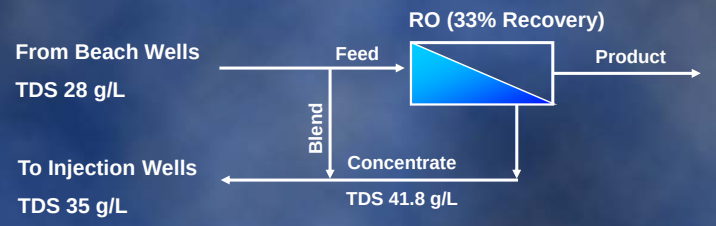
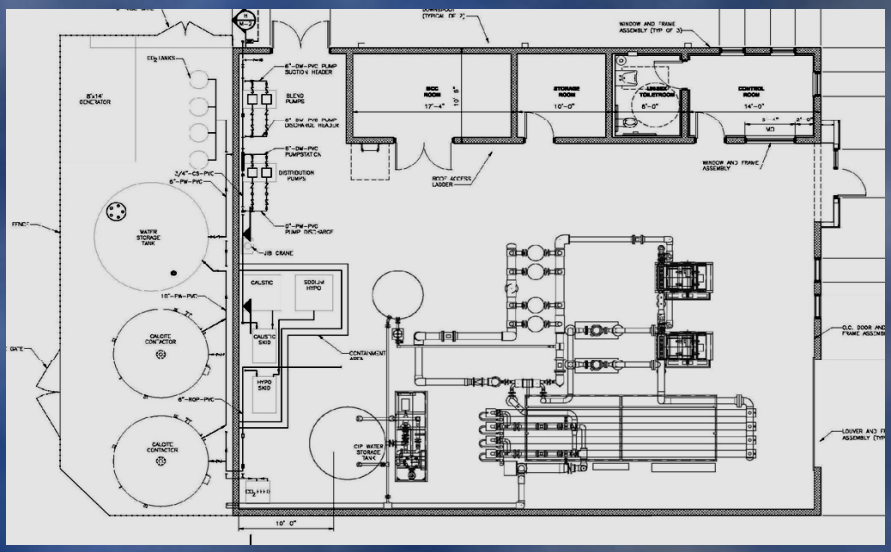
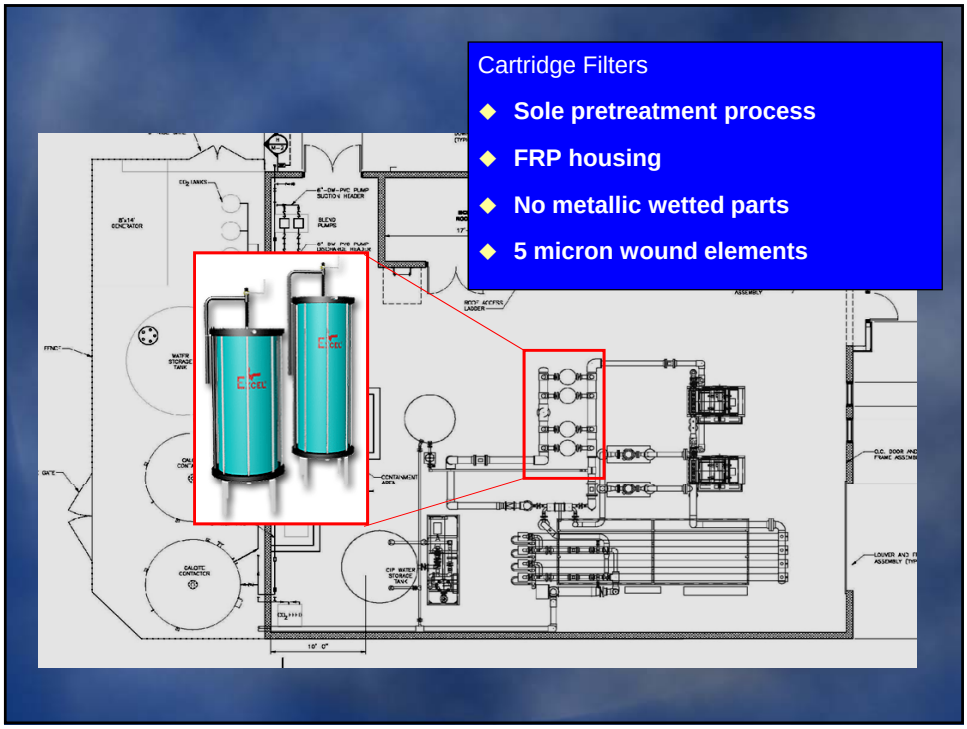
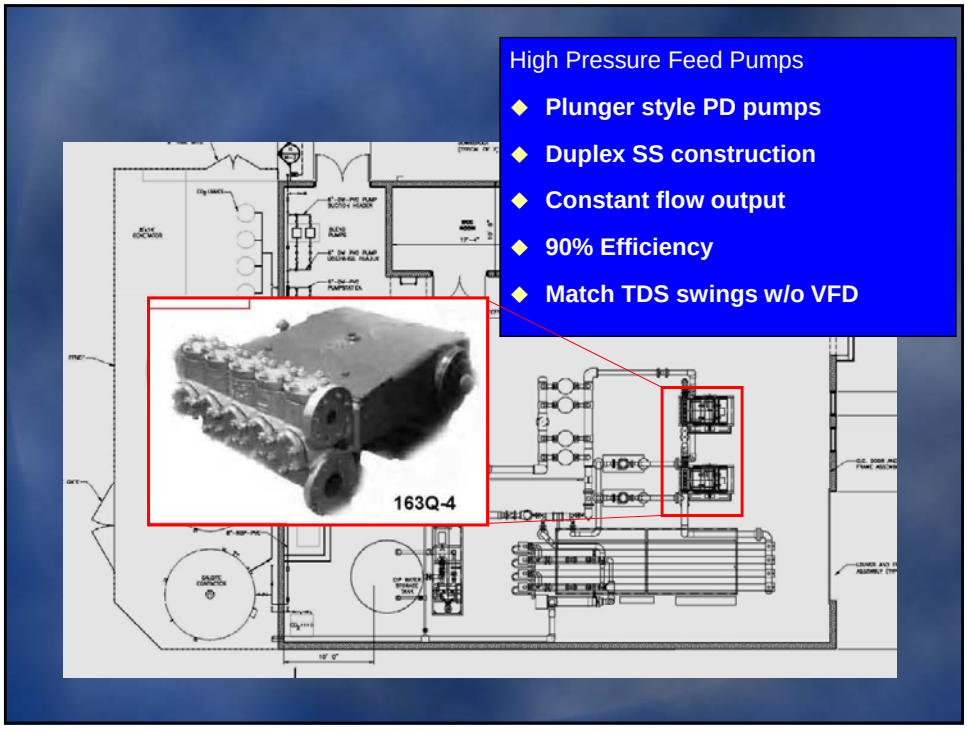
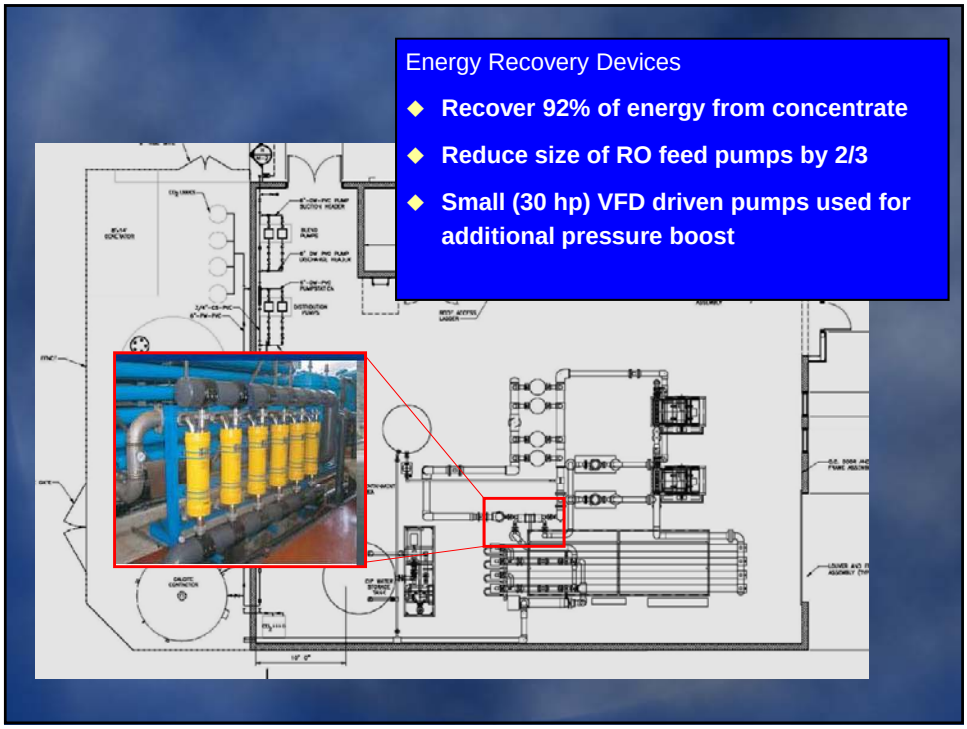


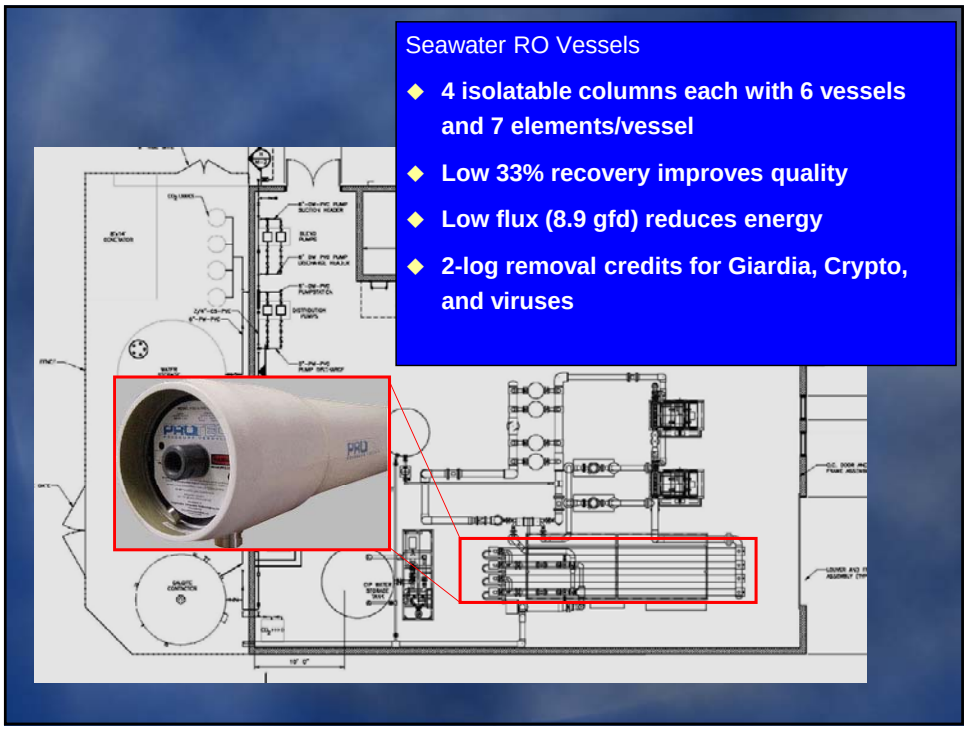
Treatment Approach




Cartridge Filters
Sole pretreatment process
FRP housing
No metallic wetted parts
5 micron wound elements

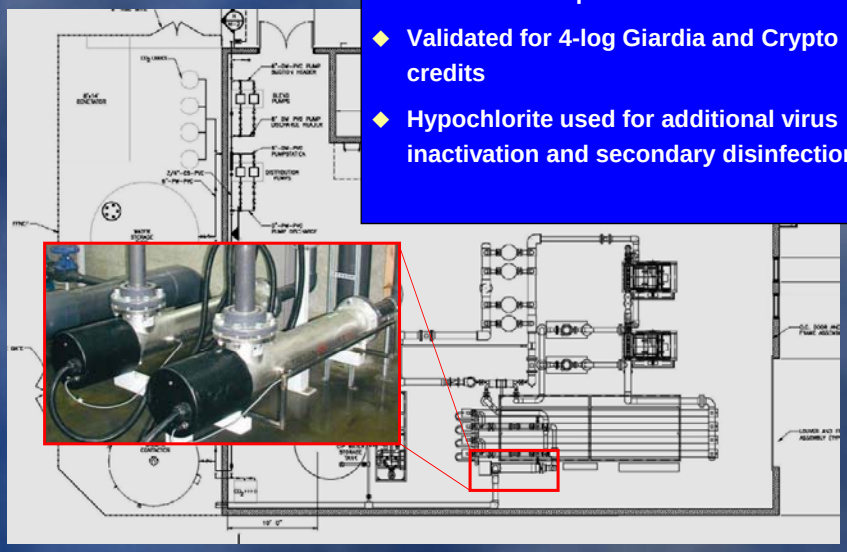

High Pressure Feed Pumps
Plunger style PD pumps
Duplex SS construction
Constant flow output
90% Efficiency
Match TDS swings w/o VFD
163Q-4


Energy Recovery Devices
Recover 92% of energy from concentrate
Reduce size of RO feed pumps by 2/3
Small (30 hp) VFD driven pumps used for additional pressure boost


Seawater RO Vessels
4 isolatable columns each with 6 vessels and 7 elements/vessel
Low 33% recovery improves quality
Low flux (8.9 gfd) reduces energy
2-log removal credits for Giardia, Crypto, and viruses

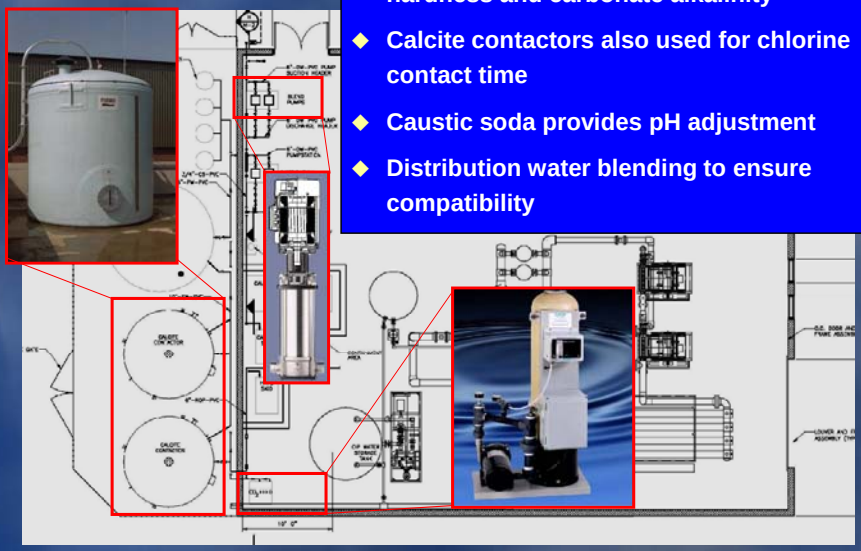
Disinfection

- **Two UV units used for additional pathogen inactivation of permeate**
- **Validated for 4-log Giardia and Crypto credits**
- **Hypochlorite used for additional virus inactivation and secondary disinfection**



Post Stabilization

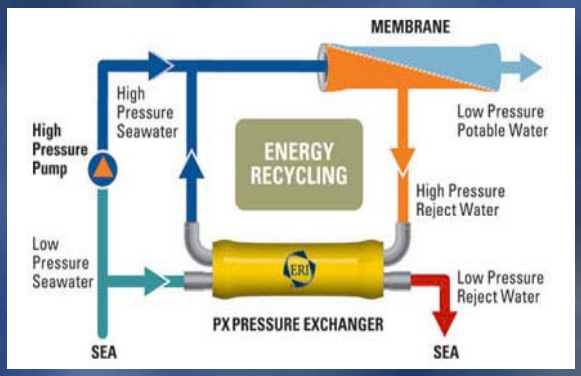
- **CO2 and calcite contactor used to add hardness and carbonate alkalinity**
- **Calcite contactors also used for chlorine contact time**
- **Caustic soda provides pH adjustment**
- **Distribution water blending to ensure compatibility**



Energy Efficiency

- Not directly tied to any permits for Sand City
- Major focus of PUC
  - Energy recovery devices recover 95% of brine energy
  - 90% efficiency PD feed pumps operate without VFDs
  - Reduced overall plant energy usage by 53%
  - Off-peak operation further reduces costs

Energy Recovery Devices: Pressure Exchangers



Cost of Implementation

- Seawater desalination often criticized as too expensive
- Cost effective operation necessary if plant is to serve as everyday supply
- Capital cost had to fit within limited budget
- Significant cost saving changes made during Plant design allowed for $5.1 mil capital cost and expansion to 0.6 mgd capacity
- Offsite Wells and Pipelines constructed within City Street Right of Ways eliminate land and easement acquisition costs
- Total Project Cost = +/- $12,000,000
- Annual Operations and Maintenance Costs +/- $370,000 including +/- $185,000 electricity

RO Feed Water Pumping

- Reduced recovery to 33%
  - lower feed pressure
  - improved product water quality
  - avoid concentrate dilution when TDS < 23.5 g/L
- Plunger pumps
  - 220 GPM: 350-450 psi boost (50 HP)
  - lower capital cost
  - eliminate VFDs
  - operate at 90% efficiency
- Energy recovery devices
  - 410 GPM: 40 psi boost (30 HP)
  - allow use of feed pumps with 2/3 less capacity

Summary

- Sand City implemented it's coastal desalination project to facilitate city-wide redevelopment with limited growth opportunity.
- Water Distribution Permit designed to limit growth and protect Peninsula Water Resources.
- Conservative approach taken for health department and environmental permitting to reduce permitting challenges
- Utilized beach wells and subsurface discharge to minimize impacts to coastal environment and eliminate pre-treatment.
- Significant measures taken to reduce capital and operating costs through energy recovery, high efficiency pumps, and passive pre-treatment.

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