Challenges with Desalination – Minimizing Impacts to the Environment

Integrated Water Plan

Wednesday, April 22, 2009

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scwd²

Collaborating to conserve, protect and create reliable water resources

Presentation Outline

- Seawater Intakes
- Brine Discharge
- Energy Use

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The primary objective of an intake is to supply seawater to the desalination facility

Important Considerations:

- Source water quality
- Construction impacts
- Operational impacts to marine organisms
- Capital and Maintenance Costs
- Regulatory Permitting

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scwd^2 is evaluating both subsurface intakes and screened open-water intakes

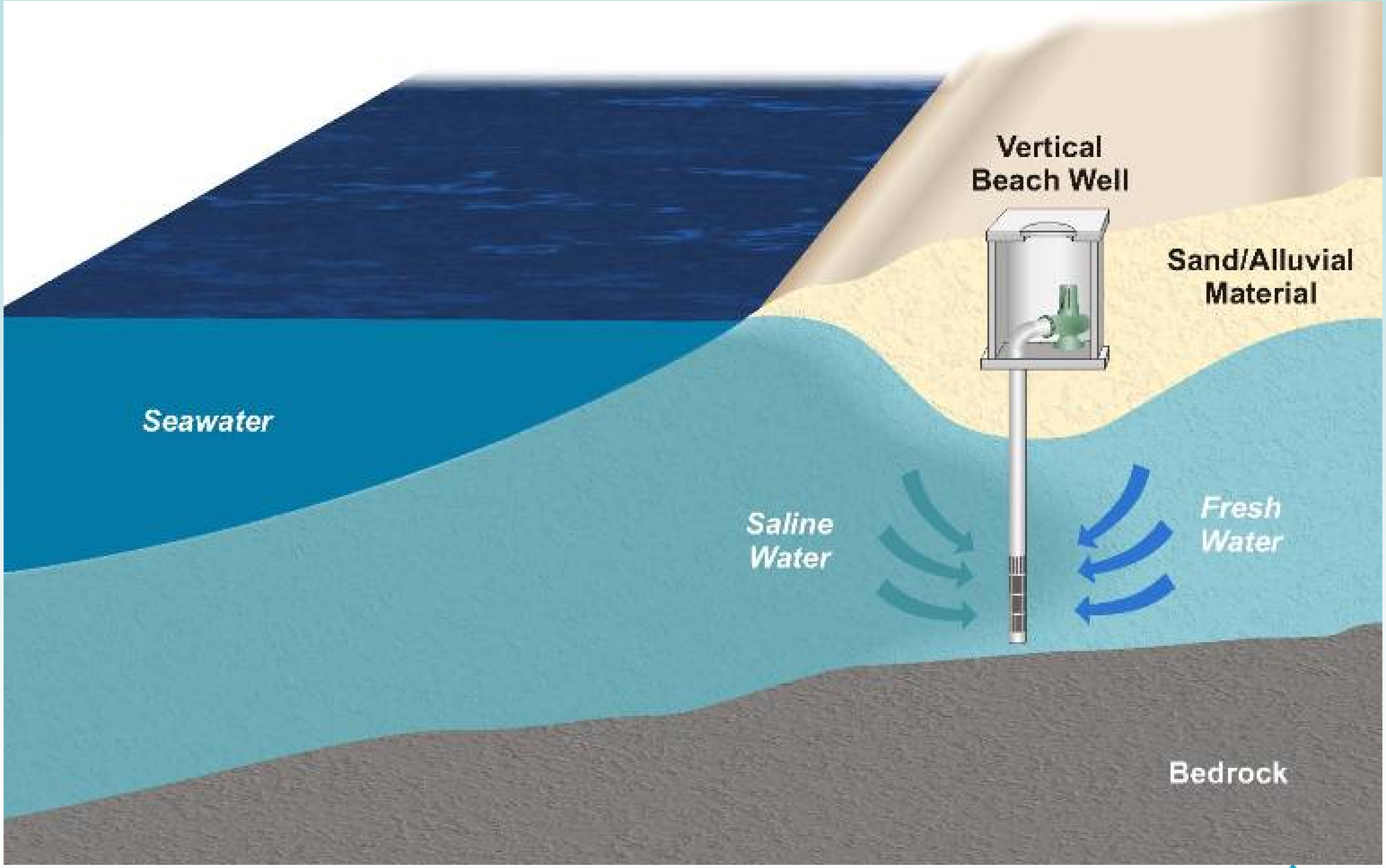
Subsurface intake advantages include:

- Potential for natural filtration pre-treatment
- Minimize impingement and entrainment issues
- Minimizes growth of marine life on the inside of the intake pipeline
- Favored by regulatory agencies

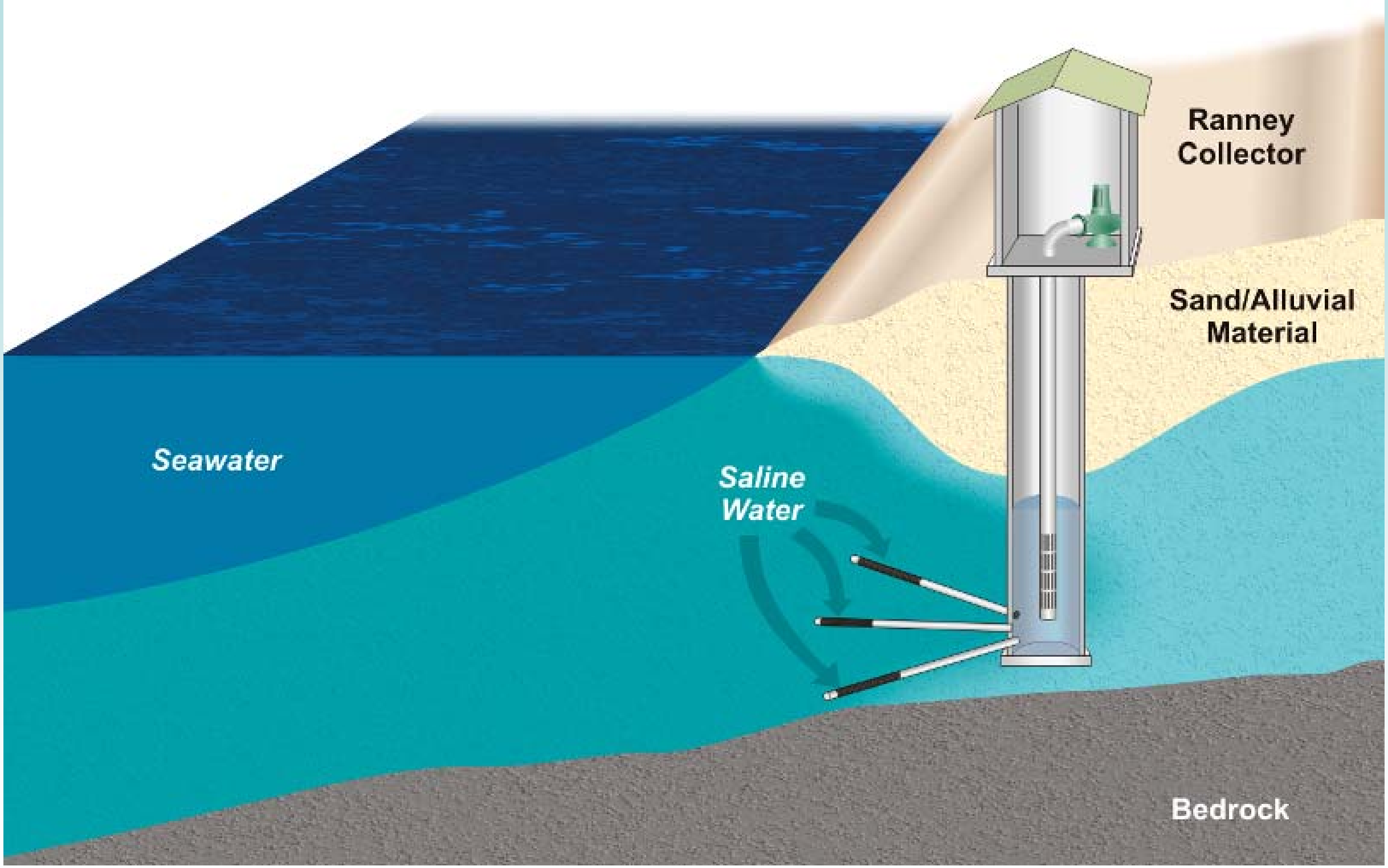
Screened Open-Water intake advantages include:

- Not dependent on local coastal and ocean floor geology
- Can provide larger volumes of water at lower cost
- Utilizes existing outfall pipeline to minimize construction impacts

Beach wells require deep beaches with large-grain sands and good hydraulics



Horizontal collector wells require similar conditions as vertical beach wells



2001 Report concluded that beach wells and collector wells would not provide sufficient water and would be damaged in storms

- Shallow beaches over bedrock
- Fine-grained sands
- Significant seasonal beach erosion
- San Lorenzo alluvial deposits have abundant organics, silts and clay

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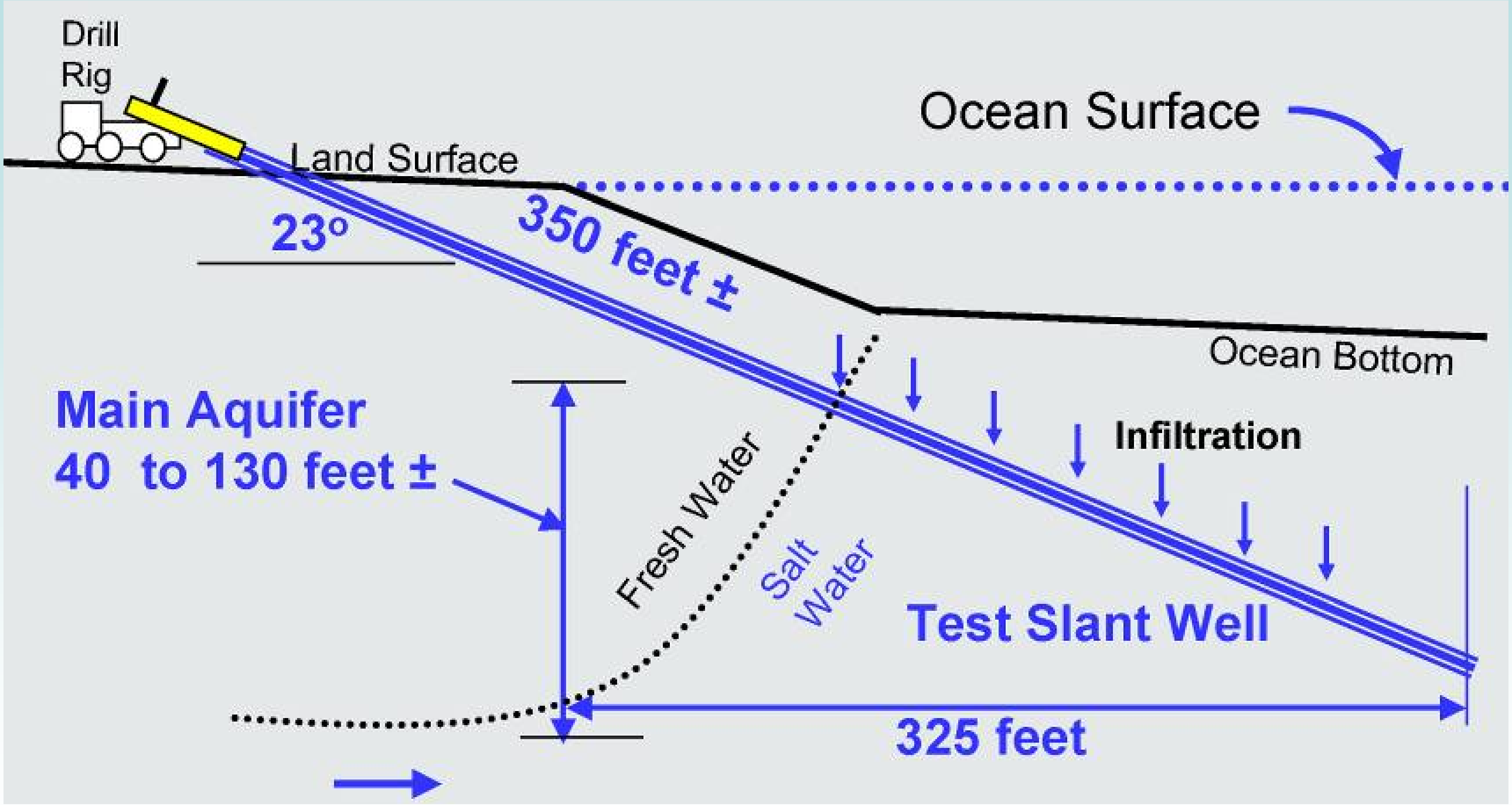
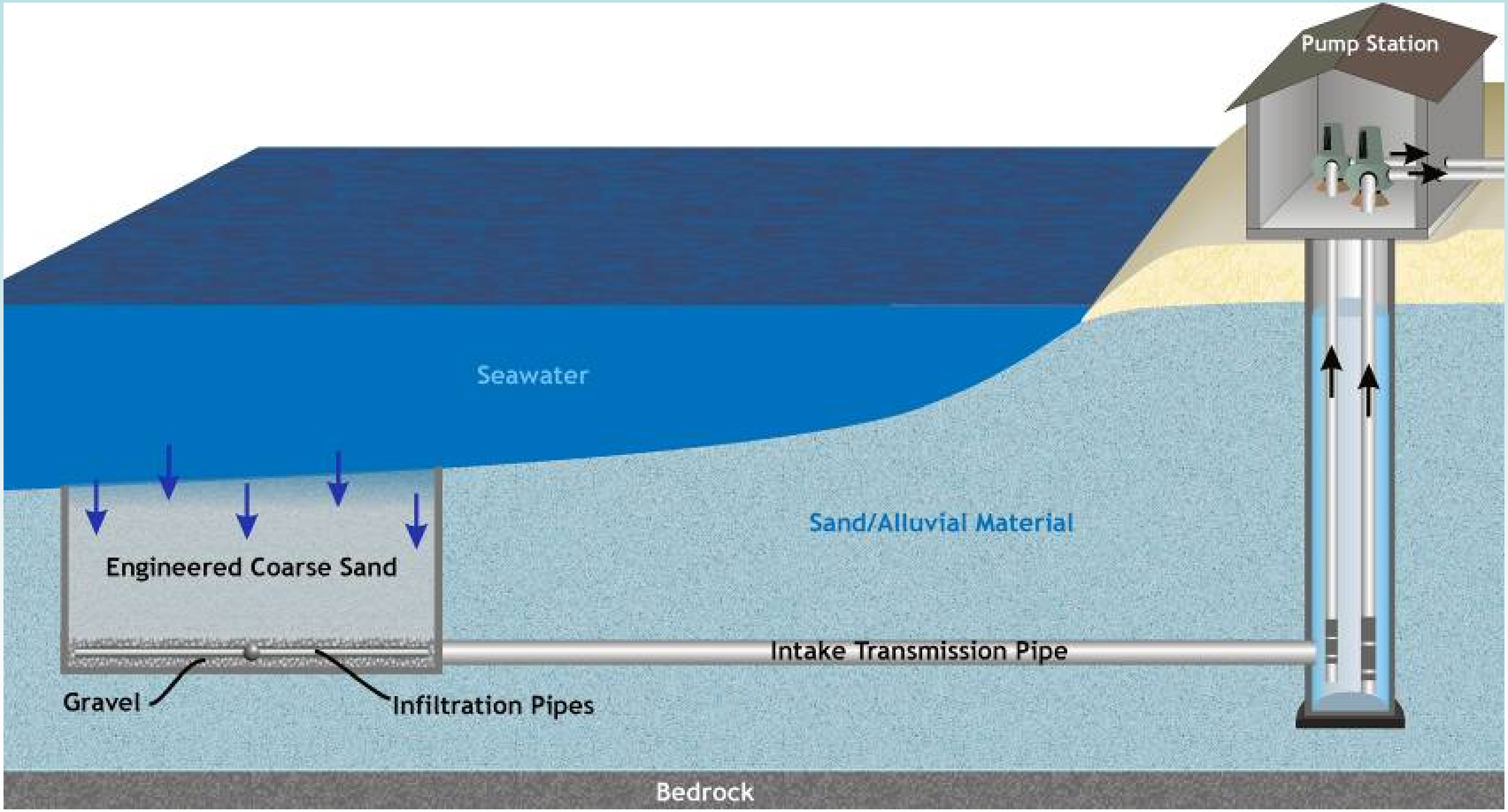
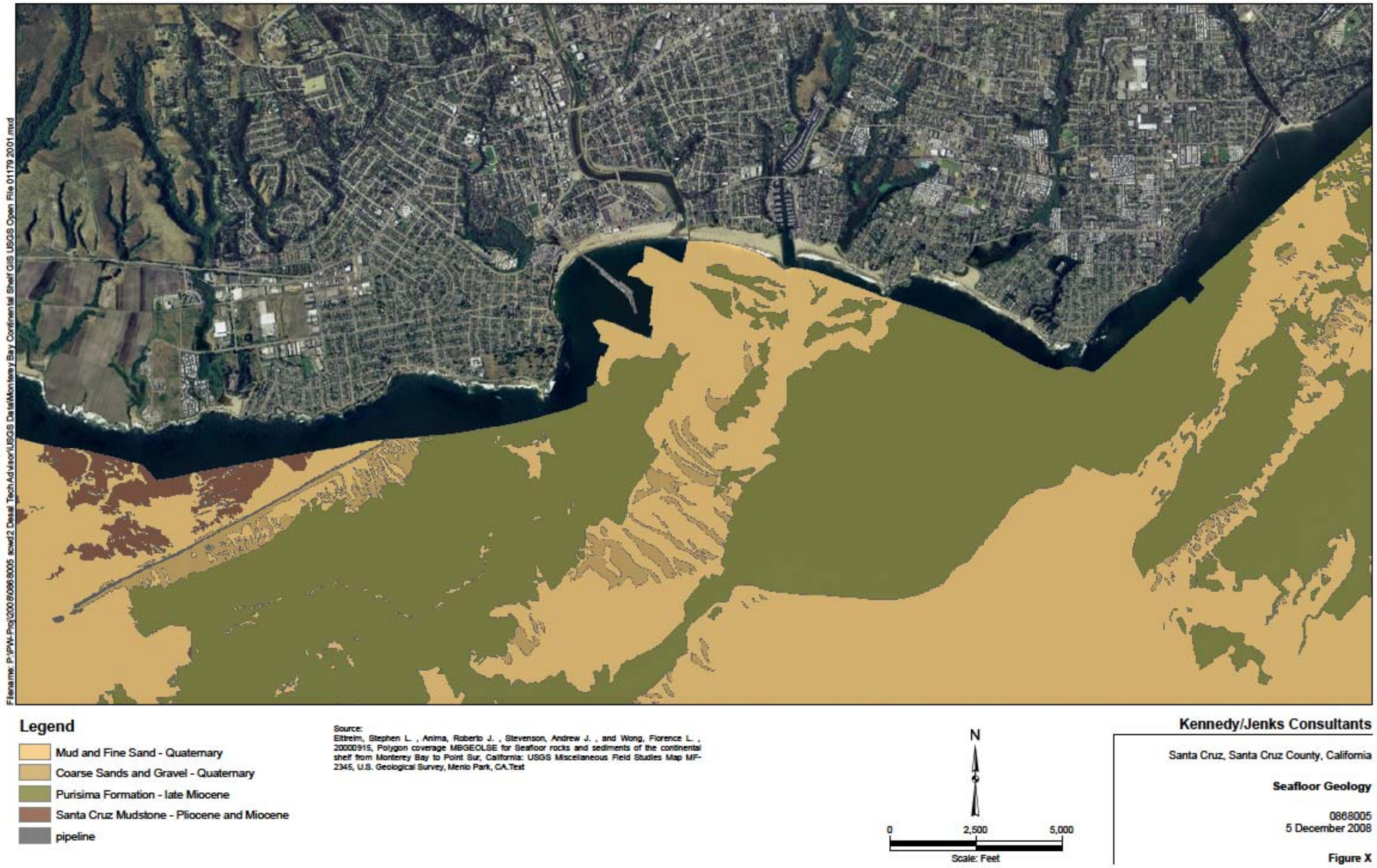
Slant or horizontal wells could potentially work where vertical wells will not



An engineered infiltration gallery could work where natural ocean floor geology is not suitable



There is an alluvial channel offshore of Santa Cruz that may support a subsurface slant well or infiltration gallery



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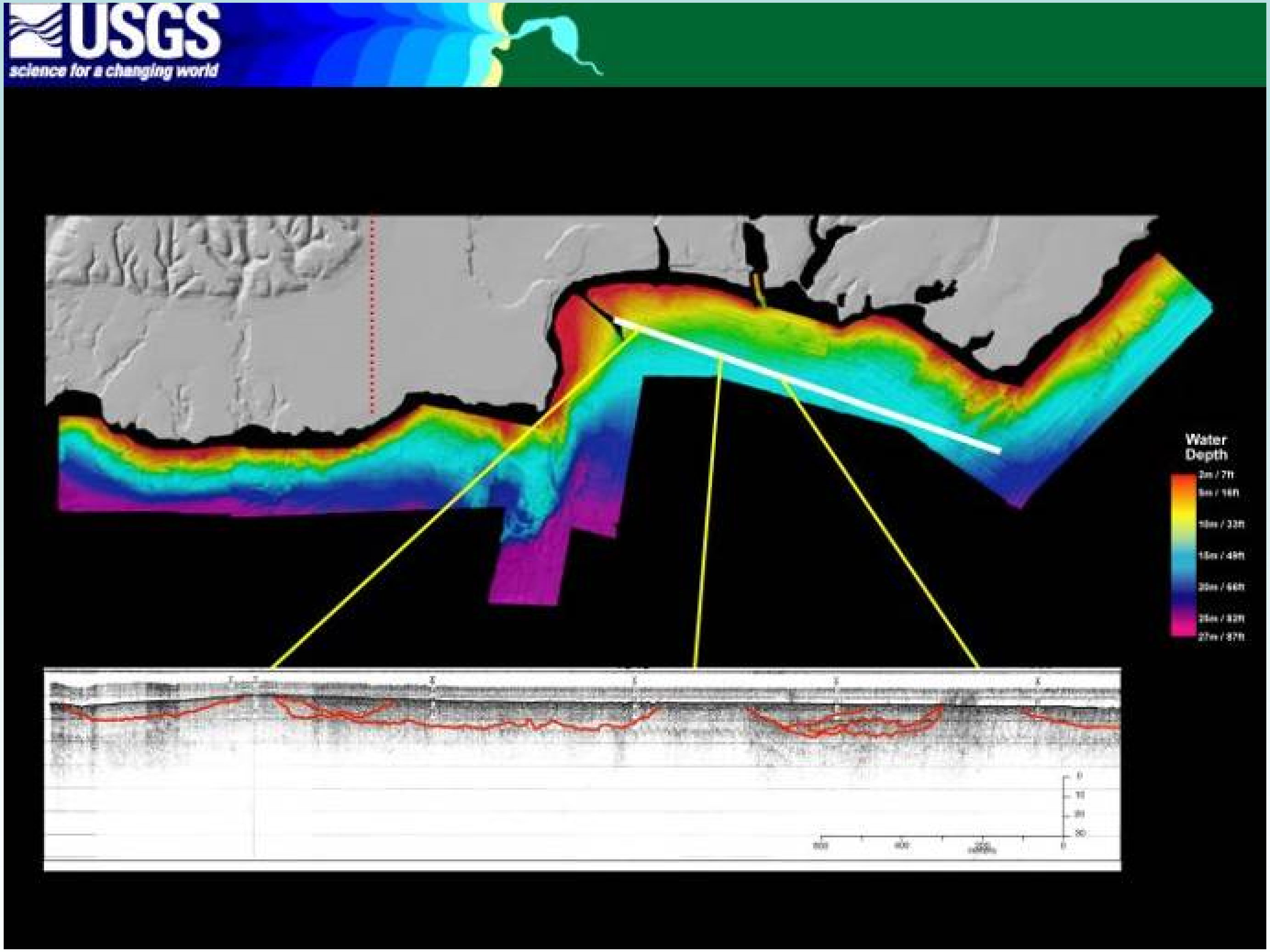
USGS Data shows a 30-ft deep, 2000-ft wide alluvial channel offshore of Santa Cruz



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Unfortunately, fine sediments from the San Lorenzo River will plug up an infiltration gallery and possibly a slant well

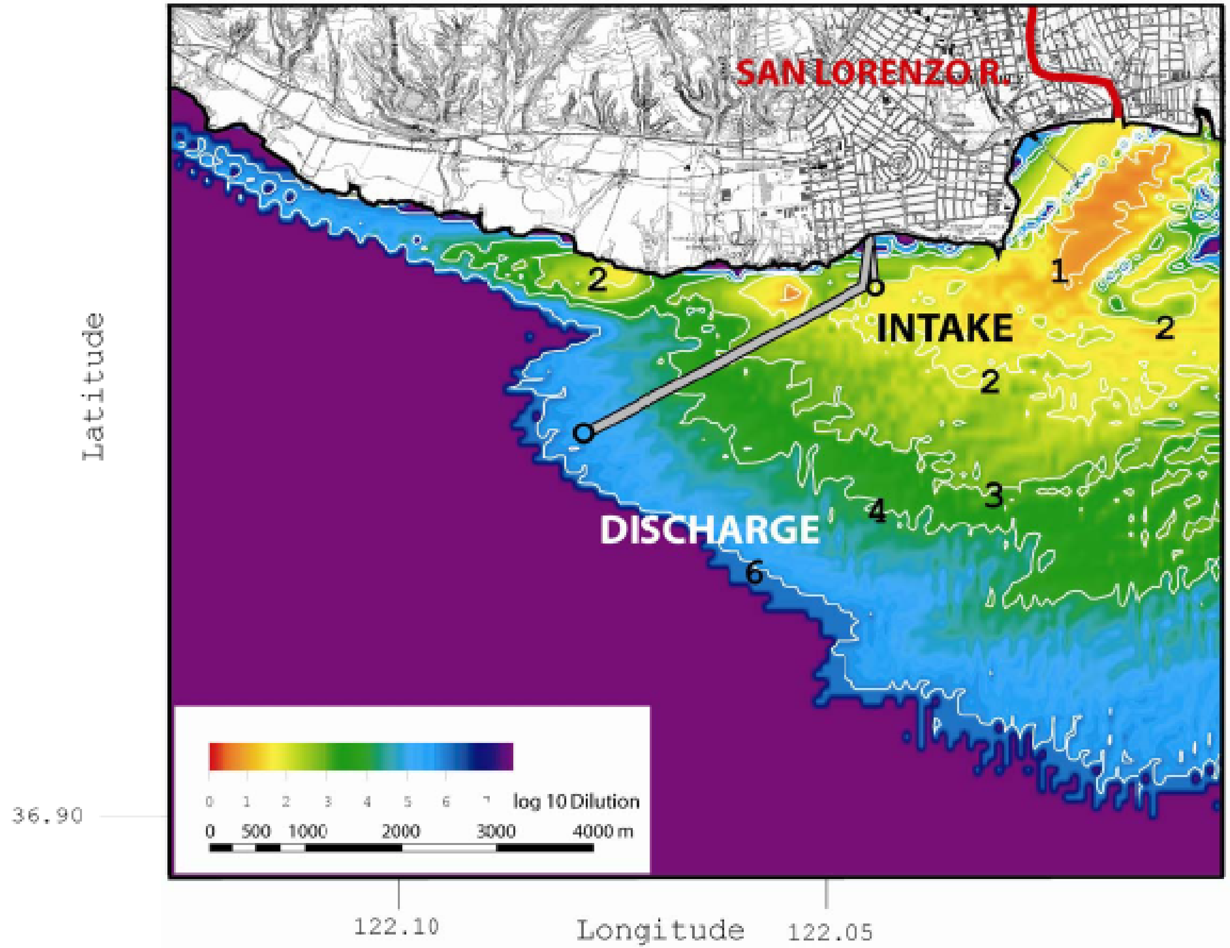

Figure 4.9. Surface dilution field of storm water runoff from 3 February 1998 storm event. Intake flow rate = 7.0 mgd.

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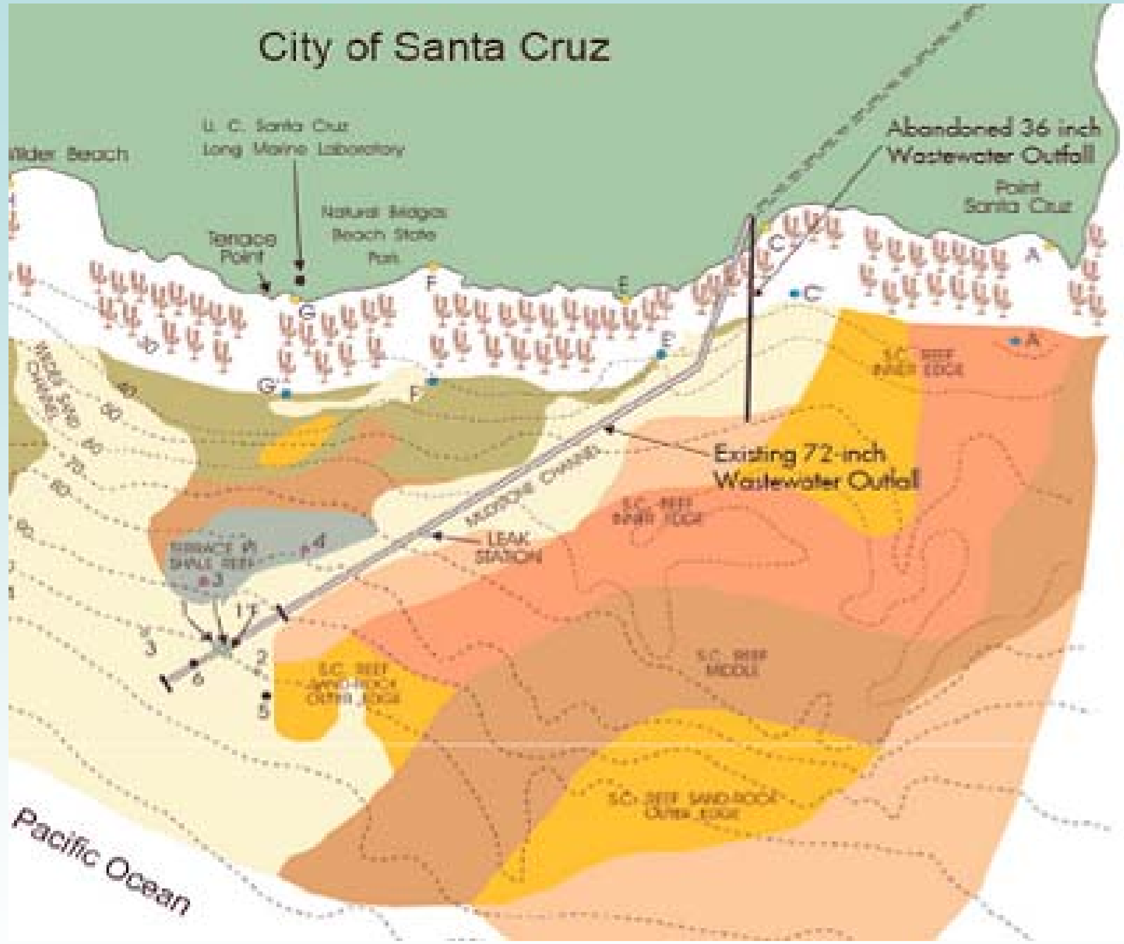
scwd^2 is also evaluating converting an abandoned outfall into a screened open-water intake

- Provides required volumes
- Uses existing infrastructure
- Reduces capital costs
- Minimizes construction impacts to ocean floor
- Cylindrical wedgewire screens to minimize impingement and entrainment



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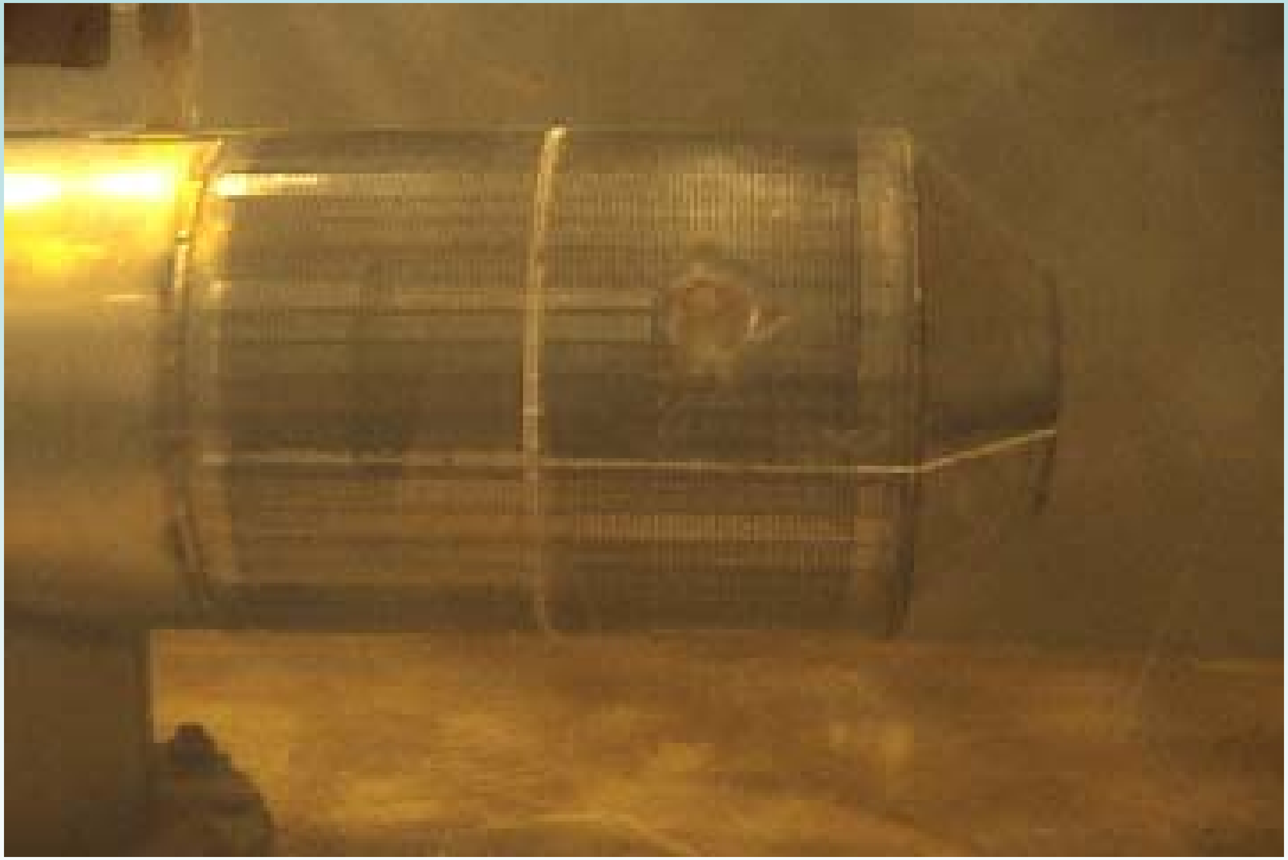
Wedgewire screens use narrow slot size and low velocities to protect marine organisms

Slot size of 2 mm

Intake velocity < 0.33 fps

vertical screens

Fish larvae are not entrained floating by a properly designed wedgewire intake (Alden Research)



2mm screen; 0.5 fps intake velocity; 0.5 fps current

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Next steps for scwd^2 intake evaluation

Subsurface/Sub-floor Intake Approach

- Work with USGS to evaluate existing studies of local seafloor
- Possible additional surveys of offshore marine channel area
- Possible borings to characterize the offshore alluvium
- Evaluate feasibility and costs of subsurface intake

Screened, Open-Water Intake Approach

- Conduct 13-month entrainment study and impact assessment
- Survey the existing outfall
- Evaluate the costs of screened, open-water intake

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Brine disposal is an important aspect of desalination

- scwd[2] brine volume would be approximately equal to the production of fresh water
- scwd[2] brine would be twice as salty as the ocean source water (approximately 64,000 ppm)

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Brine from the scwd² desalination facility would not have a negative impact on the marine environment

- Brine would be blended with effluent from Santa Cruz municipal WWTP
- Brine and effluent would be nearer to ocean salinity than current effluent
- Salt toxicity issues are eliminated by blending the brine with low-salt effluent
- scwd² is modeling the brine/effluent discharge in the same manner that effluent discharges are modeled

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The brine/effluent discharge is well away from the intake and is rapidly dispersed to background in the ocean currents

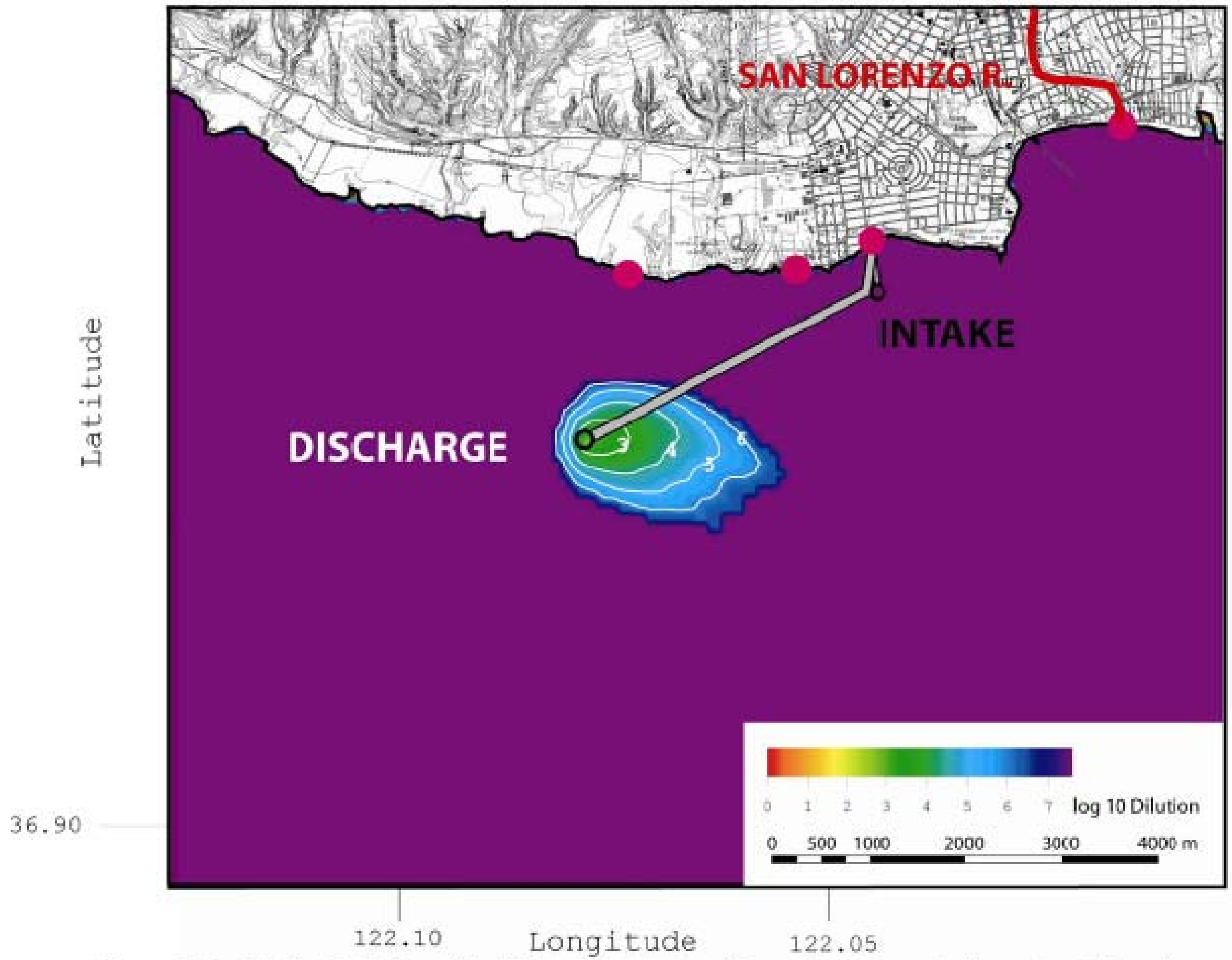

Figure 5.3. Dilution field of combined brine/wastewater effluent for R.O production rate = 2.5 mgd during flooding spring tide.

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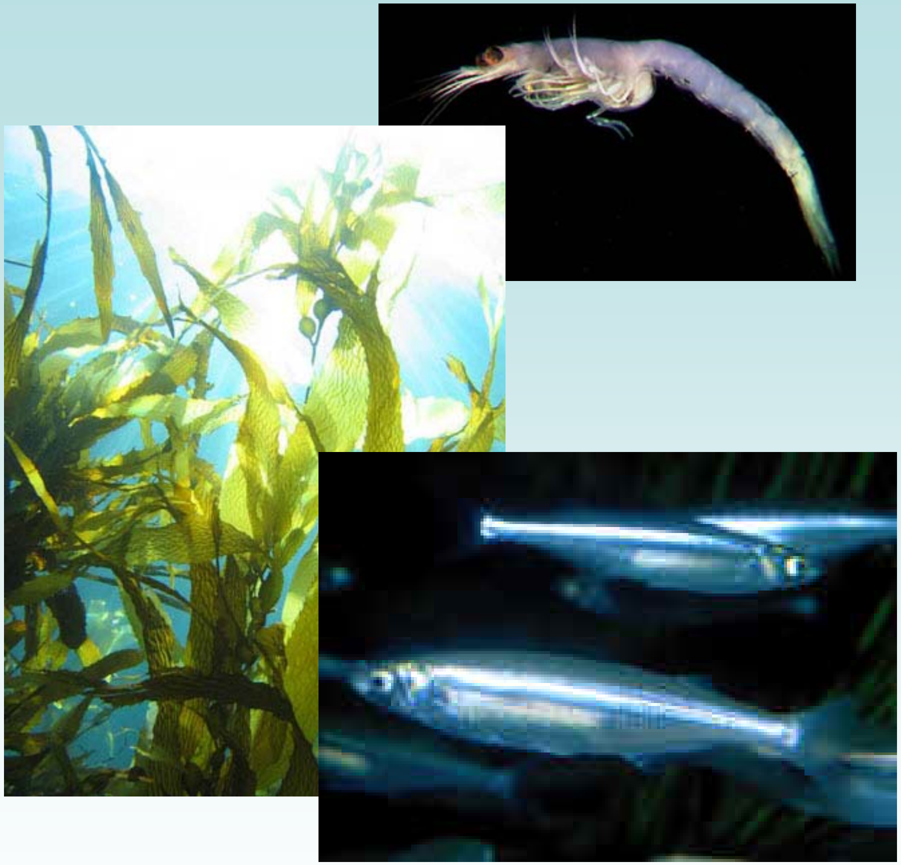
Marin seawater desalination pilot study conducted extensive bioassays to evaluate impact of similar brine/effluent blends



- Acute bioassays
  - Mysid Shrimp
  - Topsmelt
  - Marine Algae
- Chronic growth and development bioassays
  - Marine Giant Kelp
  - Bay Mussel
  - Inland Silverside
  - Opossum Shrimp
  - Marine Diatom

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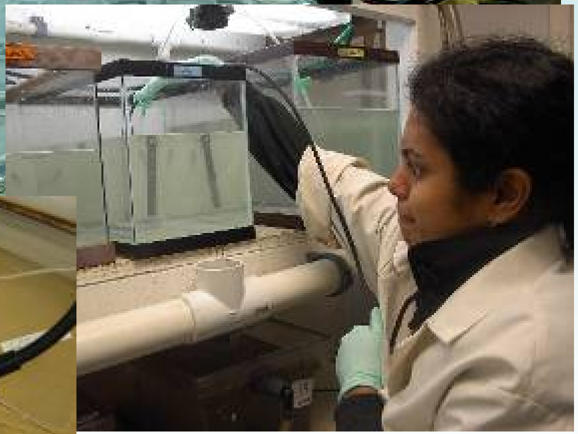
Marin pilot study bioassy tests showed the brine/ effluent blend does not adversely impact the health of the marine environment

- Brine mixed with municipal wastewater effluent
  - No significant acute bioassay effects
  - No significant chronic growth or development impacts
  - Bioassay tests were similar to municipal wastewater effluent with no brine



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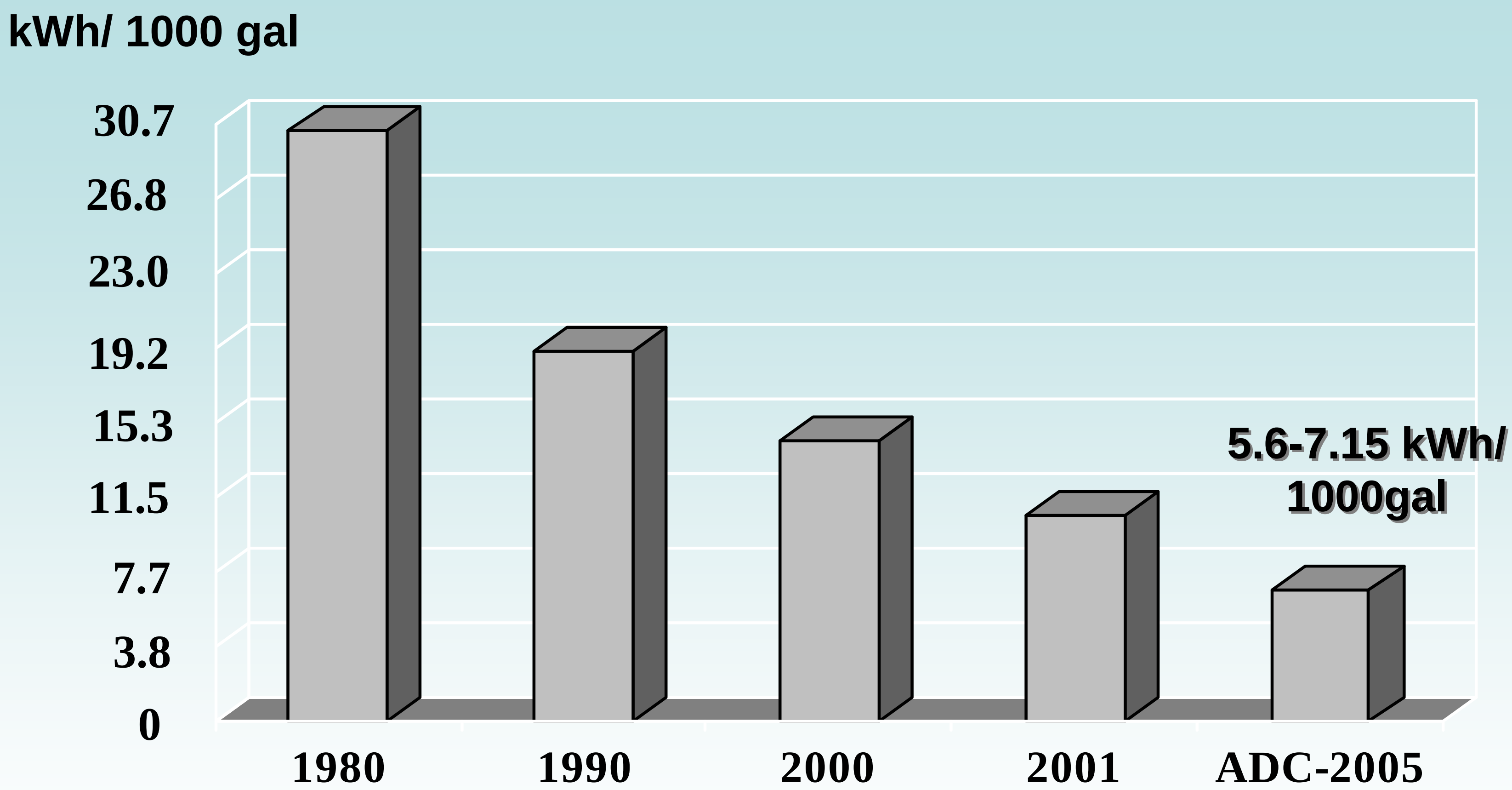
Experience from an operating velocity cap intake system in Perth Australia and direct brine discharge system

Movie of Perth Desalination Facility

Intake and Brine Discharge

SWRO energy use is lower than in the past due to advances in membrane and energy recovery technology

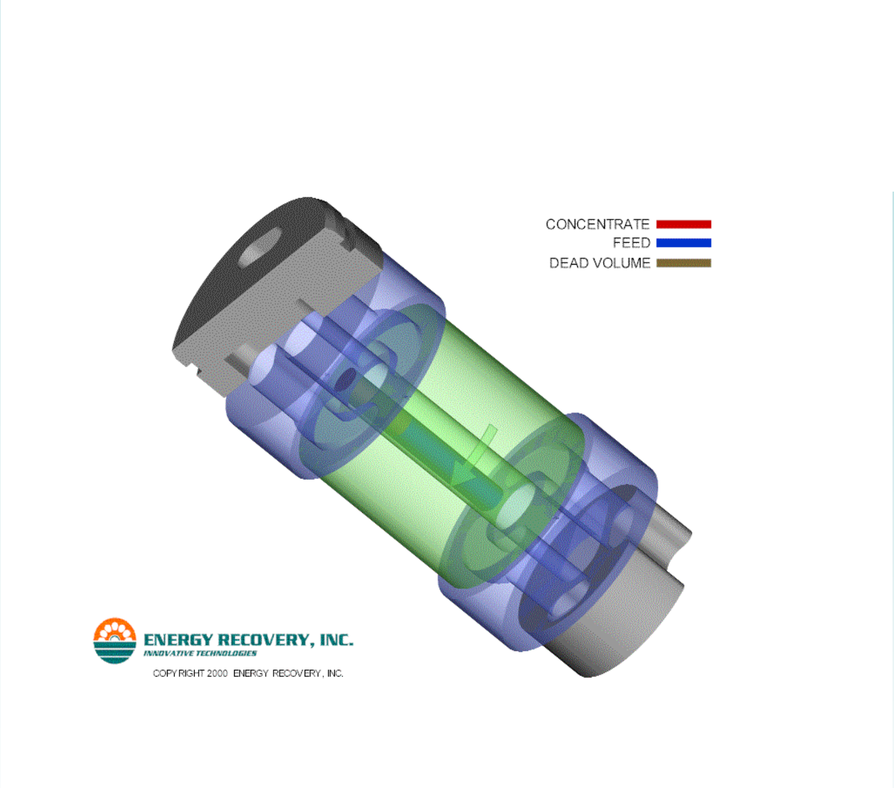


Note:

1. Numbers for energy consumption represent the RO process only. They do not include any allowance for supply or distribution.
2. Numbers are a general average for standard ASTM seawater locations.

Advanced technology reduces SWRO energy use and costs

- New membrane materials operate with higher flows at lower pressures
- Advanced energy recovery utilizes the pressure energy in the brine to reduce the feed water power requirements
- Membrane costs have decreased ~85% from 1990
- New ultrafiltration pretreatment reduces fouling and operational costs



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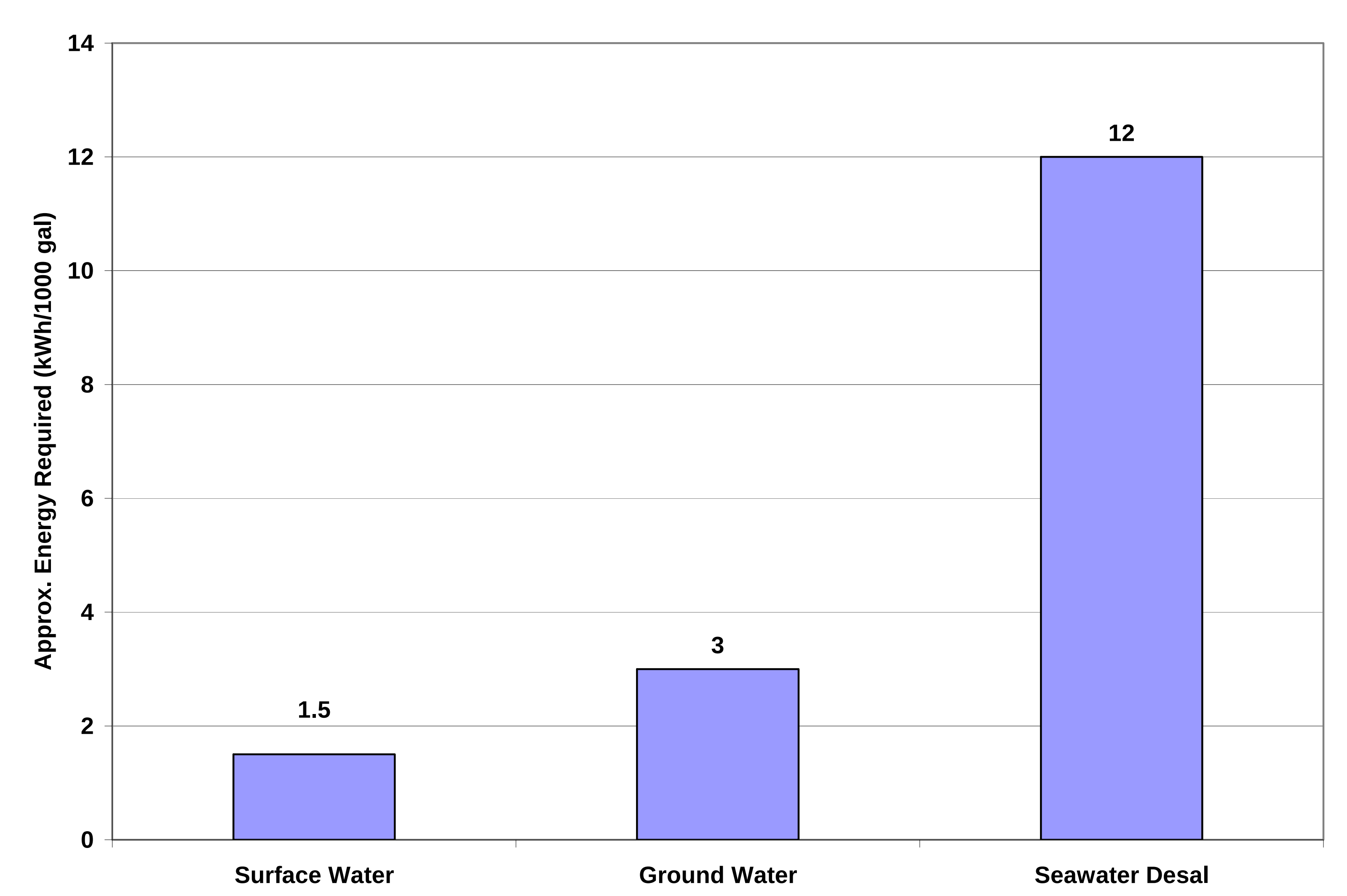
Seawater desalination uses more energy than typical surface water and groundwater supplies



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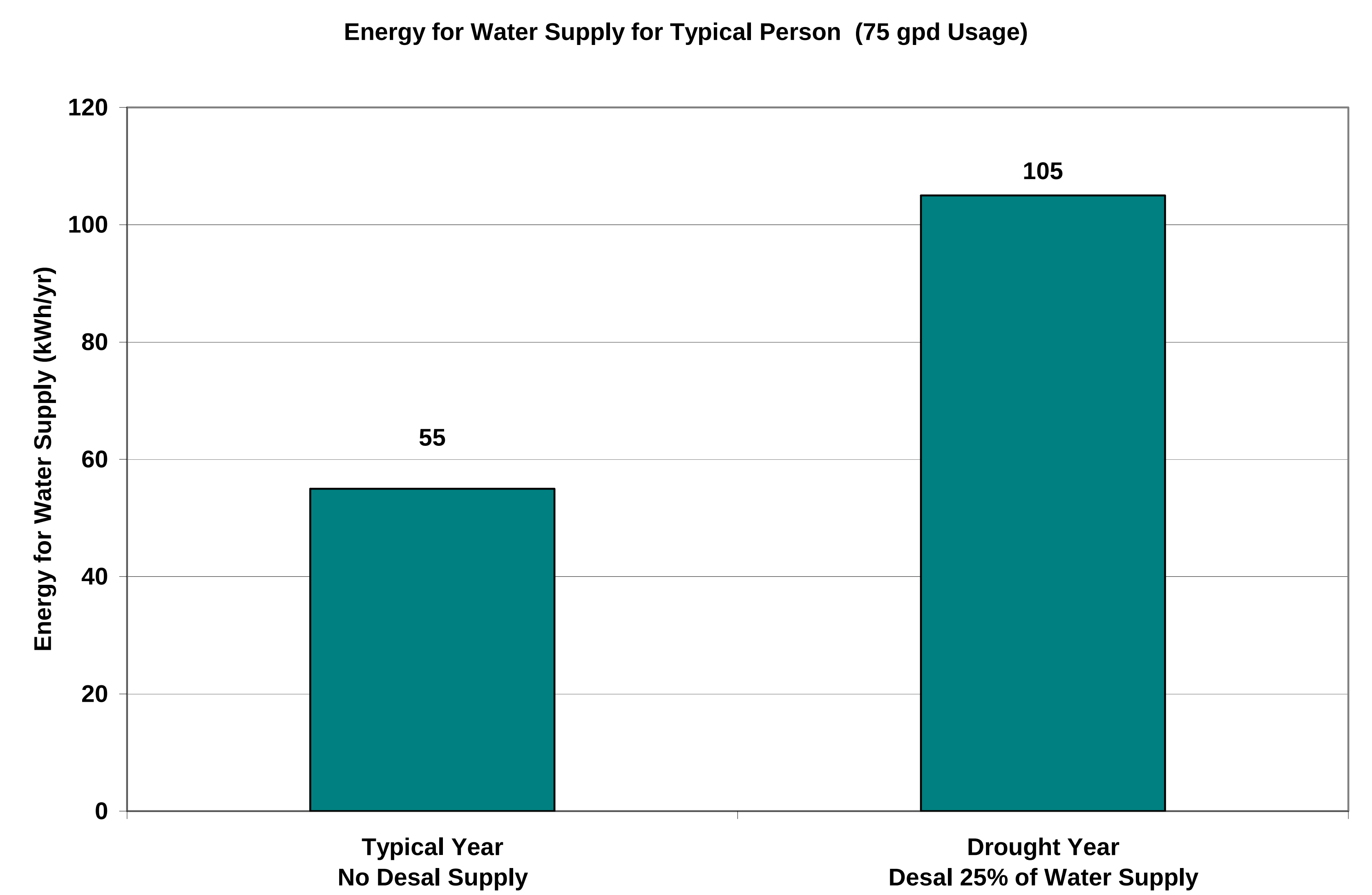
Because desal water is only a portion of water supply, increase in energy use is not as dramatic

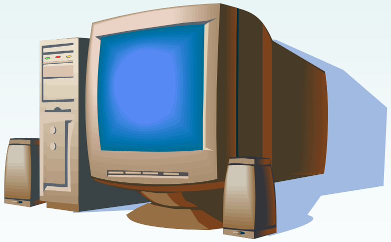


The additional 50 kWh/yr of energy to provide approximately 25% of water supply from desalination averages to 140 Whr/day per person

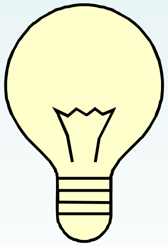
- Refrigerator running for ~1.5 hours per day
- Computer running for ~1 hours per day
- Light bulb on for ~2.5 hours per day

100 Watts avg.

140 Watts



60 Watts



100 Watts

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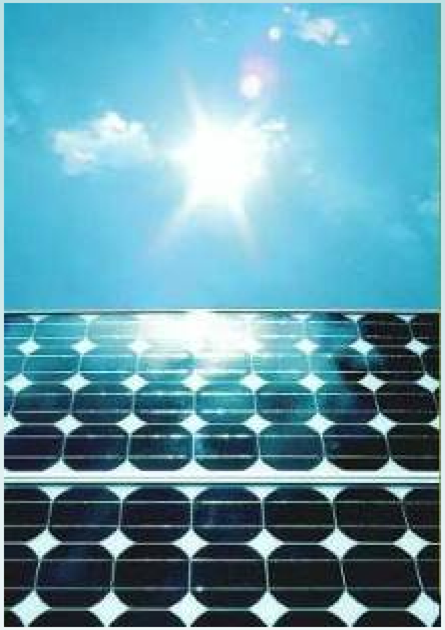
scwd² is evaluating ways to minimize energy use and greenhouse gas (GHG) production from desalination

- Solar system producing 205,000 kWh/yr at Graham Hill WTP
- Solar system producing 72,000 kWh/yr at SCWD Admin Building
- Conducting a study of additional approaches for renewable energy and GHG reductions



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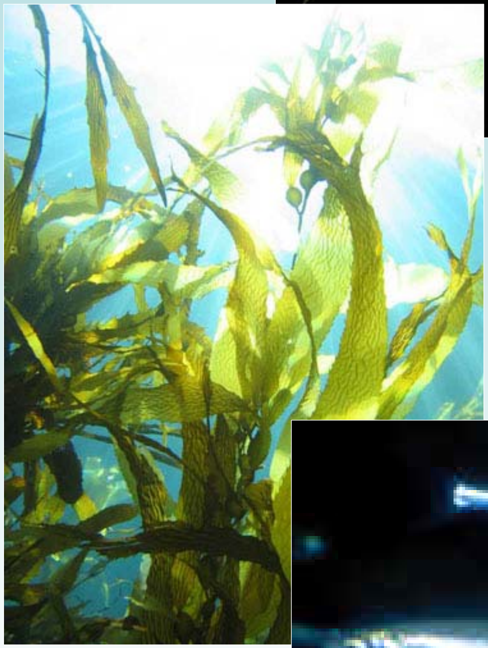
Questions



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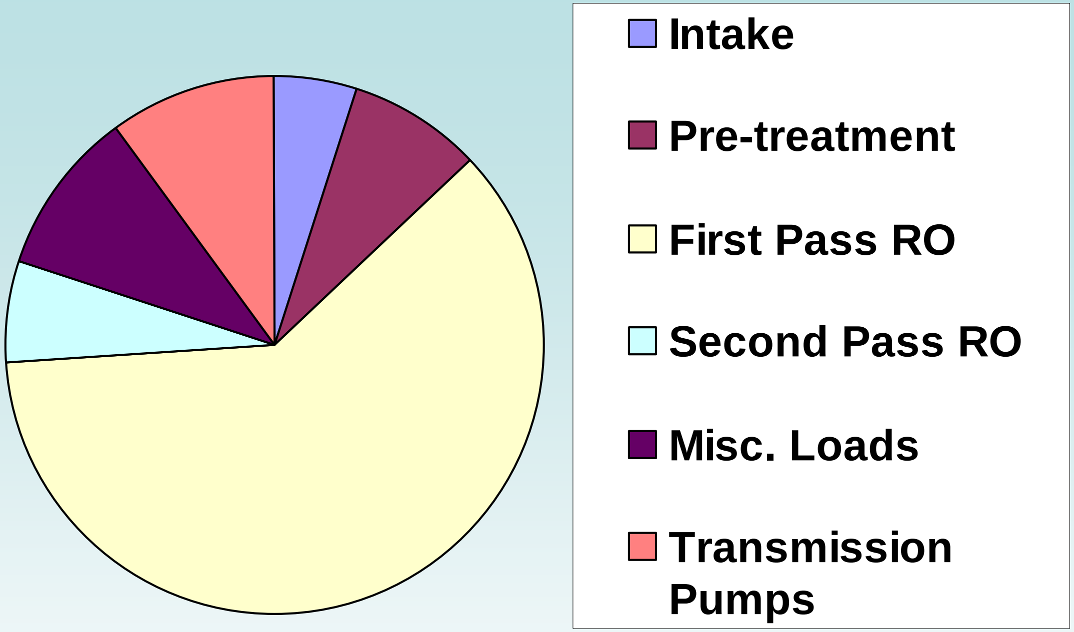
Removing the salt requires approx. 75% of the energy for seawater desalination



Intake, pretreatment, misc. and transmission energy use is similar to other water supplies