Direct Potable Reuse in Ventura?

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City of Ventura is planning to implement potable reuse within next 10 years

- Original drivers for reuse
  - Potential limitation on effluent discharge to SCRE
  - Settlement agreement with NGOs
- Drivers for potable reuse
  - Water supply and demand
  - Increased vulnerability of highest quality water supplies and water rights
  - Drought conditions
Many reuse alternatives were identified and evaluated by stakeholders…

<table>
<thead>
<tr>
<th>Reuse Alternative</th>
<th>Reliable Reduction of Effluent Flow</th>
<th>Water Supply Benefit</th>
<th>Potential to Offset other Projects</th>
<th>Treatment Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Irrigation</td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td>Low</td>
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<tr>
<td>Agricultural Irrigation</td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td>Medium</td>
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<tr>
<td>Groundwater Recharge</td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td>High</td>
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<tr>
<td>Direct Potable Reuse</td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td><img src="30x30" alt="Circle" /> <img src="30x30" alt="Circle" /></td>
<td>High</td>
</tr>
</tbody>
</table>

… potable reuse preferred by most
Indirect and Direct Potable Reuse alternatives are being considered and further developed.
City interest in direct potable reuse based on a few key issues

- Environmental buffer is a compromised groundwater aquifer (high TDS)
- Capacity of groundwater aquifer
- Incomplete recovery of purified water from aquifer
City developed a strategy for implementing potable reuse

- Feasibility Study
  - DPR treatment train
  - Costs

- Potable Reuse Demonstration Facility
  - Regulatory Demonstration and Confidence
  - Internal Demonstration and Confidence
  - Public Education and Outreach (Tours and Survey)
  - Design Criteria
  - O&M Issues
  - Novel R&D
DPR treatment train - multiple barriers for water purification

Advanced Disinfection

Pasteurization
Kills a lot of pathogens

Tertiary Filtration

Pressure Filters
Removes turbidity and TSS

Secondary Effluent

Membrane Processes

Ultrafiltration
Filters pathogens, pretreats ahead of RO

Reverse Osmosis
Removes pathogens, removes salt, removes trace pollutants

Disinfection and Advanced Oxidation

NaOCl or H₂O₂
Kills pathogens, destroys NDMA and trace pollutants

Engineered Storage

Finished Water
Pasteurization provides robust disinfection. Pasteurization provides 5+ LRV of all known pathogens.
UF Provided Robust Protozoa and Bacteria Removal

![Graph showing bacterial counts over time]

**Graph Details:**
- **Y-axis:** Bacteria Counts, MPN/100mL
- **X-axis:** Date
- **Legend:**
  - UF Feed Total Coliform
  - UF Feed E. coli
  - UF Filtate Total Coliform
  - UF Filtrate E. coli
RO Removes both TOC and Salt…

- Monitoring Data
  - Feed TDS – 1350 to 1600 mg/L
  - Permeate TDS – 20 to 70 mg/L
  - Feed TOC – 5 to 9 mg/L
  - Permeate TOC <0.5 mg/L
    …likely <0.05

…and Pathogens

- Novel R&D on RO
  - Pathogen removal and improved system monitoring
UV AOP Provides Very High Dose, Resulting in Destruction of Pathogens and Pollutants

- Dose of 235 mJ/cm² needed for 6-log broad pathogen removal
- Dose of ~900 mJ/cm² needed for 90% NDMA reduction
Innovative UV AOP Without Oxidants

Patented electrode system for in-situ radical generation (for UV AOP)

UV AOP Meets DDW Criteria Without Peroxide
Finished water meets all drinking water standards with very few detections of regulated chemicals.

**Drinking Water Standards**
- 115 MCLs and NLs (sampled 6 times)
  - Non Detects (687 out of 690)
  - Detected (3) but below regulated levels

**Compounds of Emerging Concern (CECs)**
- 33 CECs (sampled 8 times)
  - Non Detects (258 of 264)
  - Detected (6 but below health goals)
Ventura continues to be involved in research to address emerging concerns

- WRF “Blending Requirements for Water from Direct Potable Reuse Treatment Facilities” (WRF #4536)
  - Antibiotic resistant genes (ARGs)
  - Opportunistic premise plumbing pathogens (OPPPs)
  - Inorganic corrosion
  - Biological corrosion
Thank you

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### Existing condition – 6.4 mgd permeate

#### Table 10 Existing 100% Diversion Flow Cost Estimate
Diversion Infrastructure Projects Study
City of Ventura

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Alternative 1 (DPR Bailey and IPR Mound)</th>
<th>Alternative 2 (DPR Bailey and DPR Saticoy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Cost</td>
<td>$93 M to $102 M</td>
<td>$93 M to $102 M</td>
</tr>
<tr>
<td>Brine Disposal</td>
<td>$13 M to $22 M</td>
<td>$13 M to $22 M</td>
</tr>
<tr>
<td>Conveyance</td>
<td>$32 M</td>
<td>$20 M</td>
</tr>
<tr>
<td>Pond Recirculation and Lining (if required)</td>
<td>$10 M</td>
<td>$10 M</td>
</tr>
<tr>
<td>Total</td>
<td>$148 M – $166 M</td>
<td>$136 M – $154 M</td>
</tr>
</tbody>
</table>

- **Notes:**
  1. Brine disposal cost range based on potential range of costs for new outfall or tying into the Calleguas SMP. Costs presented at November 2014 Stakeholder workshop. A separate memorandum is being prepared for developing brine disposal alternatives.
WRF 4536 Tackling ARGs in Finished Water Supplies (including DPR)

% Total Sequences

10% DPR 90% Potable

10% DPR w/ Biofiltration 90% Potable

100% Potable

Bulk Water

Biofilm (Culturable)

Biofilm

Bulk Water

Multi-drug

trimethoprim

tetracycline

rifampin

polymyxin

macrolide

lincosamide

fluoroquinolone

beta-lactam

aminoglycoside

aminocoumarin
## Multiple Barrier Treatment Train for Water Purification

<table>
<thead>
<tr>
<th>Process</th>
<th>Pathogen Removal</th>
<th>Pollutant Removal</th>
<th>Salt Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurization</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Membrane Filtration</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse Osmosis</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ultraviolet Light Advanced Oxidation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Engineered Storage</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Final Water Quality Results Show High Quality Water that is Protective of Public Health

<table>
<thead>
<tr>
<th>Date Collected</th>
<th>Location</th>
<th>Tap Location</th>
<th>Units</th>
<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
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<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
<th>Concentration (ng/L)</th>
<th>UVIAQO</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/21/2015</td>
<td>Finished</td>
<td>Finished</td>
<td>&lt; 0.25</td>
<td>Gamitrofrazo</td>
<td>&lt; 0.25</td>
<td>Naproxen</td>
<td>&lt; 0.50</td>
<td>Triclosan</td>
<td>1.6</td>
<td>Ibuprofen</td>
<td>&lt; 1.0</td>
<td>Acetaminophen</td>
<td>&lt; 5.0</td>
<td>Sucralse</td>
<td>&lt; 2.5</td>
<td>Triclocarban</td>
<td>&lt; 2.0</td>
<td>Sulfamethoxazole</td>
<td>&lt; 0.25</td>
</tr>
</tbody>
</table>
## DPR Treatment Train

<table>
<thead>
<tr>
<th></th>
<th>Virus</th>
<th>Giardia</th>
<th>Crypto</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potable Goals</strong></td>
<td>12-log</td>
<td>10-log</td>
<td>10-log</td>
</tr>
<tr>
<td><strong>Primary and Secondary Treatment</strong></td>
<td>1.9-log</td>
<td>0.8-log</td>
<td>1.2-log</td>
</tr>
<tr>
<td><strong>Pasteurization</strong></td>
<td>5+ log</td>
<td>3.8+ log</td>
<td>3.8+ log</td>
</tr>
<tr>
<td><strong>Ultrafiltration</strong></td>
<td></td>
<td>4-log</td>
<td>4-log</td>
</tr>
<tr>
<td><strong>RO</strong></td>
<td></td>
<td>4-log</td>
<td>4-log</td>
</tr>
<tr>
<td><strong>GAC (if needed)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UV (high-dose) AOP</strong></td>
<td></td>
<td>6-log</td>
<td>6-log</td>
</tr>
<tr>
<td><strong>Engineered Storage with Chlorine (future)</strong></td>
<td>4-log</td>
<td>0.5-log</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>20.9-log</td>
<td>19.1-log</td>
<td>19.0-log</td>
</tr>
</tbody>
</table>

### Safety Factor of 100,000,000 to 1,000,000,000
ARGs

- Wastewater treatment plants are interfaces between different environments and, therefore, provide an opportunity for mobile elements (including resistance) to mix between pathogens, opportunistic pathogens, and environmental bacteria.[68] The presence of antibiotics in sewage selects for resistance markers that are able to spread through the microbial community and as a result, antibiotic-resistant bacteria can potentially disseminate their resistance genes widely among members of the endogenous microbial community (Figure 6). The sludge products of urban and rural wastewater treatment plants are increasingly used to fertilize agricultural crops, dispersing unknown amounts of resistance genes and antibiotics that withstand standard sewage treatment.
OPPPs

- The successful mitigation of microbiological hazards in drinking water represents one of the 10 greatest engineering achievements of the 20th century. Widespread implementation of water treatment and disinfection have virtually eliminated incidence of diseases such as typhoid in the United States. In 2008, however, the U.S. Centers for Disease Control and Prevention acknowledged that a greater incidence of waterborne disease outbreaks are attributable to microbes that persist and grow in premise plumbing (especially Legionella pneumophila) versus traditional fecal-borne pathogens leaving the treatment plant. “Premise plumbing” refers to the portion of potable water distribution systems beyond the property line and in buildings (e.g., businesses, schools, private homes, apartments). Addressing these OPPPs poses a logistical challenge because community water systems are designed and regulated to control pathogens leaving the water treatment facility, whereas OPPPs reside and multiply in building water systems. The five model OPPPs that were the focus of this study were: Legionella pneumophila,

- Mycobacterium avium Complex (MAC), Pseudomonas aeruginosa, Acanthamoeba spp., and

- Naegleria fowleri. In particular, addressing these OPPPs is challenged by research gaps in four key areas: 1.) Epidemiology. Increasing incidence of infection and outbreak and broad, nontraditional susceptibility groups suggest that OPPPs are more than “opportunistic” in that a significant and increasing portion of the population is at risk. However, because L. pneumophila is the only reportable OPPP, and only on a voluntary basis, there is very little information on the actual incidence of diseases caused by OPPPs.