INCORPORATING POTABLE REUSE IN BIG SPRING, TEXAS
A CASE STUDY

SW AWWA
October 14, 2014
Rob Haas
WATER STRESS

Only about 0.5% of global water is “available” for consumption - all other water is sea-water or ice.
Water “availability” generally looks at that 0.5% of total water and considers:
- Quality
- Quantity
- Accessibility
- Sustainability
- Affordability

Availability of that 0.5% of water is very limited
WATER STRESS: WHAT ARE THE OPTIONS?

- Reduce Growth
- Conserve Existing Water Stores
- Develop New Water Sources
- Water Transfer
- Desalination
  - Seawater
  - Brackish Water

Water Reuse
- Non-Potable Reuse to Offset DW
- Indirect or Direct Potable Reuse (IPR/DPR)
• Israel reuses over 70% of its WW

• Potable reuse water makes up over 30% of Singapore’s demand.

• Australia reuses 8% of its wastewater, has a national goal of 30% by 2015

• USA reuses 5-6% of WW for non-potable and potable purposed and this number continues to grow.

Source: Guy Carpenter. WateReuse Association 2010
WATER STRESS IN THE UNITED STATES

California
Southern cities (e.g. Los Angeles and San Diego) receive the bulk of their water from the Colorado river and from the northern part of the state

- Extreme costs associated with transportation
- 20% of energy used in state is used to move water

Texas
Extreme drought conditions causing strain on natural drinking water sources

Source: U.S. Drought Monitor (University of Nebraska, Lincoln), 2012
WATER STRESS IN THE UNITED STATES

Oklahoma

- In May 2014, the State of Oklahoma signed Senate Bill 1187
- Legislation encourages expansion of the state’s drinking water supply through water reuse initiatives and conservation efforts
- Discharges into protected catchments is now allowed as long as it is part of a potable reuse plan

Source: U.S. Drought Monitor (University of Nebraska, Lincoln)
COLORADO RIVER MUNICIPAL WATER DISTRICT

• Provides a privatized drinking water supply to municipalities in West Texas
  – Odessa
  – Snyder
  – Big Spring

• Population of service area = ~150,000

• Traditional Sources of Raw Water:
  – E.V. Spence Reservoir = 1.4 % FULL AS OF SEPT 8, 2014
  – Lake J.B. Thomas= 0.9 % FULL AS OF SEPT 8, 2014
  – O.H. Ivie Reservoir= 16.9 % FULL AS OF SEPT 8, 2014
COLORADO RIVER MUNICIPAL WATER DISTRICT

Colorado River Municipal Water District
Big Spring - Odessa - Snyder
System Map
• In 2004, the traditional reservoirs used to supply drinking water were at only 10% of their capacity
  – Today two of the three sources of raw water are UNDER 2% capacity

• In response to this as well as state mandated legislation to develop a long-term regional plan for drinking water supply, the CRMWD evaluated possible approaches to conserving or augmenting declining drinking water supplies.
Evaluated options in the study included:

1. Use of other water catchments
2. Non-potable reuse of reclaimed wastewater
   - Irrigation, Recreation, Agriculture
3. Potable reuse of reclaimed wastewater
   - Drinking water
   - Re-supply local reservoirs with high-purity treated wastewater
WHAT HAD BEEN DONE: EXTERNAL STUDIES

- Evaluating alternatives to address water shortages in San Diego County
- Desal: Higher energy costs
- Non-potable reuse (Purple Pipe): Install new distribution system
- IPR: Low cost option

*Fermian Business and Economic Institute, 2011*
What had been done: External Studies

- IPR is less energy intensive than other alternative Water Supplies
- IPR is an Attractive Option Both in Terms of:
  1. Costs / AF
  2. Energy Use

Global Water Intelligence, 2011
1) COMPARING OTHER WATER SOURCES

- Local groundwater aquifers were evaluated to show little recharge capability and withdrawal was not sustainable
- Other surface water sources too far away and at much lower elevations than end-users in the CRMWD
  - This would result in economically unfavorable pumping costs
- As a result, obtaining raw drinking water from alternative sources was not an option
2) COMPARING POTABLE AND NON-POTABLE REUSE

Reason #1 – Year-Round Demand

- **Non-potable Reuse**
  - Agriculture and recreational demand for reused wastewater is seasonal
  - Increasing aridity in the region could reduce agriculture and future demand

- **Potable Reuse**
  - Consistent demand throughout the year
2) COMPARING POTABLE AND NON-POTABLE REUSE

Reason #2 – Drinking Water Supply Sustainability

• **Non-potable Reuse**
  – Offset withdrawals from reservoir not consistent (especially during the winter)
  – Drinking water would still need to be collected from existing raw water catchments (<2% capacity in areas)
  – A sustainable supply of drinking water would not be obtained

• **Potable Reuse**
  – Allows year-round supplementation of raw water and therefore year-round augmentation
2) COMPARING POTABLE AND NON-POTABLE REUSE

Reason #3 – Distribution

• **Non-potable Reuse**
  - Requires an exclusive distribution system
  - CRMWD customers are spread out over a wide area
  - Additional pumping costs

• **Potable Reuse**
  - Drinking water distribution system already in place.
2) COMPARING POTABLE AND NON-POTABLE REUSE

Reason #4 – Wastewater Treatment Upgrades

• **Non-potable Reuse**
  – Local wastewater treatment plants would require upgrades
  – High levels of dissolved solids in wastewater
    • Reverse Osmosis required

• **Potable Reuse**
  – One centralized treatment facility, no WWTP upgrades
SELECTING POTABLE vs. NON-POTABLE REUSE

- Similar feasibility studies carried out in other areas
- Cost ranges for various approaches to drinking water augmentation

Source: Fermanian Business & Economic Institute, 2010
SELECTING POTABLE vs. NON-POTABLE REUSE

- CRMWD decided to build a single treatment plant that would treat secondary wastewater from surrounding communities to an “advanced” level

- Known as the “Raw Water Production Facility” (RWPF)

- The RWPF will generate “synthesized” raw water that will be BLENDED with “natural” surface raw water of the E.V. Spence Reservoir upstream of the local drinking water treatment facilities

- Raw water will be re-treated as drinking water at existing drinking water treatment plants
RWPF PLANT DESIGN DETAILS AND CALIFORNIA PRECEDENT

- Advanced Treatment uses microfiltration, reverse osmosis and UV-oxidation similar to existing facilities in California; designed per CA regulations for Full Advanced Treatment

- CA and Orange County GWRS precedent aids in Public Acceptance

- UV-oxidation system sized based on treatment of NDMA and 1,4-Dioxane as surrogates

- UV-oxidation serves a number of unique purposes
  - Treatment of NDMA and 1,4-Dioxane
  - Treatment of pharmaceuticals and endocrine-disrupting chemicals not removed by MF or RO
  - Additional disinfection barrier of 4-log virus credit

### Raw Water Production Facility Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Design Flow:</td>
<td>1.8 MGD</td>
</tr>
<tr>
<td>Target Contaminants:</td>
<td>NDMA, 1,4-Dioxane</td>
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<tr>
<td>Design NDMA Reduction:</td>
<td>1.2 - Log</td>
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<tr>
<td>Design 1,4-Dioxane:</td>
<td>0.5 - Log</td>
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<tr>
<td>Oxidant:</td>
<td>H₂O₂</td>
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<tr>
<td>Disinfection Method:</td>
<td>UV Light</td>
</tr>
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</table>
PROTECTING PUBLIC HEALTH – TREATMENT AT RWPF

MICROFILTRATION

• Removes 50% of organic material and effectively removes bacteria, protozoa, parasites and viruses

• Provides effective pre-treatment for downstream reverse osmosis and UV-oxidation treatment steps

• Required for Full Advanced Treatment as used in California
REVERSE OSMOSIS

- Removes molecules as small as 100 atomic mass units and 95% of organic contaminants
- Removes salts, generating a reject stream ("brine")
- As used implemented in California
UV-OXIDATION

- Removes molecular contaminants that pass through MF and RO
- Removes compounds destroyed by UV-photolysis (e.g. NDMA and other nitrosamines)
- Removes compounds destroyed by UV-Oxidation (e.g. pharmaceuticals, hormones, industrial solvents, etc.)
UV-OXIDATION

• Provides a final Disinfection Barrier (including Cryptosporidium, Giardia, Virus)
• An extra measure of protection that builds public confidence in the water quality
THE SCIENCE OF UV-OXIDATION

UV-Oxidation: Using UV and hydrogen peroxide to destroy trace organic contaminants through:

**UV-Photolysis**
UV light alone breaks down the contaminant molecules

**UV-Oxidation**
UV light plus hydrogen peroxide (H₂O₂)
   Hydrogen peroxide absorbs UV and produces hydroxyl radicals that oxidize contaminants
Chemical bonds are broken by UV light.
UV-OXIDATION

Chemical bonds are broken by hydroxyl radicals.
PROTECTING PUBLIC HEALTH – CONTAMINANTS

N-NITROSO DIMETHYLAMINE (NDMA)

• NDMA is a disinfection by-product

• It can be generated in both wastewater and drinking water

• It is on the EPA’s UCMR3

• It is a probable human carcinogen with a 1 in 1,000,000 cancer risk concentration of 0.7 ng/L (ppt) in drinking water

  – Source: USEPA Integrated Risk Information System (IRIS) Database
NDMA REMOVAL - FULL SCALE - ORANGE COUNTY, CA

Flow: >8.5 MGD
NDMA REMOVAL - FULL SCALE – WEST BASIN, CA

NDMA Concentration (ng/L)

Influent NDMA

Effluent NDMA
## POTABLE REUSE SYSTEMS GLOBALLY

<table>
<thead>
<tr>
<th>Name of Project</th>
<th>Location</th>
<th>Start-Up Date</th>
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<tbody>
<tr>
<td>Orange County Water District Factory 21</td>
<td>Fountain Valley, CA</td>
<td>1975</td>
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<tr>
<td>Orange County Water District Groundwater Replenishment System</td>
<td>Fountain Valley, CA</td>
<td>2004</td>
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<td>Leo J. Vander Lans Advanced Treatment Facility</td>
<td>Long Beach, CA</td>
<td>2003</td>
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<td>West Basin Water Recycling Facility</td>
<td>Los Angeles, CA</td>
<td>2006</td>
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<td>Bundamba Advanced Water Purification Facility</td>
<td>Brisbane, AUS</td>
<td>2007</td>
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<td>Luggage Point Advanced Water Purification Facility</td>
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<td>Gibson Island Advanced Water Purification Facility</td>
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<td>Joint Water Purification Project</td>
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<td>San Diego Water Purification Demonstration Project</td>
<td>San Diego, CA</td>
<td>2011</td>
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<td>Big Spring Water Reclamation Facility</td>
<td>Big Spring, TX</td>
<td>2012</td>
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<tr>
<td>Oxnard Advanced Water Purification Facility</td>
<td>Oxnard, CA</td>
<td>2012</td>
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CONCLUSIONS

• RWPF construction is completed and site became active in April 2013

• Potable reuse was heavily favored over non-potable reuse
  – Year-round drinking water supply
  – Sustainable supply
  – Various economic and cost advantages over alternatives

• Advanced treatment of wastewater included MF-RO-UV-oxidation treatment train
  – Multi-barrier strategy
  – UV-Oxidation treats contaminants of concern not removed by RO (E.g., NDMA)
  – Design based on extensive precedents in California, elsewhere
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QUESTIONS?

THANK YOU

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