The Advent of True Direct Potable Reuse

Brent Alspach, PE
ARCADIS
Acknowledgements

• Co-Author
  – Gilbert Trejo, El Paso Water Utilities (EPWU)

• El Paso Water Utilities:
  – John Balliew
  – Fernie Rico
  – Aide Zamarron

• ARCADIS
  – Caroline Russell
  – Corin Marron
  – Sanaan Villalobos
  – George Maseeh
  – Dan Olson
Background
# Water Resources Overview

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Water sources:
- Groundwater
- Desalinated brackish groundwater
- Rio Grande river
- Reclaimed water

Conservation has been effective!

Average annual rainfall: 8.7 inches
Current Drought Conditions

- Reduced river water allocation:
  - Normal: 60,000 AFY
  - 2013: 10,000 AF

- Received at least average allocation from the Rio Grande only 3 times in the past 17 yrs

- Reservoir storage is low

→ EPWU has instituted several drought support programs
Daily Peak Without River Water

Groundwater

2014 Supply Forecast  2014 Peak Demand Forecast
Long History of Reuse

Fred Hervey Water Reclamation Plant
WWTP designed to meet drinking water standards
EPWU has been using reclaimed water treated to drinking water standards for aquifer recharge since 1985.
Long History of Reuse

Why not utilize indirect potable reuse?
# Source Water Quality Comparison

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**Additional injection treatment required**
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*Typical bromide concentrations in conventional supplies: 0.063 mg/L*

* Water Research Foundation (2011)
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- ✔️ Direct to distribution!
Why Pipe-to-Pipe DPR…?

• Close to proximity of Roberto R. Bustamante WWTP and Jonathan Rogers WTP infrastructure

• Cost of re-treating advanced treated water

• Advanced treated water has better quality than raw water blending supplies [Big Spring (TX) model]

• No regulatory roadblocks

Direct-to-distribution DPR makes sense.
Project Status
Project Status

- Feasibility assessment
- Concept development
- Pilot testing
- Preliminary design
- Detailed design
- Construction

Advanced Purified Water Treatment Plant (APWTP)
Project Status

✓ Feasibility assessment
✓ Concept development
  • Pilot testing
  • Preliminary design
  • Detailed design
  • Construction

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  • Expert Panel
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Pilot site under construction
Treatment Processes
Bustamante WWTP

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Treatment Processes

**Bustamante WWTP**

- Pre-Aeration
- Primary Settling
- Activated Sludge
- Secondary Settling
- Return Activated Sludge
- Discharge to Riverside Canal
- 10 MGD
- To APWTP
- Denitrifying Filters

**APWTP**

- Secondary Clarifier Effluent
- Denitrifying Filters
- MF/UF
- Backwash
- Concentrate
- UV AOP
- GAC for H₂O₂ Quenching
- Clearwell
- O₃
- Cl₂
- Disinfection
Treatment Processes

Not covered today

Other key pilot test components:
- Coagulant testing
- On-line monitoring evaluation
- Process control study
- Finished water pipe loop testing

Secondary Clarifier Effluent → Denitrifying Filters → MF/UF → Backwash → NF/RO → Concentrate → UV AOP → GAC for H₂O₂ Quenching → Clearwell → Disinfection

APWTP
Treatment Processes

Secondary Clarifier Effluent → Denitrifying Filters

(Addition of $O_3$)

→ MF/UF Backwash

→ NF/RO Concentrate

→ UV AOP

→ GAC for $H_2O_2$ Quenching

→ Clearwell

(Addition of $Cl_2$ Disinfection)
## Denitrifying Filters

**Objective(s)** | **Benefit(s)**
--- | ---
Convert dissolved NO$_3^-$ to inert N$_2$ | Enable the use of NF (vs. RO)
Remove particulate matter | Enhance MF/UF pretreatment
Provide an additional pathogen barrier | *Further* reduce public health risk
Denitrifying Filters

**Objective(s)**

1. Convert dissolved NO$_3^-$ to inert N$_2$
2. Remove particulate matter
3. Provide an additional pathogen barrier

**Benefit(s)**

1. Enable the use of NF (vs. RO)
2. Enhance MF/UF pretreatment
3. Further reduce public health risk

**APWTP**
**Denitrifying Filters**

**Objective(s)**

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Ozone

**Objective(s)**

- Reduce MF/UF cleaning frequency
- Increase MF/UF flux
- Extend MF/UF backwash intervals
- Reduce concentrations of emerging contaminants

**Benefit(s)**

- Reduce capital & operating costs (???)
- Provide unquantified (yet) health benefit
## Ozone

**APWTP**

**Secondary Clarifier Effluent** → **Denitrifying Filters** → **Ozone (O₃)** → **MF/UF** → **Backwash** → **Concentrate** → **UV AOP** → **GAC for H₂O₂ Quenching** → **Cl₂** → **Disinfection** → **Clearwell**

### Objective(s)

<table>
<thead>
<tr>
<th>Objective(s)</th>
<th>Benefit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce MF/UF cleaning frequency</td>
<td>Reduce capital &amp; operating costs</td>
</tr>
<tr>
<td>Increase MF/UF flux</td>
<td><strong>Research is encouraging, but not conclusive</strong></td>
</tr>
<tr>
<td>Extend MF/UF backwash intervals</td>
<td></td>
</tr>
<tr>
<td>Reduce concentrations of emerging contaminants</td>
<td>Provide unquantified (yet) health benefit</td>
</tr>
</tbody>
</table>
Ozone

**Objective(s)**

- Reduce MF/UF cleaning frequency
- Increase MF/UF flux
- Extend MF/UF backwash intervals
- Reduce concentrations of emerging contaminants

<table>
<thead>
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<th>Benefit(s)</th>
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</thead>
<tbody>
<tr>
<td>Reduce capital &amp; operating costs</td>
</tr>
<tr>
<td>Also improves public / consumer confidence</td>
</tr>
<tr>
<td>Provide unquantified (yet) health benefit</td>
</tr>
</tbody>
</table>
Ozone

**APWTP**

Secondary Clarifier Effluent → O$_3$ → MF/UF → Backwash → Concentrate → UV AOP → GAC for H$_2$O$_2$ Quenching → Cl$_2$ → Disinfection → Clearwell

<table>
<thead>
<tr>
<th>Counter Consideration</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>No downstream biological filtration to consume assimilable organic carbon (AOC)</td>
<td>Increase RO biofouling?</td>
</tr>
</tbody>
</table>
Membrane Filtration

### Objective(s) and Benefit(s)

<table>
<thead>
<tr>
<th>Objective(s)</th>
<th>Benefit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximize removal of pathogens</td>
<td>Protect public health / achieve compliance</td>
</tr>
<tr>
<td>Achieve filtrate turbidity &lt; 0.1 NTU</td>
<td>Exceed SWTR requirements</td>
</tr>
<tr>
<td>Provide optimum NF/RO pretreatment</td>
<td>Minimize particulate fouling</td>
</tr>
</tbody>
</table>
Objective(s) | Benefit(s)
--- | ---
Reduce dissolved solids concentrations | TDS ≤ 900 mg/L
 | Chloride ≤ 300 mg/L
 | Sulfate ≤ 300 mg/L
Achieve all 1° and 2° standards in permeate | Maintain Texas and USEPA compliance
Desalination

Objective(s) | Benefit(s)
---|---
Provide an additional pathogen barrier | Protect public health
Reduce / remove emerging contaminants | Provide unquantified (yet) health benefit
Remove DBP precursors (TOC, bromide, etc.) | Minimize DBP formation
Remove DBPs (NDMA, bromate, TTHMs, HAAs…) | Maintain regulatory compliance
Desalination

**Objective(s)**

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<tr>
<th>Provide an additional pathogen barrier</th>
<th>Protect public health</th>
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<tr>
<td>Reduce / remove emerging contaminants</td>
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<td>Remove DBP precursors (TOC, bromide, etc.)</td>
<td>Minimize DBP formation</td>
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<tr>
<td>Remove DBPs (NDMA, bromate, TTHMs, HAAs…)</td>
<td>Maintain regulatory compliance</td>
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</tbody>
</table>

**Benefit(s)**

- TCEQ has not awarded pathogen removal credit to RO…
## Desalination

**Objective(s)**

- Provide an additional pathogen barrier
- Reduce / remove emerging contaminants
- Remove DBP precursors (TOC, bromide, etc.)
- Remove DBPs (NDMA, bromate, TTHMs, HAAs…)

**Benefit(s)**

- Protect public health
- Provide unquantified (yet) health benefit
- Minimize DBP formation
- Maintain regulatory compliance

---

**but public health protection is independent of credit**
### Objective(s) vs Benefit(s)

<table>
<thead>
<tr>
<th>Objective(s)</th>
<th>Benefit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieve 1.2-log reduction of NDMA</td>
<td>Protect public health</td>
</tr>
<tr>
<td>Achieve 0.5-log reduction of 1,4-dioxane</td>
<td>Protect public health</td>
</tr>
<tr>
<td>Maximize inactivation of pathogens</td>
<td>Protect public health / achieve compliance</td>
</tr>
<tr>
<td>Reduce emerging contaminants</td>
<td>Provide unquantified (yet) health benefit</td>
</tr>
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</table>
Granular Activated Carbon

Objective(s) | Benefit(s)
---|---
Quench peroxide | Control oxidation
Remove DBPs | Maintain regulatory compliance
Remove emerging contaminants | Provide unquantified (yet) health benefit
Provide an additional pathogen barrier | Protect public health
Chemical Disinfection

**Objective(s)**

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<tr>
<td>Achieve 3.0-log <em>Giardia</em> inactivation</td>
<td>Protect public health / achieve compliance</td>
</tr>
<tr>
<td>Achieve 4.0-log virus inactivation</td>
<td></td>
</tr>
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</table>
### Microbial Barriers

![Microbial Barriers Diagram]

#### Unit Process Anticipated Log Removal / Inactivation Credits

<table>
<thead>
<tr>
<th>Unit Process</th>
<th>Crypto</th>
<th>Giardia</th>
<th>Viruses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denitrifying Filters</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MF/UF</td>
<td>4</td>
<td>4</td>
<td>0-1</td>
</tr>
<tr>
<td>NF/RO</td>
<td>0-2</td>
<td>0-2</td>
<td>0-2</td>
</tr>
<tr>
<td>UV AOP</td>
<td>4-6</td>
<td>4-6</td>
<td>4-6</td>
</tr>
<tr>
<td>GAC</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cl₂</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8-12</td>
<td>11-15</td>
<td>8-13</td>
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Microbial Barriers

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<tr>
<td>Treatment Objective</td>
<td>&lt; 3.0 x 10⁻⁵ oocysts/L</td>
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## Microbial Barriers

**Unit Process**

- **Denitrifying Filters**
- **MF/UF**
- **NF/RO**
- **UV AOP**
- **GAC**
- **Cl₂**

**Anticipated Log Removal / Inactivation Credits**

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**Total**

- **8-12**
- **11-15**
- **8-13**

**Treatment Objective**

- **< 3.0 x 10⁻⁵ oocysts/L**
- **< 7.0 x 10⁻⁶ cysts/L**
- **< 2.2 x 10⁻⁷ MPN/L**

*Based on risk of one infection in 10,000 people per year*
Microbial Barriers

**Unit Process**

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<td><strong>Projected Requirement</strong></td>
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Next Steps
Next Steps…
Next Steps… For the Project

- Feasibility assessment
- Concept development
  - Pilot testing
  - Preliminary design
  - Detailed design
  - Construction
Next Steps… For the Project

✓ Feasibility assessment

✓ Concept development

• Pilot testing

• Preliminary design

• Detailed design

• Construction

Nine (9) month pilot test program to begin in April
Next Steps... For the Project

- ✔ Feasibility assessment
- ✔ Concept development
  - Pilot testing
  - Preliminary design
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  - Construction

Some elements of design may be conducted concurrent with piloting.
Next Steps… For the Industry

- Feasibility assessment

- Concept development
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Some elements of design may be conducted concurrent with piloting
Next Steps… For the Industry

Pipe-to-pipe
DPR is coming

Advanced Purified Water Treatment Plant (APWTP)
Next Steps... For the Industry

...to Texas
Next Steps… For the Industry

…and California?
Next Steps… For the Industry

“Water should not be judged by its history, but by its quality.”

Dr. Louis van Vuuren,
National Institute of Water Research, South Africa (2005)
Questions?