This presentation premiered at WaterSmart Innovations

watersmartinnovations.com
Re-Thinking Re-Cycling:

Taking Residential Water Efficiency to New Heights - Integration of Rainwater & Grey Water Harvesting
Why Re-Think Re-Cycling?

Three Good Reasons

• The Drought
• The Drought
• The Drought

We need “Enlightenment”
“When a man has the certain knowledge he is to be hanged in the morning, it concentrates his mind wonderfully”

-Dr Samuel Johnson
A Comparison Of Drought Maps

2013

2014
“We shall all know the value of water when the well runs dry.”

“To Fail to Prepare - is to Prepare to Fail”

WWBFD -What would Ben Franklin do?

“A gallon saved is a gallon earned”

“Your well is running dry - and you’re watering your lawns and flushing your toilets with drinking water? There’s got to be a better way!”
What Should Be Recycled?

Treated Wastewater:
- Refill our wells?
- Irrigate public greenspace?
- Pump it to the homes?

Grey water:
- Untreated?
- Partially Treated?
- Highly Treated?

Rainwater:
- What level of treatment?

Something Else?
Centralized vs Decentralized
Centralized vs Decentralized

The Solution to most sustainability issues is *On-Site Solutions*
Benchmark: Decentralized Energy

Monthly Energy Cost, New Home

- **2000 Typical Home**: $275
- **2014 Double ZeroHouse**: $20
## Recycled Water in the Home: Centralized vs On-Site Water Recycling

<table>
<thead>
<tr>
<th></th>
<th>On-Site Recycling</th>
<th>Centralized Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source of water</strong></td>
<td>Grey water (same home)</td>
<td>Sewage</td>
</tr>
<tr>
<td><strong>Odor of treated water</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>New homes universe - 2015</strong></td>
<td>100%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>Retrofit universe - Share of homes</strong></td>
<td>40% of SFH</td>
<td>?</td>
</tr>
<tr>
<td><strong>2015 potential savings (AF)</strong></td>
<td>6,500 AF</td>
<td>110 AF</td>
</tr>
<tr>
<td><strong>Homeowner engagement</strong></td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td><strong>Homeowner acceptability</strong></td>
<td>High</td>
<td>Questionable</td>
</tr>
<tr>
<td><strong>Capital cost</strong></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Construction impact on traffic</strong></td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td><strong>Timelag -- Planning -to-implementation</strong></td>
<td>Months</td>
<td>Years</td>
</tr>
<tr>
<td><strong>Treatment standard</strong></td>
<td>NSF-350</td>
<td>Title 22</td>
</tr>
</tbody>
</table>
# ANSI/NSF 350 vs Title 22

## Roughly Equivalent

<table>
<thead>
<tr>
<th>Measure</th>
<th>NSF350 Standard - Class R (residential)</th>
<th>Tertiary Discharge/Title 22</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test Average</td>
<td>Single Sample Maximum</td>
</tr>
<tr>
<td>CBOD (mg/L)</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Turbidity (mg/L)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>E. Coli (MPN/100mL)</td>
<td>14</td>
<td>240</td>
</tr>
<tr>
<td>pH</td>
<td>6.0 - 9.0</td>
<td>Na</td>
</tr>
<tr>
<td>Storage vessel desinfection (mg/L)</td>
<td>≥ 0.5 - ≤ 2.5</td>
<td>Na</td>
</tr>
</tbody>
</table>
Why Think About Grey Water & Rain Water Integration Now?

• Highest impact “Alternate sources of water”

• Treated grey water, untreated grey water, and rainwater all now recognized in California Plumbing Code

• Alternate sources become “new water” as drought worsens

• New upgrade fund sources in process - CA AB 2636 revolving low interest fund
Why We Started With Grey Water

• Very high volume supply: 2 out of 3 gallons indoor water ‘get a second lease on life’

• Consistent supply - daily throughout year

• Drought-time performance -- Excellent

• Very high yield -- Supply rarely exceeds demand

• Grey water can become ‘Greyless’ water: Near-Title 22 water quality can be obtained at low cost
NEXtreater makes NEXwater

- looks and smells like tap water
- NSF 350 grey water approved in California as of January 1 for indoor reuse and above ground lawn watering
What We Learned In The Field

- Unquenchable thirst for non-potable water and/or conservation
- Outdoor water budgets have biggest impact
- “Zero Potable Water for Irrigation” almost achievable with grey water alone
- NRDC 25 x 25 almost achievable today
- Hypothesis: Homeowner engagement is key to long-term drought solution
• Production home in Lancaster CA
• Goal: Zero City Water for Irrigation
• Strategy: Low-water landscape + Grey Water Recycling
• 2 of 3 gallons indoor water treated/recycled on-site
• 40,000 gallons recycled water annually
Same Home, but Different

- New "ZeroHouse" Home
  - Indoor: 80,000 Gal.
  - Outdoor: 20,000 Gal.

Recycling in the most efficient new homes uses recycled water twice.
Why Integrate Rain Water Into Grey Water?

- *More* efficiency needed to address the drought - what source?
- Rain water is the second best Alternate Water Source in the Southwest
- Technologically, can be integrated with grey water as single system
- Integrated solution is better than two independent solutions
- Issues are in the code (and manageable), not in the technology
Key Budget Planning Numbers

- 2 out of 3 gallons of Indoor Water is recyclable - 30 gallons/person/day (WaterSense Fixtures)
- 40,000+ gallons annually in Family of 4
- Rainwater production: 600~1200 gallons/inch on typical roof (1,000~2,000 sq ft)
- Low-Water Model Landscape: 38,000 gallons annually (avg 104g/day)
- Toilet flush water: 6~9 gallons/day/person (avg 30 G/day in Family of 4)
- Non-potable water budget for Fam-4: 49,000 gallons
Your Sources of On-Site Water

<table>
<thead>
<tr>
<th>Source</th>
<th>Annual Availability (Gal.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain on Roof</td>
<td>7,000</td>
</tr>
<tr>
<td>Black Water</td>
<td>20,000</td>
</tr>
<tr>
<td>Grey Water</td>
<td>45,000</td>
</tr>
</tbody>
</table>
Greywater Recycling: The Ultimate HED?

Annual Savings (Gal.)

Where will you invest your dollar?

FUTURE (20% greater)

Greywater Recycling:
The Ultimate HED?
California Rainwater Potential: More Seasonal Than Geographic Variance

SACRAMENTO
11,500 annual
2,250 Max Month

SAN LUIS OBISPO
11,900 annual
2,900 Max Month

LANCASTER
4,600 annual
1,100 Max Month

SAN DIEGO
6,500 annual
1,400 Max Month

*Valid at 2/13/14
<table>
<thead>
<tr>
<th></th>
<th>Treated Grey Water (Home Water Recycling)</th>
<th>Rain Water</th>
<th>Untreated Grey Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certification standard</td>
<td>NSF/ANSI 350</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Allowed non-potable applications</td>
<td>All irrigation, Toilet flushing</td>
<td>All irrigation, Toilet flushing</td>
<td>Sub-surface irrigation of shrubs/lawns (no edible root plants) <strong>No toilets</strong></td>
</tr>
<tr>
<td>Drought-time performance</td>
<td>Excellent</td>
<td>Terrible</td>
<td>Excellent</td>
</tr>
<tr>
<td>Water Quality</td>
<td>Excellent when treated</td>
<td>Excellent with filtration + disinfection</td>
<td>Highly Variable; Health Concerns</td>
</tr>
<tr>
<td>Challenge</td>
<td>Retrofits on slab foundations</td>
<td>Accessing entire roof; storing peak volumes</td>
<td>Cannot be stored &gt;24 hrs</td>
</tr>
</tbody>
</table>
### Performance Characteristics Summarized

<table>
<thead>
<tr>
<th></th>
<th>Treated Grey Water</th>
<th>Rain Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent on</td>
<td>Occupancy</td>
<td>Weather</td>
</tr>
<tr>
<td>Consistency</td>
<td>Consistent year-round</td>
<td>Highly variable</td>
</tr>
<tr>
<td>Drought-time</td>
<td>Excellent</td>
<td>Terrible</td>
</tr>
<tr>
<td>performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Quality</td>
<td>Excellent when treated</td>
<td>Excellent with limited treatment</td>
</tr>
<tr>
<td>Rule of Thumb</td>
<td>30 gallons/person/day</td>
<td>600-1200 gallons/inch</td>
</tr>
</tbody>
</table>
# California Code Treatment Compared

<table>
<thead>
<tr>
<th></th>
<th>Treated Grey Water</th>
<th>Rain Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Filtration requirement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disinfection</strong></td>
<td>Required to control pathogens</td>
<td>Not required, but preferred for long-term storage</td>
</tr>
<tr>
<td><strong>Top-up issues (cross connection)</strong></td>
<td>Inlet air gap must be above grade</td>
<td>Inlet air gap must be above grade</td>
</tr>
<tr>
<td><strong>Storage Tank Overflows</strong></td>
<td>Must be able to overflow to sewer</td>
<td>Not permitted to overflow to sewer</td>
</tr>
<tr>
<td><strong>Commingling with other “Alternate Water”</strong></td>
<td>Not stipulated in Code</td>
<td>Not stipulated in Code</td>
</tr>
</tbody>
</table>
# Kohler’s NSF 2012 Chart

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
<th>Clarity</th>
<th>Biology</th>
<th>Chem.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Turbidity</td>
<td>TSS</td>
<td>CBOD5</td>
</tr>
<tr>
<td>1 - Filtration, Chlorination</td>
<td>$2,600</td>
<td>5.6</td>
<td>10.6</td>
<td>16.4</td>
</tr>
<tr>
<td>2 - Advanced Oxidation</td>
<td>$4,500</td>
<td>8.3</td>
<td>10.2</td>
<td>13.3</td>
</tr>
<tr>
<td>3 - Membrane Bioreactor</td>
<td>$7,500</td>
<td>0.2</td>
<td>&lt;1.0</td>
<td>&lt;4.3</td>
</tr>
<tr>
<td>4 - Biological, Media Filter</td>
<td>$8,950</td>
<td>0.5</td>
<td>&lt;1.2</td>
<td>&lt;2.4</td>
</tr>
<tr>
<td>NEXtreater</td>
<td>$3,995</td>
<td>0.5</td>
<td>&lt;1.0</td>
<td>&lt;3.0</td>
</tr>
</tbody>
</table>
Immediate Payback: Mortgage vs Monthly Costs

Example: San Diego - Today

- Maintenance
- Finance
- Energy
- Sewer
- Water

$/month

Cost | Savings
--- | ---

0 | 100
10 | 90
20 | 80
30 | 70
40 | 60
50 | 50
60 | 40
70 | 30
80 | 20
90 | 10
100 | 0
Rising Water and Sewer Rates: You Ain’t Seen Nothin’ Yet

Rising Water and Sewer Rates - Pre-Drought
(Source: Black & Veatch - Largest 50 metros)
HOW DOES THE DOUBLE ZEROHOUSE WORK?

KB Home's Double ZeroHouse 3.0 in El Dorado Hills generates as much energy as it uses. It recycles drain water for toilets and sprinklers and heats fresh water with warmth from gray water.

**A** Rooftop solar panels generate enough energy to power the home. Batteries store electricity for use in case the grid fails.

**B** Drain water from sinks, showers and laundry is collected, filtered and disinfected.

**C** The reclaimed water, along with collected rainwater, is stored in an underground reservoir, then used to flush toilets and irrigate landscaping.

**D** The system also collects remaining warmth from the drain water and uses it to heat fresh water.

**E** The system also collects remaining warmth from the drain water and uses it to heat fresh water.

Source: nexuswater.com

Sharon Okada sokada@sacbee.com
Issues Integrating Rainwater Into Nexus Recycling System

• Rainwater commingled with Treated Grey Water in cleaned storage and supply system, the NEXservoir

• Rain Water is collected in downspouts, filtered and directed to the NEXservoir storage tank

• Overflows diverted prior to entering NEXservoir

• Stored water disinfected regularly (UV)

• CODE ISSUE: Rainwater can theoretically overflow into sewer from NEXservoir (but not a practical concern)
Solution Development Goals - Grey Water + Rain Water Integration

• Eliminate need for separate solutions

• Reduce/eliminate possible cross connection points

• Focus integration on post-filtration storage and supply system

• Maintain both waters at standard that permits widest possible use

• Disinfection required
Next Steps On “Grainwater” Integration

• Technology demonstration - planned for early 2015

• Code revision

• Work with Public Health, Water Resources, and legislators

• Roll out products
Other benefits:

Water use drops 25-40% below WaterSense homes

But - sewage drops 67%

- Less overloaded pipes
- Less SSO’s
- Smaller WWTP’s
- Lower energy costs: less pumping and treating

Energy can also be recycled!

- Three out of every 4 watts get ‘a second lease on life’
What is eWater?

WATER + ENERGY
ANNUAL ENERGY REQUIRED FOR WATER HEATING, kWh

- Gas Storage Tank
- High Efficiency Gas Tankless
- Solar + Gas
- Greywater-sourced HPWH
WWBFD?

“You may delay - but Time will not!”

“Never put off till tomorrow what you can do today”

“Especially when your well is running dry!”
What Can be Done Today

The Sustainable Energy Community makes homes ‘Solar-Ready’ (July 1 mandate]

New homes should be ‘Recycle-Ready’

• Dual Plumbing in homes
• Recycling Infrastructure
• >1% of new home construction

Start a rebate program for retrofitting homes
Summary

• Sending centralized recycled wastewater to the home is usually impractical and expensive

• On-site greywater recycling is the most consistent solution, but additional potential remains

• Rainwater is Next Best alternative Water Source

• Technology has caught up with the opportunity

• NRDC 25 x 25 is almost achievable today

• Code and policy ambiguities are the only barriers to market introduction

• ‘Recycle-ready’ cities can be implemented today
Thank You

Ralph Petroff            Tom Wood
Chairman                  Chief Technology Officer
Nexus eWater Inc.       Nexus eWater Inc.
ralph@nexusewater.com   tom@nexusewater.com
## Recycling Potential of the Recycle-Ready City

*Assumes 3 percent annual growth for 20 years*

<table>
<thead>
<tr>
<th></th>
<th>The City Today</th>
<th>The City in 20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>30,000</td>
<td>58,900</td>
</tr>
<tr>
<td>Homes</td>
<td>10,000</td>
<td>18,900</td>
</tr>
<tr>
<td>Average water use (gpcd)</td>
<td>154</td>
<td>129</td>
</tr>
</tbody>
</table>