Wastewater Recycling in Buildings: Best Practices from Down Under

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Onsite Wastewater Reuse is moving the needle in water conservation in the built environment like never before.

But you have to do it RIGHT...

And it’s not easy to do right.
If Done Right...

- SAFE
- RELIABLE
- ECONOMICAL
- Viable Conservation Option

And the Potential is...

HUGE!!
90 installations in Greater Sydney = 13 billion gallons a year saved
Multiple Conservation Options Needed

• HE/Low Flow Fixtures
• Rain/Stormwater Reuse

• Onsite Wastewater Reuse
Uptake has not been rapid.... Why?

Challenge:
How to safely and economically implement and manage schemes over their life-cycle
So How Is It Done Right?

AGWR – International Best Practice Framework

12 ELEMENTS
1. Commitment to responsible use and management of recycled water quality
2. Assessment of the recycled water system
3. Preventive measures for recycled water management
4. Operational procedures and process control
5. Verification of recycled water quality and environmental performance
6. Management of incidents and emergencies
7. Operator, contractor and end user awareness and training
8. Community involvement and awareness
9. Validation, research and development
10. Documentation and reporting
11. Evaluation and audit
12. Review and continuous improvement
“Waste”water – Is This the Future?

Fresh Water Source → Municipal Water Treatment

Wastewater Treatment → Water Use & Wastewater Production

Discharge to Environment

WATER -> ENERGY

$
Decentralized Approach

1. Zero Discharge
2. Consume up to 90% Less Water Onsite

Discharge to Environment
- Non-potable reuse
- 70% of waste stream (residential/hospitality)
- Conserve up to 60%
- Dual plumbing
- Robust treatment!!
- Targets: multifamily residential and hospitality
Residential/Hospitality Greywater Supply

56%

Office/Institutional Greywater Supply

3%


- Non-potable reuse
- 100% of waste stream
- Conserve up to 90%
- No dual plumbing
- Retrofits/existing bldgs
- No infrastructure, no problem
- Targets: Low potable users - Office/institutional, business parks, airports, off grid projects
The Future is Decentralized?

Not IF...
But WHEN
The Future is Decentralized?

✓ Technology on the rise, cost on the decline

✓ Sustainability goals

✓ New Regulations/Code
  - NSF 350
  - EPA U.S. Guidelines for Water Reuse
  - IGCC
  - IAPMO Green
  - New laws encouraging onsite reuse in some cities
  - Grants / Rebates for onsite reuse
Growing Freshwater Demand
Waning Freshwater Supply

Risk of Water Shortage in 2050
Water/Sewer Infrastructure Woes
Smart Growth for New Developments

The Incumbent Scenario

High cost, long-distance piping to existing sewer areas

The Aquacell Solution

1. Staged to parallel requirements of development
2. Aquacell Unit

Staged to parallel requirements of development
It’s Time to WAKE UP!!!

Rates rising faster than any other utility...

18% Rise Since 2010*

What will building owners pay for water/sewer in 20 years?

*Circle of Blue
The Future is Decentralized?

More Practical than Ever Before

✓ SAFE

✓ RELIABLE

✓ ECONOMICAL
AGWR – International Best Practice Framework

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11. Evaluation and audit
12. Review and continuous improvement
Continuity from A to Z

Risk Management
Regulatory Approvals
Engineering
Turn-Key Treatment
Installation / Commissioning
Operations and Management
Compliance Reporting
Risk Management

How can you be sure every ounce of treated water is safe for reuse?

Validation (Can It Work?)

Verification Sampling (Did It Work?)
Risk Management

How can you be sure every ounce of treated water is safe for reuse?

Verification Sampling
(Did It Work?)
Integrated Risk Management

How can you be sure every ounce of treated water is safe for reuse?

Validation (Can It Work?)

Operational Monitoring (Is It Working Now?)

Verification Sampling (Did It Work?)
HACCP - Critical Control Points
24/7 Web-based Remote Monitoring
How can you be sure *every ounce* of treated water is safe for reuse?

- Real-time Quality Control
- Less Onsite Supervision
- Less End of Pipe Sampling
- Less Operational Cost

**More Safe, Less Cost**
Proven Technology
Turn-Key Treatment System
Safe, Reliable and Economical: Things to Remember

1. A to Z Solution
   ...Critical for Seamless Integration

2. Integrated & Automated Controls
   ...Risk Management as Basis of Design – Failure Sensors Won’t Do

3. Turn-Key / Packaged Technology
   ...Science Project Otherwise

4. Proven Track Record is Irreplaceable
   ...Where’s the Data??
The Alternative...

- Integrated & Automated Controls
- Turn-Key / Packaged Technology
- Proven Track Record
- A to Z Solution

Vancouver, BC Convention Center
All Under ONE Roof

- Site Specific Design
- Packaged Equipment
- Commissioning & Operations
Tools Make Life Easier
**Water Reuse Calculator**

**Calculator:** To determine estimated savings, insert consumption values based on fixtures and fixture fittings installed

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>Consumption</th>
<th>Daily Uses</th>
<th>Duration</th>
<th>Occupants</th>
<th>Daily Water Use (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.28 gpf toilet - male</td>
<td>1.28</td>
<td>1</td>
<td>1</td>
<td>2,500</td>
<td>3,200</td>
</tr>
<tr>
<td>1.28 gpf toilet - female</td>
<td>1.28</td>
<td>4</td>
<td>1</td>
<td>2,500</td>
<td>13,800</td>
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<tr>
<td>0.5 gpf urinal - male</td>
<td>0.5</td>
<td>3</td>
<td>1</td>
<td>2,500</td>
<td>3,750</td>
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<tr>
<td>Kitchen sink - 2.2 gpm</td>
<td>2.2</td>
<td>1</td>
<td>0.25</td>
<td>5,000</td>
<td>2,750</td>
</tr>
<tr>
<td>Commercial Lavatory Faucet - 0.5 gpm</td>
<td>0.5</td>
<td>4</td>
<td>0.25</td>
<td>5,000</td>
<td>2,500</td>
</tr>
<tr>
<td>Showerhead - 1.5 gpm</td>
<td>1.5</td>
<td>0.01</td>
<td>5</td>
<td>5,000</td>
<td>375</td>
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<tr>
<td>Cooling Tower make-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10,000</td>
</tr>
</tbody>
</table>

**Irrigation**

<table>
<thead>
<tr>
<th>Landscaped area, irrigations per week</th>
<th>Irrigation rate, inches</th>
<th>Annual Work Days</th>
<th>Total Daily Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>0.5</td>
<td>6,277</td>
</tr>
</tbody>
</table>

**WATER SAVINGS SUMMARY**

Projected Annual Savings from Baseline Water Usage

- High-Efficiency Fixtures: 2,080,000 gal, 18.1%
- HE + Greywater Reuse: 2,827,500 gal, 21.9%
- HE + Blackwater Reuse: 8,677,500 gal, 77.2%
- HE + Blackwater Reuse + Sewer Mining: 11,440,994 gal, 88.7%

High-Efficiency Fixtures Water Usage

- Total Daily Demand: 41,652 gal
- Annual Usage: 10,829,494 gal
- Annual Savings: 2,080,000 gal
- % Reduction: -16.1%

**Important Daily Totals**

- Greywater Supply: 2,875 gal
- Blackwater (total w/w) Supply: 25,375 gal
- Total Urinal Flushing Demand: 19,750 gal
- Non-Potable Demand: 36,027 gal
- Potable Demand: 5,825 gal
- Total Daily Water Demand: 41,652 gal

**Greywater Reuse**

- 2,875 daily savings (recycled daily)
- 38,777 new daily water usage
- 10,081,994 new annual water usage
- 747,500 annual water savings
- 6.9% in addition to HE water savings

**Blackwater Reuse**

- 25,375 daily savings (recycled daily)
- 16,277 new daily water usage
- 4,231,994 new annual water usage
- 6,597,500 annual water savings
- 67.2% in addition to HE water savings

**Blackwater Reuse + Sewer Mining to Meet Non-Potable Demand**

- 1,462,500 new annual usage w/ sewer mining
- 88.7% HE fixtures, blackwater reuse & sewer mining
# Wastewater Reuse Cost Analysis

## Seattle Commercial Office Tower

<table>
<thead>
<tr>
<th>Year</th>
<th>Project in 2012</th>
<th>Ongoing Asset Maintenance</th>
<th>Links: aquacell, blackwater</th>
<th>Blackwater System (daily gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>35,000</td>
<td></td>
<td></td>
<td>260 Operational costs</td>
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</table>

## Baseline Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 9</th>
<th>Year 10</th>
<th>Year 11</th>
<th>Year 12</th>
<th>Year 13</th>
<th>Year 14</th>
<th>Year 15</th>
<th>Year 16</th>
<th>Year 17</th>
<th>Year 18</th>
<th>Year 19</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>55,000</td>
<td>55,000</td>
<td>55,000</td>
<td>55,000</td>
<td>55,000</td>
<td>55,000</td>
<td>56,650</td>
<td>58,350</td>
<td>60,100</td>
<td>61,903</td>
<td>63,760</td>
<td>65,673</td>
<td>67,643</td>
<td>69,672</td>
<td>71,763</td>
<td>73,915</td>
<td>76,133</td>
<td>78,417</td>
<td>80,769</td>
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</tr>
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</table>

## Blackwater Recycling Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 9</th>
<th>Year 10</th>
<th>Year 11</th>
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<th>Year 13</th>
<th>Year 14</th>
<th>Year 15</th>
<th>Year 16</th>
<th>Year 17</th>
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<th>Year 19</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>293,514</td>
<td>311,125</td>
<td>329,792</td>
<td>349,580</td>
<td>370,555</td>
<td>392,788</td>
<td>416,355</td>
<td>441,337</td>
<td>467,817</td>
<td>495,886</td>
<td>525,639</td>
<td>557,177</td>
<td>590,608</td>
<td>626,044</td>
<td>663,607</td>
<td>703,423</td>
<td>745,629</td>
<td>790,367</td>
<td>837,789</td>
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</table>

## Blackwater Recycle Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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<th>Year 6</th>
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<th>Year 17</th>
<th>Year 18</th>
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<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>131,195</td>
<td>202,754</td>
<td>278,606</td>
<td>359,010</td>
<td>444,237</td>
<td>534,578</td>
<td>630,340</td>
<td>731,847</td>
<td>839,445</td>
<td>953,499</td>
<td>1,074,396</td>
<td>1,202,547</td>
<td>1,338,387</td>
<td>1,482,377</td>
<td>1,635,006</td>
<td>1,796,794</td>
<td>1,968,288</td>
<td>2,150,073</td>
<td>2,342,764</td>
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</table>

## Input Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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<th>Year 6</th>
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<th>Year 16</th>
<th>Year 17</th>
<th>Year 18</th>
<th>Year 19</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>692,634</td>
<td>758,123</td>
<td>841,735</td>
<td>932,373</td>
<td>1,032,011</td>
<td>1,139,718</td>
<td>1,256,530</td>
<td>1,382,590</td>
<td>1,518,007</td>
<td>1,652,797</td>
<td>1,796,066</td>
<td>1,948,703</td>
<td>2,110,705</td>
<td>2,282,034</td>
<td>2,463,707</td>
<td>2,656,614</td>
<td>2,859,867</td>
<td>3,073,465</td>
<td>3,298,308</td>
<td></td>
</tr>
</tbody>
</table>

## Payback Period

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 9</th>
<th>Year 10</th>
<th>Year 11</th>
<th>Year 12</th>
<th>Year 13</th>
<th>Year 14</th>
<th>Year 15</th>
<th>Year 16</th>
<th>Year 17</th>
<th>Year 18</th>
<th>Year 19</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>72.04</td>
<td>51.34</td>
<td>39.33</td>
<td>33.60</td>
<td>29.95</td>
<td>26.93</td>
<td>24.50</td>
<td>22.53</td>
<td>20.96</td>
<td>20.01</td>
<td>19.50</td>
<td>19.31</td>
<td>19.29</td>
<td>19.29</td>
<td>19.29</td>
<td>19.29</td>
<td>19.29</td>
<td>19.29</td>
<td>19.29</td>
<td></td>
</tr>
</tbody>
</table>

## Notes

1. $2,273,194 in OPEX & O&M (includes buffer storage, ongoing maintenance, and annual maintenance)
Case Studies & Lessons Learned: Greywater Reuse
2,600 gal/day
Multifamily Housing
Master Planned Sustainable Community

5x Greywater Plants
2,600 GPD
Luxury Condominiums
2,600 gal/day
Luxury Condominiums
3,000 gal/day
Commercial Office Tower
Case Studies & Lessons Learned: Blackwater Reuse
26,000 gal/day
Canberra Airport Business Park
26,000 gal/day
Hotel, Casino and Sports Complex
• 27-story development
• 6 star – Green Star
• 2012 CTBUH’s Most Outstanding Tall Building in Australasia region
• Recycling 26,000 gal/day of blackwater
• Toilet/urinal flushing and cooling tower reuse
• [1 Bligh Street Video]
Cooling towers

Plant irrigation from rainwater catchment

25,000 litres of treated water piped to 23 levels daily

4 star toilets

AQUACELL BLACKWATER RECYCLING PLANT

Blackwater intake from Bondi Sewer Main

Treated Water Storage

1,000 litres returned to Blackwater system
Sewer Mining

Discharge to Ocean (2km offshore)

Bondi Sewage Treatment Plant

Bondi Beach

1 Bligh Street Sydney

Aquacell Blackwater Recycling Plant

Sewer Main
Want to learn more about design & technical side?

Go to ASPE.org for ‘Wastewater Reuse Technically Speaking’ webinar