Constructed wetlands for domestic greywater treatment in urban villages

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Beth Strang
Presentation Overview

Background Information
Case Study #1 Bridgewater Lifestyle Village
Case Study #2 Timbers Edge Residential Village
Background

Perth is the capital city of Western Australia
Currently 1.5 million people
And growing rapidly north-south along coastal plain
Mediterranean climate
Expected reduced rainfall
Sandy soil structure
Background cont’d

- Average household (3 people) uses 1260L/Day
- 707L/Day is for outside uses such as garden irrigation
- Houses are the traditional home unit Gardens with lush lawns and exotic water loving plants are often favoured
Why Decentralised?

- Perth’s traditional “Big Pipes in, Big Pipes out” centralised wastewater system is aging and with limited recycling
- Peri-urban areas, suitable for residential development, will be waiting 8-10 years for connection to central sewerage
- Decentralised systems allow for local reuse of treated wastewater, helping to reduce potable demand
Recycling Systems

At present there are only two scales of recycling in Perth:

- Individual home scale i.e. aerobic treatment units
- Large scale wastewater treatment plant i.e. Kwinana treatment plant

There are several systems in country WA in operation, but only a few are involved with residential wastewater treatment and recycling.
Constructed Wetlands

Over the past decade - increasingly used for treating a variety of wastewaters including industrial effluents.

• Alternative to conventional systems:
  • Lower costs,
  • Reasonably simple installation and maintenance,
  • Reduced need for electrical power,
  • Good removal rates for different parameters,
  • Favourable aesthetics and acceptance by the general public.
Why sub-surface wetlands?

- They are site specific
- Low cost
- Low-energy process
- Good pollutant removal
- Require minimal operation and maintenance
- Suitable for a range of development sizes
- There is reduced mosquito risk
- There is reduced odour issue
- Reduced public health risk
Case Study Information

Both case studies are located in the City of Mandurah

- 72km’s south of Perth
- Population of 61,900 (2005)
- Growth rate of 5.9% or 3,500 people/year
- Annual maximum temperature 17 - 29°
- Annual minimum temperature 10 - 19°
- Annual rainfall 634.6mm
Department of Health Guidelines

All sites are required to abide by the Code of Practice for the Reuse of Greywater in Western Australia

<table>
<thead>
<tr>
<th>Number of Bedrooms</th>
<th>Domestic Greywater (Litres per day)</th>
<th>Greywater Source</th>
<th>Volumes</th>
<th>Total Greywater flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or less</td>
<td>Kitchen* 75</td>
<td>Laundry 126</td>
<td>Bathroom 153</td>
<td>351</td>
</tr>
<tr>
<td>3</td>
<td>96</td>
<td>168</td>
<td>204</td>
<td>468</td>
</tr>
<tr>
<td>4</td>
<td>120</td>
<td>210</td>
<td>255</td>
<td>585</td>
</tr>
<tr>
<td>5 or more</td>
<td>144</td>
<td>252</td>
<td>306</td>
<td>702</td>
</tr>
</tbody>
</table>
## Design Parameters

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Raw greywater</th>
<th>Final max. allowable effluent quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (mg/L)</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>BOD (mg/L)</td>
<td>160</td>
<td>150</td>
</tr>
<tr>
<td>TN (mg/L)</td>
<td>12.3</td>
<td>11</td>
</tr>
<tr>
<td>TP (mg/L)</td>
<td>8</td>
<td>1.2</td>
</tr>
<tr>
<td>Faecal coliforms (cfu/100mL)</td>
<td>$1 \times 10^6$</td>
<td>&lt;1,000</td>
</tr>
</tbody>
</table>
Bridgewater Lifestyle Village
Bridgewater Lifestyle Village

Greyflow with subsurface dripline irrigation
Evapotranspiration Trenches (ETTs)
Bridgewater Lifestyle Village

Greywater is collected from laundry, shower and basins
The Advanced Waste Water System's Grey-Flow is a compact greywater interception & reuse system consisting of an:

- interception unit,
- a sensor activated pump station,
- a primary & secondary sponge filters,
- a low pressure sub-strata drip irrigation system,
- Connected to a low pressure subsurface drip irrigation.
Bridgewater Lifestyle Village

Evapotranspiration Trenches

• Installed for homes with less than 0.5m clearance from the groundwater level
• consist of a low maintenance biological system for the treatment of domestic greywater
Evapotranspiration
Trenches (cont’d)

- planted with various hardy aquatic plants through which the greywater is retained for several days before discharging to subsurface leach drains.
- The greywater is maintained in sealed pipes and below the gravel surface of the system at all times to ensure there are no mosquito or odour issues.
**Bridgewater Lifestyle Village**

**Evapotranspiration Trenches (cont’d)**

- 7m long x 450mm deep with width dependent on the number of rooms
- Hydraulic drainage levels are set at 100mm to the aggregate surface
- Design based upon Kadlec & Knight rate coefficients

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<th>Design number of bedrooms in the house</th>
<th>Design number of people in the house</th>
<th>Design quantity of greywater not inc kitchen</th>
<th>Subsurface (or sub-mulch)dripline irrigation Min. area required</th>
<th>ETTs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>186L/day</td>
<td>19 sq metres</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>279</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>372</td>
<td>38</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>ETT area</th>
<th>ETT width</th>
<th>Overflow leach drain length (200 x 200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 sq metres</td>
<td>720 mm</td>
<td>10.5 m</td>
</tr>
<tr>
<td>5</td>
<td>720</td>
<td>10.5</td>
</tr>
<tr>
<td>6.7</td>
<td>960</td>
<td>10.5</td>
</tr>
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</table>
TIMBERS EDGE GREY WATER SYSTEM SCHEMATIC FLOW DIAGRAM
Timbers Edge Residential Village

Biofilter system includes:
• Pre-filter for lint and solids;
• Greywater balance tank;
• 6 x subsurface flow wetland cells;
• Treated greywater return tank;
• 2 x Virophos media tanks;
• Irrigation tank;
• Subsurface irrigation system;
• Winter excess recharge zone.
Timbers Edge Residential Village

Schematic of system design (left)

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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>mg/l</td>
<td>mg/l</td>
<td>kg/day</td>
<td>%</td>
</tr>
<tr>
<td>BOD</td>
<td>160</td>
<td>0.002</td>
<td>11.20</td>
<td>99.9</td>
</tr>
<tr>
<td>N</td>
<td>12.3</td>
<td>2.6</td>
<td>0.68</td>
<td>78.9</td>
</tr>
<tr>
<td>P&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>8</td>
<td>1.2</td>
<td>0.10</td>
<td>85.0</td>
</tr>
</tbody>
</table>

Treatment targets (above)
TimbersEdge Residential Village

- Six Biofilters comprise the main biological greywater treatment process and cover a total area of 1600m².
- They have an average depth of 0.55m with the water level maintained at least 40mm below the gravel media surface to avoid mosquito and odour issues.
- The Biofilters have been planted with *Schoenoplectus validus* and *Baumea articulata* with each species comprising approximately half of each Biofilter.
Conclusions

• Both case study systems have been subject to significant investigation by regulatory authorities at all stages;
• Which has led to delays in construction and commissioning;
• WA lagging Eastern States in use and approval of constructed wetlands;
• Hopefully these examples plus data will accelerate the uptake and approvals of this low-cost, decentralised technology
Importance of Case Studies

• They provide evidence of technological capacity and treatment levels;
• They can provide confidence of system management for regulatory departments;
• Stepping stone for future projects;
• Provide evidence of community support and acceptance.
Project Sponsors

Western Australian Premiers Water Foundation

National Lifestyle Villages (Bridgewater Lifestyle Village)

Timbers Edge Residential Village

Murdoch University Environmental Technology Centre
Thank you Questions?

Beth Strang