TOWARDS WASTEWATER NUTRIENT CYCLING ASSESSMENT OF DECENTRALISED SYSTEMS IN URBAN VILLAGES

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ONSITE AND DECENTRALISED SEWERAGE CONFERENCE AWA, October 2008

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Perth - Western Australia

Expanding population & geographical size

Climate change (rainfall fluctuation & decrease)

Great pressure on water resource

Question: HOW TO MANAGE WATER RESOURCE EFFICIENTLY?

A centralised or decentralised approach to wastewater sanitation?

Drainage, Nutrient and Irrigation Management Plans
Water Resource Management

State Water Strategy
(Western Australia Government, 2003)

Premiers Water Foundation (PWF)

Demonstration of Decentralised Water Recycling in Urban Villages
(Environmental Technology Centre, Murdoch University)
Project Aim

Complete a waste water recycling trial by June 2009 at 3 sites within the Metropolitan and Peel Regions to demonstrate and evaluate the performance, reliability, attributes and feasibility of decentralised wastewater recycling.
Zero Emission Nutrients (ZEN)

Monitoring protocols: Nutrient levels in relative components have to be sampled and analysed
Objectives

Provide an overview of the progress and early findings focusing on ZERO EMISSION NUTRIENTS model for urban land developments in 3 studied sites
Studied sites

- **Bridgewater Lifestyle Village** - household greywater;
- **Timbers Edge Residential Resort** - village greywater;
- **Banksia Village** - village wastewater;
Monitoring protocols

- Sampling and analysing nutrient levels in greywater, groundwater, soil

- Managing sampling bores (location, depth) by GPS, maps, aerial photos

- The practical results will be compared with model outputs of contaminant flows at Ellenbrook, a suburb of Perth (predicted by Gray and Becker, 2002)
### Case study 1

#### Bridgewater Village

<table>
<thead>
<tr>
<th>No. of houses</th>
<th>389</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development area</strong></td>
<td>14ha</td>
</tr>
<tr>
<td><strong>Wastewater streams (flows/volumes)</strong></td>
<td>Blackwater + kitchen to sewer. Greywater onsite – 25,550m³/year.</td>
</tr>
<tr>
<td><strong>Treatment systems</strong></td>
<td>Each house has direct to subsurface irrigation – primary filter only. 88 with reedbeds for nutrient removal</td>
</tr>
<tr>
<td><strong>Soil types/water bodies/groundwater</strong></td>
<td>Sand PRI = 1-2, category A, high groundwater area. Close proximity to Peel-Harvey estuary</td>
</tr>
<tr>
<td><strong>Reuse systems</strong></td>
<td>Subsurface drip irrigation to 301 lots. 88 lots with reedbeds followed by leach drain disposal</td>
</tr>
<tr>
<td><strong>Application rates</strong></td>
<td>10mm of greywater per m² as per (DoH 2005)</td>
</tr>
</tbody>
</table>
Bridgewater village

- ETT constructed wetland for nutrient removal
- Clubhouse with rainwater collection tanks
- Pump and control room

Village layout
### Case Study 2
#### Timbers Edge (City of Mandurah)

<table>
<thead>
<tr>
<th>No. of houses</th>
<th>260</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development area</td>
<td>18ha</td>
</tr>
<tr>
<td><strong>Wastewater streams</strong> (flows/volumes)</td>
<td>Blackwater + kitchen to sewer. Greywater onsite.</td>
</tr>
<tr>
<td>Treatment systems</td>
<td>All greywater collected at central point followed by constructed wetlands</td>
</tr>
<tr>
<td><strong>Soil types/water bodies/groundwater</strong></td>
<td>Fine-medium grained loamy sands-sandy loams. PRI = “medium” (5.5-76.5), category A. High groundwater area (1.5-7.3m below ground level). Close (&lt;1km) proximity to Peel-Harvey estuary</td>
</tr>
<tr>
<td>Reuse systems</td>
<td>Subsurface drip irrigation on public open space (2.1ha) and road verges</td>
</tr>
<tr>
<td>Application rates</td>
<td>Max. rates: &lt;140kg/ha/yr inorganic nitrogen; &lt;10kg/ha/yr1 reactive phosphorus Est’d volumes: 25.6-38.0x10³ m³/yr.</td>
</tr>
</tbody>
</table>
Timbers Edge

Greywater irrigated area with signage
### Case Study 3
**Banksia Tourist & Caravan Village**
*(City of Swan)*

<table>
<thead>
<tr>
<th><strong>No. of houses</strong></th>
<th>76 park homes, 95 caravans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development area</strong></td>
<td>7ha</td>
</tr>
<tr>
<td><strong>Wastewater streams (flows/volumes)</strong></td>
<td>Combined</td>
</tr>
<tr>
<td><strong>Treatment systems</strong></td>
<td>Moving bed bioreactor (MBBR) for all wastewater</td>
</tr>
<tr>
<td><strong>Soil types/water bodies/groundwater</strong></td>
<td>Sand, no nearby water bodies</td>
</tr>
<tr>
<td><strong>Reuse systems</strong></td>
<td>A percentage directed to subsurface drip irrigation on 40m² of public open space. Remainder to existing oxidation ditch</td>
</tr>
<tr>
<td><strong>Application rates</strong></td>
<td>To be determined subject to PRI analysis</td>
</tr>
</tbody>
</table>
Banksia

Dripline irrigation system

Current sewage lagoon
Scheme Water into the village

76 Park Hones, 95 Caravan sites

Sump

All wastewater, 50kL/day, from village to sump

Moving bed Bioreactor

Gravity fed to oxidation pond.

Oxidation pond

Trial site Irrigation through dripline with treated wastewater

Water meter

Sampling bores

Banksia Tourist Park

Waste water System Schematic Flow Diagram

Note

WM Water Meter

Lysimeter

Pump

Scheme water

Untreated wastewater

Treated wastewater

Version 3, last updated 16th May 2008

Oxidation pond

Pump

Gravity fed to oxidation pond.

WM

Trial site Irrigation through dripline with treated wastewater

Tube lysimeters

Sampling bores

Banksia Wastewater System Flow Schematic
Initial results
Bridgewater Village

Groundwater: low background concentration of nutrients

- N-NH$_3$ lightly increase after one year commenced greywater reuse.
- Total N: stable and low (0.6-2.8mg/L)
- Total P: low before and after reusing greywater (0.01-0.3 mgP/L)

New lysimeters will be installed soon.
Groundwater has low nutrients

- Total N: 0.57-1.8 mg/L
- Total P: 0.04-0.07 mg/L

Some bores no water due to water levels drop down.

New lysimeters will be installed soon

Low phosphorous detergents and cleaning products are encouraged
Initial results - Banksia

Groundwater sampling protocols are on-going

Dripline system has been installed

New lysimeters are installed
Conclusion

Two possible future development scenarios for urban water system infrastructure (Eiwirth et al. 2000)

"a continuation of the present high tech end of pipe approach with further refinement = centralised;

or low cost, low energy solutions based upon maximising source control procedures and the application of alternative decentralised biological systems"
Conclusion

Three case studies represent the applications of latter model in Western Australia conditions.

More accurate equipment will be used for sampling protocols

Establish the nutrient balance

Answer the feasibility of ZEN
THANK YOU

Any questions?