Wungong Urban Water Project
A major innovation in alternative water supply in WA

Wayne Schafer | GHD | Principle Water Resources Engineer
Stuart Devenish | Devenish Consulting |
Content

1. Overview
2. Water Demands
3. Options Assessment
4. Governance Issues
Wungong Urban Water Master Plan
The Plan

• Development:
  – Area 1,580 ha
  – 16,000 dwellings
  – Population 40,000

• Wungong Urban Master Plan
  – Showcase best practice in sustainable urban development
  – Natural resource management
  – Energy-efficient housing
  – Water sensitive urban design
    - Park Avenues and Living Streams
    - Non-drinking water (NDW) supply
The Objectives

• Model to guide development in similar water sensitive areas
• Reduce potable water demand to 50 kL/person/yr by:
  – Adopting ‘waterwise’ practices
  – Utilising alternative water source
• Manage urban stormwater :
  – Innovative best management practices
  – Provide a sustainable NDW source
  – Protect water quality & quantity in receiving environment
The Project

- NDW supply scheme (3rd pipe system)
- Alternative water sources
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NDW Uses

• In-house
  – Toilet flushing
  – Cold water inlet to washing machines

• Ex-house
  – Irrigation
  – Washing cars, paving etc.

• Irrigation of public areas
  – Public Open Space (POS)
  – Landscaping
  – Schools
NDW Demands (Basis for Design)

• In-house
  – WC Waterwise Calculator

• Ex-house - Irrigation
  – Application 730mm/yr
  – Peak week 30mm
  – Peak instant
    - 20% houses irrigate on same day
    - Rate 0.5 L/sec/house
    - 80% of controllers set to irrigate between 4am and 6am

• Ex-house - Other
NDW Demands – Cont.

• Irrigation of public areas
  – Application
    • Turf 780 mm/yr (Active)
    • Other 400 mm/yr (Passive)
  – Area
    • Total area 238 ha
      • Irrigate 156 ha (83 ha turf, 73 ha landscape)
  – Peak week 40/30 mm/wk (active/passive)
  – Peak instant less than & does not coincide with domestic peak
NDW Demands – Cont.

- Residential lot yield & domestic irrigation area

<table>
<thead>
<tr>
<th>Type</th>
<th>Dwellings</th>
<th>Irrigation area/lot (m²/lot)</th>
<th>Irrigation Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5</td>
<td>111</td>
<td>500</td>
<td>6</td>
</tr>
<tr>
<td>R20</td>
<td>9,839</td>
<td>175</td>
<td>172</td>
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<tr>
<td>R30</td>
<td>2,190</td>
<td>105</td>
<td>23</td>
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<tr>
<td>R35</td>
<td>1,894</td>
<td>91</td>
<td>17</td>
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<tr>
<td>R40</td>
<td>1,856</td>
<td>77</td>
<td>14</td>
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<tr>
<td>R60</td>
<td>456</td>
<td>56</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Irrigation Area: 235 ha
## NDW Demands – Cont.

<table>
<thead>
<tr>
<th>Total NDW Demand</th>
<th>Unit Res. Demand (R20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg Annual</td>
<td>5.0 GL/yr (14 ML/d)</td>
</tr>
<tr>
<td>Avg Day Peak Week</td>
<td>27 ML/d</td>
</tr>
<tr>
<td>Max Day</td>
<td>29 ML/d</td>
</tr>
<tr>
<td>Peak Instant</td>
<td>1,700 L/s</td>
</tr>
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</table>

**Peak instant NDW?**  
Review of design criteria
Seasonality of NDW Demand
Content

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Options

• Local groundwater
• Stormwater harvesting & aquifer storage and recovery
• Sewer mining
Local groundwater

- **Availability:**
  - Available allocation:
    - Superficial Aquifer - 650 ML/yr
    - Leederville Aquifer - 0 ML/yr
  - Trade existing water entitlements:
    - Superficial Aquifer - 291 ML/yr
    - Leederville Aquifer - 47 ML/yr
Stormwater harvesting & aquifer storage and recovery (ASR)
Ecological Water Requirements

- Southern River at Anaconda Drive

**Equation:**

\[ y = 2.2764x^{0.8593} \]

**Average Monthly Flow (ML):**

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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<td>45</td>
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<td>12</td>
<td>80</td>
<td>260</td>
<td>609</td>
<td>866</td>
<td>970</td>
<td>750</td>
<td>432</td>
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<tr>
<td>139</td>
<td>40</td>
<td>76</td>
<td>229</td>
<td>589</td>
<td>1349</td>
<td>1767</td>
<td>1907</td>
<td>1408</td>
<td>762</td>
<td>340</td>
<td>129</td>
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</table>

**Monthly EWR (ML):**

- Pre Dev EWR
- Post Dev EWR
Yield Analysis

- Diversion efficiency
Harvested volume (monthly)

Assuming a 20 ML/day Pumping Capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>Est Dev Discharge</th>
<th>Est Pre-Dev Flows</th>
<th>Est Vol Missed</th>
<th>Est Harvested Vol</th>
<th>Annual Est EWR</th>
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<td>1997</td>
<td>3.5</td>
<td>5.0</td>
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<td>0.7</td>
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<td>1998</td>
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Assuming a 100 ML/day Pumping Capacity

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<th>Est Vol Missed</th>
<th>Est Harvested Vol</th>
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<td>2.5</td>
<td>0.1</td>
<td>0.3</td>
<td>8.9</td>
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</table>
Harvested volume (daily)

- **Storage**
  - 250 – 1,000 ML
Bore Locations

AM46A,B (1.5-4; 4.3-12)

AM47A,B (2.3-3.5; 0.3-)
Lithology

Seismic transect, Oxley Road (SW-S central)

- Superficial
- Pinjar Shales
- Leederville Aquifer
- Superficial Leederville Formation
- Sltst / Sst
- Sst
- Pinjar Shales (?)

Depth in meters:
- 0m
- 50m
- 100m
- 150m
- 200m
- 250m

Lithology layers:
- AM46A.B
- AM47A,B
- 2002-1102
- 2002-1147
## Injection Rates

<table>
<thead>
<tr>
<th>Location</th>
<th>Transmissivity (m²/day)</th>
<th>Injection Rate (ML/day)</th>
<th>Injection Rate (L/sec)</th>
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</thead>
<tbody>
<tr>
<td>Jandakot (WC)</td>
<td>100</td>
<td>3 - 4</td>
<td>25 - 33</td>
</tr>
<tr>
<td>Midland (MRA)</td>
<td>13 - 22</td>
<td>0.5 - 0.8</td>
<td>6 - 9</td>
</tr>
<tr>
<td>Wungong</td>
<td>50</td>
<td>1.5 - 2.8</td>
<td>17 - 23</td>
</tr>
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</table>
# Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Surface Water</th>
<th>Groundwater</th>
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<tbody>
<tr>
<td>pH</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>TDS</td>
<td>6</td>
<td>600</td>
</tr>
<tr>
<td>Ca</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td>0.74</td>
<td>1.8</td>
</tr>
<tr>
<td>TP</td>
<td>0.07</td>
<td>0.13</td>
</tr>
<tr>
<td>Fe</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>HCO3</td>
<td></td>
<td>111</td>
</tr>
<tr>
<td>TSS</td>
<td>150</td>
<td>55</td>
</tr>
<tr>
<td>SO4</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

- Pesticides
- Hydrocarbons
- Heavy metals
Target NDW Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>&lt; 2 mg/L</td>
</tr>
<tr>
<td>BOD</td>
<td>&lt; 5 mg/L</td>
</tr>
<tr>
<td>TN</td>
<td>&lt; 5-10 mg/L</td>
</tr>
<tr>
<td>TP</td>
<td>&lt; 1 mg/L</td>
</tr>
<tr>
<td>Turbidity</td>
<td>&lt; 0.5 NTU</td>
</tr>
<tr>
<td>E.Coli</td>
<td>&lt; 1 TFC/100mL</td>
</tr>
<tr>
<td>Chlorine Residual</td>
<td>&gt; 1.0 mg/L</td>
</tr>
<tr>
<td>Bacteria Removal</td>
<td>&gt; 5 log removal</td>
</tr>
<tr>
<td>Virus Removal</td>
<td>&gt; 6.5 log removal</td>
</tr>
<tr>
<td>Protozoa Removal</td>
<td>&gt; 5 log removal</td>
</tr>
</tbody>
</table>

**Nutrients:** Resultant application rates within DoW guideline limits for irrigation of coarse grained soils near ‘sensitive waters’

**Microbiological quality:** In accordance with Australian Guidelines for Water Recycling, and as informed by qualitative HRA
Treatment

• For injection:
  – Removal of TSS and Nutrients
  – Coagulation?
  – Filtration (< 5 micron to prevent clogging)
  – Disinfection?

• For NDW supply
  – Removal of iron and TSS
  – Clarification
  – Filtration
  – Disinfection

• Sludge disposal
Sewer Mining
Existing WC Infrastructure
Wastewater Flows
Supply-Demand Balance

There is potential for sewer mining to increase detention times during peak NDW demand periods.

Require supplementary flow from Anaconda WWPS

Available - Waterworks Rd PS plus Anaconda St PS (WC Forecast [2007])

Available - Waterworks Rd PS (WC Forecast [2007])
Water Reclamation Plant

• Assumed wastewater characteristics:
  – No data, assume characteristics of Woodman Point
    • COD = 735 mg/L
    • TKN = 65 mg/L
    • TP = 12 mg/L
  – No significant trade waste in Waterworks Rd catchment, though more at Anaconda

• Two process options (both bio-P removal):
  – Conventional Oxidation Ditch + Tertiary UF + UV + Cl
  – Oxidation Ditch Membrane Bioreactor + UV + Cl
Water Reclamation Plant

• Redundancy
  – 2 x 50% capacity process trains
  – Emergency backup from potable network?

• Sludge Management
  – EAS returned to sewer
  – Dilution required for quality of EAS to meet trade waste acceptance criteria
  – 36 ML/d of wastewater required to produce 28 ML/d of NDW

• High level of odour control (covers, scrubber, stack)
Process Flow – MBR Option

Raw Wastewater Quality
COD = 735 mg/L
TSS = 340 mg/L
TKN = 65 mg/L
TP = 12 mg/L
Design Flow, Q = 265 ML/d
Diurnal peaking factor = 1.4

5R = 120d at 25°C (summer)

Waterworks Rd
Pump Station 1800 ML/d

Anacordia
Pump Station 2720 ML/d

Enclosed Grit & Screenings Bin

Raw Wastewater for Waste Solids Dilution 720 ML/d

50 m Exhaust Stack

Chlorination and Drum Storage
2 No. 308 kph Cl₂ drums

Final Effluent
2600 ML/d
COD < 60 mg/L
TSS < 1 mg/L
TN < 32 mg/L
TP < 0.05 mg/L
Total Chlorine > 1 mg/L

Tertiary Treatment Plant
By-Pass to Seaver

Waste Solids Balance Tank 50 ML

Waste Solids To Sewer
5.5 ML/d
COD < 2500 mg/L
TSS < 1500 mg/L
TN < 150 mg/L
TP < 50 mg/L

Chlorine Contact Tank
3 No. 0.2 ML
30 min contact time
6 mg/L Cl₂ dose
Concept Layout – MBR Option
Technical Issues & Risks

• NDW demands & staging
• WRP process:
  – Process validation (additional treatment barrier?)
  – Colour of recycled water
  – Low plant loading
• EAS:
  – Transfer of EAS & excess wastewater
  – Relaxation of trade waste acceptance criteria (dilution)
• Supply-demand balance
• Operation of Woodman Point WWTP
Content

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Thank you for listening

www.ghd.com
Governance and Project Management
Lessons Learned from Practical Experience – Wungong Urban Water Project

Stuart Devenish | Devenish Consulting

Stewart Dallas | Woodsome Management
The Mouse Trap

- hammer
- spring
- platform
- hold-down bar
- catch
Lessons Learned:

Corporate Governance

Project Governance

Perspective: PROPONENT
Lessons Learned:

Corporate Governance

Motivations

Implications

IMPORTANCE

Importance → Level of Commitment → Risk Profile

- Direct costs
- Opportunity costs
- Time costs
Lessons Learned:

Corporate Governance

- Development Strategy: IP access, collaboration
- Incremental decision-making step points
- Cost parameters
Lessons Learned:

Corporate Governance – Wungong Urban Water

• Implementation of Total Water Cycle Management
• Potential for 85% water substitution
• Demonstration Project: large scale urbanisation
• Irrigation demand exceeds groundwater availability
• Federal funding assistance: Water Smart Australia program
Lessons Learned:
Lessons Learned:

Project Governance

- **Demand**: Water balance choices and ‘level of service’ choices
- **Supply**: Feasibility of sources
- **Technical**: Sourcing, treating, storing, distributing
- **Environmental**: Risks and capacity to mitigate
- **Health**: Risks and capacity to mitigate
- **Regulatory**: Capacity to satisfy regulatory requirements
- **Social**: Marketability of service to prospective purchasers
- **Economic**: Costs, revenue, timing
Lessons Learned:

Project Governance

H2Options:

Step 1 – Develop Plan
Step 2 – Determine Feasibility
Step 3 – Develop Business Case
Step 4 – Secure a Service Provider
Step 5 – Clearances and Approvals
Step 6 – Detailed Design
Step 7 – Review prior to implementation
Lessons Learned:

Project Governance

Draft Approval Framework for the use of Non-Drinking Water in WA:

Step 1 – Option evaluation and Concept Design Study

Step 2 – Preliminary Design Study

Step 3 – Detailed Design Study

Step 4 – Implementation
Lessons Learned:

Wungong Urban Water Project - Non-Potable Water Supply
Project Plan Framework

Concept Development
- Preliminary Economic Analysis
  - Deliverables:
    1. Critical pricing parameters
    2. CSO/other reliance
    3. Broad feasibility
  - Methodology:
    See Work Breakdown Structure (WBS)

Supply Option
- Deliverables:
  1. Demonstrated supply option capable of satisfying
  2. Technical
  3. Environmental
  4. Social
  5. Financial
  6. Regulatory
  7. Risk
- Methodology:
  Decision matrix flowchart
  Option Assessment Plan (OAP)
  See Work Breakdown Structure (WBS)

Business Plan
- Deliverables:
  1. BP capable of engaging a service provider
  2. Basis for expectations
  3. Scope of work remaining
- Methodology:
  See Work Breakdown Structure (WBS)

Service Provider Engagement
- Deliverable:
  Service provision contract

Design Approvals Implementation
- Deliverables:
  1. Technical development & design
  2. Regulatory approvals
  3. Construction
  4. Commissioning
  5. Administration, Maintenance, Management

Note: Non-potable water distribution, reticulation and plumbing standards are addressed separately to this framework.

Prepared by ARA, October 2008
Lessons Learned:

Project Governance

Economics:

Costs:
• Supply infrastructure
• Distribution headworks
• Reticulation mains
• On-lot costs

Revenue:
• Consumption charges
• Offsets
• Subsidies
• Developer contributions

Timing:
• Capital availability
Lessons Learned:

Project Governance

Economic Regulation Authority, Inquiry into Pricing of Recycled Water in Western Australia, 6 February 2009:

“It would generally be inefficient to develop recycling options that have a per kL cost that is higher than traditional sources ...”

“... there is a risk that recycling targets could artificially encourage projects that are not the most efficient options to balance supply and demand (or discourage others that are).”
Lessons Learned:

Project Governance

Decision Criteria

Weightings

Points of view:

1. Proponent / Developer
2. Regulators
3. Providers
4. Consumers (Local Government)
Governance and Project Management
Lessons Learned from Practical Experience – Wungong Urban Water Project