RECYCLED WATER AT SYDNEY OLYMPIC PARK

Andrzej Listowski
SYDNEY OLYMPIC PARK AUTHORITY
INTEGRATED URBAN WATER CYCLE AT SYDNEY OLYMPIC PARK - CONTEXT

◆ INTRODUCTION TO SYDNEY OLYMPIC PARK
◆ INTEGRATED WATER CYCLE CONCEPT
◆ TREATMENT TECHNOLOGY
◆ RECYCLED WATER QUALITY
◆ RECYCLED WATER USES
◆ AC COOLING TOWERS
Sydney Olympic Park

- 640 ha site
- Approx two thirds parkland
- Major sporting & show facilities
- Residential
- Commercial
- Future residential & commercial
SYDNEY OLYMPIC PARK
MASTERPLAN 2030
Design Principles

• ESD principles for the site
  – Conservation of species
  – Conservation of Resources
  – Minimise pollution

• Water management
  – Minimise sewage discharge
  – Reverse stormwater impact
  – Harvest stormwater
  – Treatment of sewage & stormwater for reuse
  – Reduce potable water demand
TRADITIONAL WATER SERVICES

VERY HIGH ECONOMIC AND ECOLOGICAL COSTS ARE RELATED TO TRADITIONAL WATER SYSTEMS

RAIN

DRINKING WATER FOR ALL USES

SEWAGE DISPOSAL

SEWAGE

STORMWATER DRAINAGE – NO RAINWATER COLLECTION AND NO REUSE

RUN OFF TO RIVERS
INTEGRATED WATER CYCLE

COMMUNITY
- Education
- Perception
- Participation
- Acceptance
- Risk Safety
- Health
- Hygiene

ECONOMY
- Costs / Price / Value
- Benefits
- Incentives
- LC Costing
- Investment & Funding

ECOLOGY
- Flora
- Fauna
- Habitat Health
- Environmental
- Management
- Risk Impact

WETLANDS
- Natural
- Constructed
- Hydraulics
- Management
- Functions
- Benefits

LANDSCAPING / IRRIGATION
- Functions
- Appearance
- Plant Selection
- Water Features
- Public Art

DISTRIBUTION SYSTEMS
- Water Quality Management
- DUAL WATER SOURCE
- DUAL SYSTEM
- Hydraulics

BUILDINGS & FACILITIES
- Design Stand.
- Building Life Cycle: Concept
- Efficiency
- Environmental Quality

POTABLE WATER
- Water Sources
- Supply / Demand Management
- Infrastructure
- Quality

SEWAGE
- Quality
- Treatment
- Reuse
- Trade Waste
- Products

RECYCLED WATER
- Water Sources
- Treatment Tech.
- Risk Management
- Operation
- Water Quality

RAIN & STORMWATER
- Catchment Management
- Pollution Control
- Storage Req.
- Quality

ENERGY MATERIALS
- Chemicals, Residues
- Backwash
- Biosolids
- Waste Disposal
- Emissions

INTEGRATED WATER SYSTEM (BASE MODEL)

INTEGRATED WATER CYCLE

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- Environment
- Economy
- Resources
- Technology
- Science
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INTEGRATED WATER SYSTEM (BASE MODEL)
WATER RECLAMATION AND MANAGEMENT SCHEME
SYDNEY OLYMPIC PARK

SYDNEY OLYMPIC PARK VENUES
FACILITIES & BUILDINGS
- STADIUM
- SHOWGROUND
- SUPERDOME
- HOTELS
- OTHER VENUES
- PUBLIC DOMAIN
- NEWINGTON, NSW

POTABLE / DRINKING WATER
from SYDNEY's WATER SYSTEM

STORMWATER

RECYCLED WATER SUPPLY

OTHER AREAS
FUTURE EXPANSION
- INDUSTRIAL
- COMMERCIAL
- RESIDENTIAL

STORMWATER

POTABLE / DRINKING WATER
(off site / on site residual management facility)

WATER RECLAMATION PLANT

TREATED SEWAGE- EFFLUENT
(in frequent flow)

SEWAGE from
SYDNEY's SEWERAGE SYSTEM

RECYCLED WATER SUPPLY

BRICKPIT STORAGE

TREATED STORMWATER

TO ENVIRONMENT

WATER TREATMENT PLANT

RESIDUAL MATERIALS
(biosolids, grit, etc.)

STORMWATER TREATMENT PONDS

TREATED STORMWATER

OFF SITE / ON SITE RESIDUAL
MANAGEMENT FACILITY
(interim arrangement)

FUTURE ON SITE RESIDUAL
MANAGEMENT FACILITY eg. composting.

RESIDUAL MATERIALS

RO backwash to
receiving brackish water

JANUARY 2007
INTEGRATED WATER CYCLE

1. Sewage treatment – SBR,
   – SBR, Biological nutrient removal, UV
2. Wetlands, Rainwater collection, transfer & storage
3. Recycled water production
   – MF, RO, Chlorination
Micro-filtration filters all particles over 0.2 micron.
That’s about 1 / 200 the size of a human hair.
Filters out most harmful organisms including bacteria, Cryptosporidium and Giardia.
LEGACY OF WATER RECYCLING

- Potable demand REDUCED by over 50% that Sydney’s average
- 800 ML/year of sewage treated & reused
- 700 ML/year of stormwater harvested & used beneficially
- 850 ML of recycled water supplied to over 15,000 customers
RECYCLED WATER APPLICATIONS AFTER ~ 9 YEARS

- TOILET FLUSHING √
- CAR WASHING √
- EXTERNAL WASH DOWN √
- CONSTRUCTION √
- IRRIGATION PARKLANDS √
- RESIDENTIAL GARDENS √
- IRRIGATION ALL PLAYING FIELDS √
- CLOTHES WASHING √
- ORNAMENTAL WATER FEATURES √
- FOUNTAINS √
- FIREFIGHTING √
- CONSTRUCTION √
- COOLING TOWERS √
- SWIMMING POOLS FILTERS BACKWASHING √

ALL RESIDENTIAL PROPERTIES, SPORTING VENUES, COMMERCIAL FACILITIES, PUBLIC SPACE, PARKLANDS
### WRAMS ANALYSIS SUMMARY

<table>
<thead>
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<th>Parameter</th>
<th>Unit</th>
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<th>Tolerance</th>
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</table>

* Criteria Derived from:
- NSW Guidelines for Urban and Residential Use of Reclaimed Water
- Australian Drinking Water Guidelines, 1996, NHMRC
- NSW Health Department
# Recycled Water Quality

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>LIMIT</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>5 mg/L</td>
<td>0.06</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.1 mg/L</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.1 mg/L</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Copper</td>
<td>0.2 mg/L</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Iron</td>
<td>1 mg/L</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Lead</td>
<td>0.2 mg/L</td>
<td>0.05</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.2 mg/L</td>
<td>0.06</td>
</tr>
<tr>
<td>Mercury</td>
<td>2 ug/L</td>
<td>0.9</td>
</tr>
<tr>
<td>Zinc</td>
<td>2 mg/L</td>
<td>0.08</td>
</tr>
</tbody>
</table>
CASE STUDY – Rhodes Business Park, Water Balance

Average Daily Water Demand at Rhodes Corporate Park (Business as Usual Case)

<table>
<thead>
<tr>
<th>Water Source</th>
<th>(KL/d)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable</td>
<td>20</td>
<td>11%</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>14</td>
<td>7%</td>
</tr>
<tr>
<td>Urinal flushing</td>
<td>7</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Water savings already achieved by other measures</strong></td>
<td>17</td>
<td>9%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>18</td>
<td>10%</td>
</tr>
<tr>
<td>Cooling Tower</td>
<td>113</td>
<td>59%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>189</td>
<td></td>
</tr>
</tbody>
</table>

Potential for Recycled Water Use

<table>
<thead>
<tr>
<th>Water Source</th>
<th>(KL/d)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable</td>
<td>20</td>
<td>12%</td>
</tr>
<tr>
<td>Recycled</td>
<td>152</td>
<td>88%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>172</td>
<td></td>
</tr>
<tr>
<td><strong>Overall Reduction in Potable Water</strong></td>
<td></td>
<td>88%</td>
</tr>
</tbody>
</table>

Source: MHW, Australand, 2004
KEY ISSUES FOR COOLING TOWERS:

*Legionella pneumophila* bacteria - the presence of Legionella bacteria is a serious health risk, and requires careful management and treatment.

The risk of Legionella bacteria propagating in the cooling towers may be amplified by the use of recycled water caused by nutrients and salts particularly iron salts that are present in recycled water.
### Key recycled water quality and cooling towers issues:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit (mg/L)</th>
<th>Reclaimed Water (mg/L)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>9th Dec</td>
<td>17th Dec</td>
</tr>
<tr>
<td>Silica (SiO2)</td>
<td>50</td>
<td>2.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Aluminium (Al)</td>
<td>0.1</td>
<td>0.06</td>
<td>0.11</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.5</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.5</td>
<td>0.003</td>
<td>0.008</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>50</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>Ammonia (NH3-N)</td>
<td>1</td>
<td>&lt;0.01</td>
<td>1.3</td>
</tr>
<tr>
<td>Bicarbonate (HCO3)</td>
<td>24</td>
<td>67</td>
<td>101</td>
</tr>
<tr>
<td>Sulphate (SO4)</td>
<td>200</td>
<td>46</td>
<td>69</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>500</td>
<td>120</td>
<td>210</td>
</tr>
<tr>
<td>TDS</td>
<td>500</td>
<td>360</td>
<td>600</td>
</tr>
<tr>
<td>Hardness (CaCO3)</td>
<td>650</td>
<td>90.2</td>
<td>139</td>
</tr>
<tr>
<td>Alkalinity (CaCO3)</td>
<td>350</td>
<td>67</td>
<td>101</td>
</tr>
<tr>
<td>Methylene blue active substance</td>
<td>1</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>COD</td>
<td>75</td>
<td>8</td>
<td>96</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>100</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1</td>
<td>0.63</td>
<td>0.86</td>
</tr>
</tbody>
</table>

The results indicate that:
- some parameters fluctuate
- chemical treatment would be required to address:
  - ammonia,
  - bicarbonate
  - COD.
- high levels of TDS

Source: Steve Paul and Partners for water quality limits, water testing results from SOPA
Key recycled water quality and cooling towers issues:

1. **Scaling** – formation of hard deposits on hot surfaces, reducing heat exchange efficiency. The water quality requirements are set by the concentration of the following constituents:
   - Calcium
   - Magnesium
   - Sodium
   - Chlorine
   - Phosphate and other organics that can cause scaling, biological growth and accelerated corrosion.
Key recycled water quality and cooling towers issues:

Metallic corrosion – electric potential is created between (dissimilar) metal surfaces, forming a corrosion cell. TDS is a major contributing factor, increasing the electrical conductivity of the water, accelerating corrosion.

Biological Growth – arises from the warm, moist, nutrient rich environment in cooling towers using recycled water. Problem can be reduced by providing advanced wastewater treatment, in the removal of nutrients and carbon.

Fouling – formation of deposits if biological growth, suspended solids, silt, corrosion, all which inhibit heat transfer. Chemical dispersants can be used to prevent aggregation and settling of particles.
## Water Usage & Costs by SOPA

<table>
<thead>
<tr>
<th>Period</th>
<th>Potable Water price</th>
<th>Recycled Water price</th>
<th>Potable water use (ML/y)</th>
<th>Recycled water use (ML/y)</th>
<th>Stormwater usage (ML/y)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-02</td>
<td>$0.925</td>
<td>$0.775</td>
<td>140</td>
<td>51</td>
<td>250</td>
<td>441</td>
</tr>
<tr>
<td>2002-03</td>
<td>$0.942</td>
<td>$0.792</td>
<td>139</td>
<td>92</td>
<td>300</td>
<td>531</td>
</tr>
<tr>
<td>2003-04</td>
<td>$0.98</td>
<td>$0.830</td>
<td>57</td>
<td>413</td>
<td>365</td>
<td>835</td>
</tr>
<tr>
<td>2004-05</td>
<td>$1.01</td>
<td>$0.863</td>
<td>22</td>
<td>200</td>
<td>388</td>
<td>610</td>
</tr>
<tr>
<td>2005-06</td>
<td>$1.20</td>
<td>$1.050</td>
<td>9</td>
<td>181</td>
<td>412</td>
<td>602</td>
</tr>
<tr>
<td>2006-07</td>
<td>$1.26</td>
<td>$1.114</td>
<td>8</td>
<td>158</td>
<td>324</td>
<td>490</td>
</tr>
<tr>
<td>2007-08</td>
<td>$1.34</td>
<td>$1.189</td>
<td>6</td>
<td>150</td>
<td>345</td>
<td>501</td>
</tr>
<tr>
<td>2008-09</td>
<td>$1.61</td>
<td>$1.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The real test of successful performance is the extent to which it has “made a difference”
"Salinity limits in cooling towers are controlled by bleeding that is typically set at 1,000 mg/L TDS”.

“The presence of phosphate, nitrate, and ammonia could present some problems”

What are the drivers and limiting factors…?

- Cooling tower design and materials
- Chemicals used in treatment process
- Risk management - understanding of real issues or avoidance
- Lack of actual data from installations using recycled water
- Other drivers eg. lower maintenance cost, discharge criteria, formal guidelines or limits
1. **Review Control Capabilities**: Good chemistry control will be more important with recycled water than with fresh water make-up.

2. **Consider a Chemical Flow Monitor**: With the recycled water use it will be important to maintain a minimum concentration of the scale control polymer to control phosphate.

3. **Collect Good Base Data**: Before you evaluate the performance of the recycled water, you need to know your current corrosion rates (copper & steel & galvanized), fouling rates, microbiological activity (*Legionella* and total aerobic bacteria) and chemical costs.

4. **Operator Training**: Since there are some changes required in the chemicals, procedures and chemistry control limits, it is important to review all these changes with the operators and prepare a reference/operating manual. This will significantly impact on success on any treatment program and minimize safety concerns.
CONCLUSIONS

✓ Recycled water can be successfully utilized when properly treated in conventional cooling systems.

✓ An effective treatment program can control corrosion, deposition and microbiological growth.

✓ Effective control strategies (physical, chemical, biological) are needed to allow use of other water sources and assure good performance.
Thank you

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