Testing the paradigm of recreational risk in drinking water supplies: A QMRA approach
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Seqwater Catchments

- Catchment Area - 1.4 Million ha
- Limited Seqwater ownership
Seqwater Catchments

- Catchment Area - 1.4 Million ha
- Limited Seqwater ownership
- Seqwater – no regulatory powers over catchments
- Open catchments, mixed land use
- Watershed population
  - 60,000 regional towns
  - 290,000 rural
- 420,000 cattle
- ~25% intact original vegetation
Drivers of Drinking WQ Management

- Strategic Vision – Healthy Communities, Prosperous Region
- Statement of Obligations
  - The Authority’s core business is to deliver safe, secure, resilient and reliable water supplies at least cost to its customers
  - The core business activities of the Authority include:
    a) water supply
    b) water security
    c) water quality
    d) asset management
    e) environmental management
    f) recreation management
    g) flood mitigation
Drivers of Drinking WQ Management

Statement of Obligations

- The Authority will plan and manage water in a total water cycle framework including its water supply catchments (Catchment to Tap).

- The Authority will implement and maintain an accredited Quality Management System (9001 / 22,000)
Drivers of Drinking WQ Management

Water Supply (Safety and Reliability) Act 2008:

- Approved Drinking Water Quality Management Plan
- Based around the ADWG Framework – 12 elements
- Meet all public Health guidelines in ADWG
Drivers of Drinking WQ Management

• ADWG Guiding Principle 1
  “greatest risk are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised”

• ADWG Guiding Principle 2
  “The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply. The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water. No single barrier is effective against all conceivable sources of contamination, is effective 100 per cent of the time or constantly functions at maximum efficiency. Prevention of contamination provides greater surety than removal of contaminants by treatment, so the most effective barrier is protection of source waters to the maximum degree practical.”
Drivers of Drinking WQ Management

- Recreational activity is explicitly identified in the ADWG as a potential hazardous event for drinking water assessment

- Many documented cases of recreators infecting recreators
  - recreational water environments were identified as the most common cause of waterborne disease outbreaks in the UK
  - Australian swimming pools regularly suffer outbreaks of cryptosporidiosis
Drivers of Drinking WQ Management

Figure. Cryptosporidium notifications, Queensland 1997-1998, by Local Government Area and month

- 1997 Brisbane City (south)
- 1997 Gold Coast
- 1997 Logan City
- 1997 Redland Shire

Stafford et al. 1999

Fig. 1.
Total average enterococci and S. aureus densities (CFU/100mL) in the water column per cycle as observed during the large pool experiment. Error bars correspond to the standard deviation of replicate analyses.

Elmir et al 2006
<table>
<thead>
<tr>
<th>City</th>
<th>Reservoir</th>
<th>Catchment type</th>
<th>Recreation on reservoir</th>
<th>Recreation in catchment</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane</td>
<td>Wivenhoe, Somerset, Samsonvale, Hinze, Baroon Pocket</td>
<td>Mixed landuse, all types</td>
<td>Some motorised, non-motorised and primary contact</td>
<td>Open catchment, recreation around reservoirs</td>
<td>Filtration, Disinfection, Advanced treatment</td>
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<tr>
<td>Melbourne</td>
<td>Sugarloaf</td>
<td>Mixed landuse, all types</td>
<td>Non-motorised secondary contact (sailing)</td>
<td>Open catchment, no recreation around reservoirs</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Canberra</td>
<td>Googong</td>
<td>Mixed landuse, all types</td>
<td>Non-motorised secondary contact</td>
<td>Open catchment, recreation around reservoirs</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Newcastle</td>
<td>Grahamstown</td>
<td>Mixed landuse, all types</td>
<td>Non-motorised secondary contact</td>
<td>Open catchment</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Sydney</td>
<td>Warragamba</td>
<td>Mixed landuse, all types</td>
<td>None permitted</td>
<td>None permitted within 3 km</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Melbourne</td>
<td>Thomson, Upper Yarra, Silvan, Cardinia</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Canberra</td>
<td>Corin, Bendra</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Darwin</td>
<td>Darwin Dam</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Sydney</td>
<td>Woronora, Cataract, Cordeaux</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Perth</td>
<td>Victoria, Wungong, Canning</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted within 2 km</td>
<td>Filtration, Disinfection</td>
</tr>
<tr>
<td>Wollongong</td>
<td>Avon</td>
<td>Native bushland</td>
<td>None permitted</td>
<td>None permitted</td>
<td>Filtration, Disinfection</td>
</tr>
</tbody>
</table>

(Deere 2013)
Drivers of Recreation Management

- Strategic Vision – Healthy Communities, Prosperous Region
- Statement of Obligations

  - The core business activities of the Authority include:
    a) water supply
    b) water security
    c) water quality
    d) asset management
    e) environmental management
    f) recreation management
    g) flood mitigation
Statement of Obligations

• The Authority must strive to balance the ongoing health of the catchments and quality of the region’s drinking water supply with providing access to a range of water-based and on-shore activities at its lakes and recreation areas.

• The Authority must consider the views and recreation needs of the local communities, recreation users and special interest groups across the SEQ region.
Finding the right balance

Healthy Communities, Prosperous Region

Source water risk management

Safe, reliable and secure water supply

Community expectations for recreational opportunities

Source investment

Significant Green Space Manager

~ 2.5 million visitors a year to lakes and recreation areas
Our objective

To manage access to recreation opportunities while protecting natural resources and water quality
Seqwater Recreation Management Framework

• Key management principles:
  1) Minimise risks to water quality
  2) Ensure environmental sustainability
  3) Diversity in the range of outdoor recreation activities, locations and settings
  4) Ensure all use is consistent with Seqwater’s asset and land management practices
  5) Facilitating sustainable recreation
  6) Engage with external regulating agencies
  7) Meet financial management outcomes
Recreation Review

• Community (Recreation) feedback on opportunities for recreation:
  – more than 2,500 surveys
  – numerous workshops
  – information sessions
  – submissions.

• Demand for more recreation activities
**Preliminary assessment**

1. Screening QMRA
2. Risk Assessment Review
   - New or increased hazards?
     - Yes
     - Can the additional hazards be managed to an acceptable level?
       - Yes
       - Economic Feasibility Assessment
         - Can WTP be upgraded or risk augmented elsewhere in catchment?
           - Yes
           - Approve activity
           - No
           - Reject activity
     - No
   - Meet other Policy?
     - Yes
     - Approve activity
     - No

Screening QMRA

Background Risk

- New recreators?
  - Swimming
  - Boating
  - Hiking

- Faecal inputs & epidemiological assumptions?
  - Gastro rates
  - AFRs
  - [Pathogen]

- Hydrodynamics
  - Volume
  - Residence time
  - dilution

Pathogen reduction across treatment

- background raw water [pathogen]
- Revised raw water [pathogen]

Exposure Assessment and Dose Response

- background treated water [pathogen]
- Revised treated water [pathogen]

- Background DALYs
- Revised DALYs

(Deere 2013)
• Findings indicated the North Pine Water Treatment Plant would be impacted by more on-lake activities

• Recommended no further changes without conducting a significantly more complex and detailed study

• Demand for recreation suggested this should be explored
Seqwater have committed to undertake a Quantitative Microbial Risk Assessment (QMRA) for Lake Samsonvale. Expensive and time consuming.

Aims:
- Specifically investigate the impacts of certain recreational options and broader catchment activities on drinking water.
- Validate the screening level tool for other systems.

Will be the most comprehensive study of its kind - Independent.

Aim for completion by Mid 2016.
Samsonvale QMRA

- **Whole of system assessment**
  - Catchment processes
  - Lake processes (including recreators)
  - Treatment processes

- **Target Pathogens**
  - Adenovirus/rotavirus hybrid
  - Cryptosporidium
  - Campylobacter
  - E. coli (indicator)
  - Enterococci (indicator)
Samsonvale QMRA

- **Microbial processes captured:**
  - Catchment processes
    - Catchment characteristics
    - Point sources
  - Lake processes
    - Transport, settling, mixing, mortality, inactivation
    - Recreators
  - Treatment processes
    - All capability at North Pine WTP
    - Consumption
Project Status

- Literature Review
  » Completed
- Methods development
  » Under peer review
- Catchment modelling
  » Commenced
- Lake modelling
  » Calibration well progressed
- Treatment assessment
  » Ready for inputs from above models
Detailed update – lake model

- Temperature Calibration
Detailed update – lake model

Example inflow event – plan view
Detailed update – lake model

Example inflow event – curtain view
Detailed update – lake model

Example inflow event – simplified AFR

Release at $10^5$ cfu/s (No Decay, Inactivation or Settling)
Thank you