Overview of Water Reuse

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Drivers for Reuse

• **Principal driver is water stress (need for water)**
  – Scarcity of renewable freshwater resources due to:
    • Population increases
    • Industrial development
    • Global climate changes
    • Droughts

• **Other drivers include:**
  – Conservation of potable supply
  – Regulatory policies/regulations
  – Environmental enhancement
  – Pollution abatement
  – Reliability of supply
  – Public policy
Institutional Issues/Constraints

- Water rights
- Established instream flow requirements
- Ownership of reclaimed water
- Conflicting laws and regulations
- Water reclamation and reuse criteria
- Permitting
- Local planning ordinances
- Environmental assessment and impact
- Public involvement/education/acceptance
- Legal agreements/contracts between suppliers and users
- Memoranda of understanding among agencies
- Agency jurisdictions
- Service duplication
- Financing, fee structures, etc.
Current Status in U.S.

- More than 1,500 water reuse facilities
- Only 5% of municipal wastewater is reused
- About 2.5 billion gallons/day of municipal wastewater was reclaimed in 2005
- 4 states account for more than 90% of reclaimed water use
  - Arizona
  - California
  - Florida
  - Texas
Current Uses of Reclaimed Water
Agricultural Irrigation

- Fodder, fiber, & seed crops
- Pasture
- Livestock watering
- Orchards and vineyards
- Processed food crops
- Food crops consumed raw
Landscape Irrigation

- Golf courses
- Cemeteries
- Freeway and street medians
- Schoolyards
- Parks
- Playgrounds
- Commercial landscapes
- Residential property
Recreational & Environmental Enhancement

- Wildlife habitats
- Wetlands
- Stream flow augmentation
- Decorative ponds and lakes
- Restricted recreational lakes (fishing & boating)
- Nonrestricted recreational lakes (full body contact allowed)
Industrial & Commercial Uses

- Cooling water (power plants, etc.)
- Boiler feed water
- Process water
- Washdown water
- Car washes
- Laundromats
- Chiller water in commercial air conditioning systems
Groundwater Recharge

- Prevent seawater intrusion
- Aquifer storage & recovery (ASR)
- Indirect potable reuse
  - surface spreading
  - Injection

Groundwater recharge by surface spreading

Groundwater recharge by direct injection for a salt water intrusion barrier
Miscellaneous Uses

- Toilet & urinal flushing
- Fire Protection
- Snow-making
- Street washing
- Dust control
- Pump seal water
- Concrete manufacture
- Augmentation of surface water supplies
Public Acceptance of Water Reuse

• Public generally strongly supports nonpotable uses
  – Uses involving no or minimal contact with reclaimed water (e.g., irrigation) are favored
  – Acceptance of potable reuse has been problematic in some cases

• Lower level of acceptance for potable reuse
  – Surveys indicate about 50% of people opposed
  – Major concerns are pathogens and long term health effects of organics
  – Some projects have been rejected due to public or political opposition
Considerations for Water Quality Criteria

• Public health protection
• Irrigation effects
• Specific use requirements
• Environmental concerns
• Aesthetics
• Public perception
• Political realities
• Economics
• Technical feasibility
Health Concerns

- **Pathogens (acute effects)**
  - Bacteria
  - Viruses
  - Parasites
  - Emerging pathogens

- **Chemicals (acute & chronic effects)**
  - Regulated contaminants (MCLs)
  - Nonregulated contaminants
    - Pharmaceuticals
    - Endocrine disruptors
    - Etc.
Microbial Contaminants
### Pathogens in Wastewater - Examples-

<table>
<thead>
<tr>
<th>Agent</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td></td>
</tr>
<tr>
<td><em>Salmonella</em> (1700 spp.)</td>
<td>Salmonellosis</td>
</tr>
<tr>
<td><em>Shigella</em> (4 spp.)</td>
<td>Shigellosis</td>
</tr>
<tr>
<td><strong>Protozoa</strong></td>
<td></td>
</tr>
<tr>
<td><em>Giardia</em></td>
<td>Giardiasis</td>
</tr>
<tr>
<td><em>Cryptosporidium</em></td>
<td>Cryptosporidiosis</td>
</tr>
<tr>
<td><strong>Helminths</strong></td>
<td></td>
</tr>
<tr>
<td><em>Ascaris lumbricoides</em></td>
<td>Ascariasis</td>
</tr>
<tr>
<td><em>Taenia saginata</em></td>
<td>Taeniasis</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
</tr>
<tr>
<td>Enteroviruses</td>
<td>Gastroenteritis, others</td>
</tr>
<tr>
<td><em>Hepatitis A</em></td>
<td>Infectious Hepatitis</td>
</tr>
</tbody>
</table>
Chemical Contaminants
Adverse Effects of Organics

- Aesthetically displeasing
- Nuisance
- Clogging
- Limit uses
- Consume oxygen
- Interfere with disinfection
- Possible health hazard if ingested
# Water Quality Concerns
- Agricultural Irrigation -

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogens</td>
<td>Infectious disease</td>
</tr>
<tr>
<td>Organics</td>
<td>Adverse health effects</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Deposition, clogging</td>
</tr>
<tr>
<td>Dissolved solids</td>
<td>Salinity problems, ion toxicity, soil permeability</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Plant and animal toxicity</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Effects on crops, groundwater contamination</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Crop damage, leaf-tip burn</td>
</tr>
</tbody>
</table>
Water Reuse Criteria
Guidelines vs. Regulations

• Guidelines are:
  • Advisory
  • Voluntary
  • Non-enforceable

• Regulations are:
  • Legally-adopted
  • Enforceable
  • Mandatory
Guidelines vs. Regulations

• Guidelines
  – Become *de facto* criteria in some states
  – Can lead to inconsistent decisions by regulators
  – Proponents may be unsure of requirements to meet

• Regulations
  – Provide definitive requirements to meet for conventional treatment processes
    • May hamper approval of new or innovative treatment processes not included in regulations
  – Precedent-setting decisions by regulators often difficult to obtain
Regulations and Guidelines Vary Depending on Type of Reuse

- Indirect potable reuse
- Agricultural Reuse on Food Crops
- Unrestricted Recreational Reuse
- Unrestricted Urban Irrigation Reuse
- Restricted Urban Irrigation Reuse
- Restricted Recreational Reuse
- Industrial Reuse
- Environmental Reuse
- Agricultural Reuse on Non-food Crops

More Stringent Regulations

Less Stringent Regulations
Water Reuse Criteria

• Generally include:
  – Water quality requirements
  – Treatment process requirements
  – Treatment reliability requirements
  – Monitoring requirements
  – Operational requirements
  – Cross-connection control provisions
  – Use area controls
# State Standards for Urban Irrigation with Reclaimed Water

<table>
<thead>
<tr>
<th>State</th>
<th>Quality Limits</th>
<th>Treatment Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>• No detectable fecal coli/100 mL</td>
<td>• Secondary</td>
</tr>
<tr>
<td></td>
<td>• ≤ 2 NTU</td>
<td>• Filtration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Disinfection</td>
</tr>
<tr>
<td>California</td>
<td>• ≤ 2.2 total coli/100 mL</td>
<td>• Secondary</td>
</tr>
<tr>
<td></td>
<td>• ≤ 2 NTU</td>
<td>• Coagulation*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Filtration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Disinfection</td>
</tr>
<tr>
<td>Florida</td>
<td>• No detectable fecal coli/100 mL</td>
<td>• Secondary</td>
</tr>
<tr>
<td></td>
<td>• ≤ 20 mg/L BOD</td>
<td>• Filtration</td>
</tr>
<tr>
<td></td>
<td>• ≤ 5 mg/L TSS</td>
<td>• Disinfection</td>
</tr>
<tr>
<td>Texas</td>
<td>• ≤ 20 fecal coli/100 mL</td>
<td>• Not specified</td>
</tr>
<tr>
<td></td>
<td>• ≤ 5 mg/L BOD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ≤ 3 NTU</td>
<td></td>
</tr>
</tbody>
</table>

* Not required under certain conditions
Trends in Water Reuse

- Integrated resource planning
- Dual systems
- Decentralized systems
- Indirect potable reuse
- UV for disinfection
- Membrane processes
- Microbial risk assessments
- Regulation development
- Public perception studies