Wastewater Treatment for Small Communities

Summary of the 2003 Workshop sponsored by Canadian Council of Ministers of the Environment (CCME)
Presentation Format

- Definitions
- Technology Options
- Cost Comparison
  - Centralized vs. Decentralized Systems
- Elements for Program Success
Definitions

• **Small Community**
  - no clear cut
  - suggest 2000 people

• **Type of Community**
  - rural
  - cottage
  - fringe
  - semi-urban

• **Treatment Systems**
  - Centralized
  - De-centralized
    - on-site
    - clusters
Centralized System
Centralized System Cost

Collection = 70%

Treatment = 30%

Population

Cost Per Capita
On-Site System
Decentralized System
Population

2,000

Centralized Treatment

Lagoons / Mechanical

De-centralized Treatment

On-site / Clusters
Presentation Format

- Definitions
  - ≤ 2000 population
  - centralized/decentralized
  - no clear cut solution

- Technology Options

- Cost Comparison
  - Centralized vs. Decentralized System

- Elements for Program Success
Technology Options for Centralized System

- Mechanical
- Lagoon
RBC discs drive
Moving Bed Technology
... floating homes for bugs?

Waterdown STP
Membrane AS plant
(hollow fiber)
SBR process (Sequencing Batch Reactor):

Biol. process and sedimentation in the same tank:

- influent
- fill
- cycle
- effluent
- excess sludge
- decantation
- aeration
- sedimentation
Lagoon Performance
Effluent BOD

LAGOON FALL DISCHARGES

6 MONTH STORAGE

12 MONTH STORAGE

MECHANICAL PLANTS

BOD mg/L

upper 95%

mean

lower 95%

0S,1L

4S,2L

0S,1L

4S,2L

AS

AL

EA

RBC

(7,19)

(5,43)

(5,7)

(17,39)

(9,97)

(25,391)

(10,173)

(10,257)
Numerical data and graphical representation showing concentrations of Alkylphenolics in STPs across various sites, with red bars indicating influent concentrations and blue bars indicating effluent concentrations.
Median Per Cent Reduction of Acidic Drugs
Thames River, Grand River and Highland Creek plants

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon (4)</td>
<td></td>
</tr>
<tr>
<td>Secondary (12)</td>
<td></td>
</tr>
<tr>
<td>Tertiary (3)</td>
<td></td>
</tr>
</tbody>
</table>

- Ibuprofen
- Gemfibrozil
- Naproxen
- Triclosan
- Ketoprofen
- Diclofenac
- Indomethacin
Technology Options for Decentralized System

- soil-based
- package plants
19th Century
England
Soil-based System
Examples of Dispersal Technologies

- Drip Irrigation
- Chamber System
- Contour Trench
- Mound System
Peat Filter + Wetland
Recirculating Sand Filter Schematic
Waterloo Biofilter
Air-tight 5000 L/d Polyethylene Tanks

- modules installed as needed
- new or existing garage-type structure
- standard plumbing & electrical
- no confined space problem
Waterloo 30-40 m³/d ISO Container

- 30-40 m³/d ISO container combines building & Biofilter
- shipped as standard container; ideal for off-shore
- St. Louis & Paddockwood, Saskatchewan
Presentation Format

- Definitions
- Technology Options
  - centralized/decentralized systems
  - no clear cut
- Cost Comparison
  - Centralized vs. Decentralized System
- Elements for Program Success
Scenario 1 – Rural Community

- 450 people
- 135 homes
- 1 acre lots
- 50% on-site systems failed
Scenario 1 – Centralized System

- collection
  - gravity sewers
- treatment
  - facultative lagoon
  - disinfection
Scenario 1 – Cluster System

- collection
  - small diameter gravity sewers
- treatment
  - septic tank
  - sand filter
  - leach field
Scenario 1 – On-Site System

- failing on-site systems
  - septic tank and leach field
- new on-site systems
  - septic tank
  - sand filter
  - leach field
# Summary of Rural Community System Costs (1995 $)

<table>
<thead>
<tr>
<th>System Option</th>
<th>Capital Cost</th>
<th>Annual O &amp; M Cost</th>
<th>Total Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized System</td>
<td>$ 2,321,840</td>
<td>$ 29,740</td>
<td>$ 216,850</td>
</tr>
<tr>
<td>Small Cluster System</td>
<td>$ 598,100</td>
<td>$ 7,290</td>
<td>$ 55,500</td>
</tr>
<tr>
<td>On-site System</td>
<td>$ 510,000</td>
<td>$ 13,400</td>
<td>$ 54,500</td>
</tr>
</tbody>
</table>

Rural community consists of 450 people in 135 homes
Scenario 2 – Fringe Community

- 770 people → 1550 people
- 220 homes → 443 homes
- ½ acre lots
- 50% (110 homes) failed on-site systems
## Summary of Fringe Community System Costs (1995 $)

<table>
<thead>
<tr>
<th>System Option</th>
<th>Capital Cost</th>
<th>Annual O &amp; M Cost</th>
<th>Total Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• at 5 miles from existing sewer</td>
<td>$5,377,800</td>
<td>$95,900</td>
<td>$529,300</td>
</tr>
<tr>
<td>• at 1 mile from existing sewer</td>
<td>$3,322,900</td>
<td>$83,800</td>
<td>$351,600</td>
</tr>
<tr>
<td>Small Cluster Systems</td>
<td>$3,783,700</td>
<td>$18,000</td>
<td>$322,900</td>
</tr>
<tr>
<td>On-site Systems</td>
<td>$2,117,100</td>
<td>$59,240</td>
<td>$229,900</td>
</tr>
</tbody>
</table>

Fringe community consists of 1,550 people in 43 homes
(includes future growth)
Conclusion

- A decentralized system is generally cost effective for:
  - rural community
  - fringe community
    (except when situated very close to an existing centralized system)

- Each case based on site-specific considerations
Presentation Format

- Definitions
- Technology Options
- Centralized vs. Decentralized Cost Comparison
  - decentralized system could be cost effective
- Elements for Program Success
Elements for Program Success

- appropriate technology
- responsive regulation
- adequate finance
- tighter management
Appropriate Technology

- technology certification/verification
- innovative technology demonstration
- education and training
Responsive Regulatory Control

- harmonize regulation coverage
- performance-based limits (vs. prescriptive codes)
- inspection and monitoring
- enforcement
- licensed/certified practitioners
Adequate Financing

- government grants
  - equitable distribution
- revolving funds
- amalgamation to district organization
- public-private partnership
EPA Proposed Five Levels of System Management

1. homeowner awareness
2. maintenance contracts
3. operating permits
4. RME operation and maintenance
5. RME ownership/management

* RME = Responsible Management Entity
Application of the Management Levels

Increasing Risks

Risk Factors

1. Inventory & maintenance awareness
2. Maintenance contracts
3. Operating permits
4. RME O&M
5. RME ownership

Environmental Sensitivity
Public Health
Wastewater Characteristics
Treatment Complexity
HOMEOWNER AWARENESS OF MAINTENANCE NEEDS

- Covers conventional septic systems
- Low environmental sensitivity
  - i.e., adequate space, separation distance, etc.
- Local agency is aware of system locations
- Periodic operation and maintenance reminders
MANAGEMENT LEVEL 2
Maintenance Contracts

- Complex systems given more attention
  - e.g., mounds, pressure dosed systems
- Maintenance contracts with trained service providers
MANAGEMENT LEVEL 3

Operating Permits

- Minimum for clusters, aerobic units, large capacity systems

- Sensitive sites
  - lakes, aquifers

- Renewable operating permits
  - Performance requirements
  - Regular monitoring and reporting
MANAGEMENT LEVEL 4
Responsible Management Entity
Operation and Maintenance

- Very sensitive areas - recreational uses, wellhead protection
- Responsible Management Entity for operation and maintenance
  - Systems still owned by homeowners
  - RME performs routine inspections & maintenance
  - Ensures consistent performance
MANAGEMENT LEVEL 5
Responsible Management Entity
Ownership and Management

- Ultra sensitive environment and public health protection
- Same as Level 4, except RME is owner
  - Professional management of all activities
  - Analogous to centralized collection and treatment
Canadian Case Study – Nova Scotia

- Guysborough (population 360)
- formed a wastewater management district
  - one cluster – small conventional treatment plant
  - one cluster – aerated lagoon
  - individual homes – septic tank and leaching bed
- all home owners paid $ 2,100 initially and have annual fees of $ 125 (in 1994)
Canadian Case Study – Nova Scotia

- 19 communities in Nova Scotia were considered
- 17 were recommended decentralized system
  - 3 formed Wastewater Management District (WMD)
  - 6 chose to centralize
  - 5 actively considering WMD
  - 5 in prolonged debate

Problems
- equity costs and services
- public perception favours centralized system
Presentation Format

- Definitions
- Technology Options
- Cost Comparison
  - Centralized vs. Decentralized System
- Elements for Program Success
  - technology
  - responsive regulation
  - adequate finance
  - tighter management
Examples of Provincial Initiatives

- Nova Scotia – wastewater management district
  - centre for water resource studies
  - program review

- Newfoundland – technology demonstration

- Quebec – updated regulation
  - system maintenance
  - technology performance standards
  - new technology testing & certification
Examples of Provincial Initiatives

- Ontario
  - municipal agreement for private systems
  - require septage treatment
  - Ontario rural wastewater centre

- British Columbia
  - new regulation for on-site systems
    - performance-based standards
    - O&M requirements
    - training and certification
    - enforcement
Future Coordination

- national body to coordinate efforts
  - harmonize provincial regulations
  - prioritize research
  - protocols for technology testing/certification/selection
  - national best practice
  - financing
  - continue dialogue among stakeholders
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