Treatment Methods and Disposal Options for Radionuclides
TREATMENT METHODS
Ion Exchange Radionuclide Removal Process

Issues:
- Corrosion of piping & values
- Sodium in drinking water

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Reverse Osmosis Radionuclide Removal Process

- **Raw Water**
- **Pressure Pump**
- **R.O. Membrane**
- **Rejected Water**
  - **Treated Water**
  - **Reject Water**
    - U, Ca, Mg, K
- **Sewer Pipe**
- **Waste Water Treatment Plant**
- **Waste Water**
- **Radionuclide + Sludge**
- **Waterways**
- **Land Application**
- **Appropriate Landfill**

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Lime Softening Radionuclide Removal Process

1. **Raw Water** → **Mix Tank**

2. **CaO** or **Na$_2$CO$_3$** addition to **Reaction Vessel**

3. **Clarifier**

4. **Radionuclides + Sludge** → **Drying Lagoons**

5. **Land Application**

6. **Compliant Water**

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Absorbent Media
Radionuclide Removal Process

Compliant Water

Raw Water

Partially Loaded Media

Loaded Media

New Media

Licensed & Permitted Disposal Facility

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## Comparison of Radium Treatment Technologies

<table>
<thead>
<tr>
<th></th>
<th>WRT Z-88®</th>
<th>Conventional Ion Exchange</th>
<th>HMO</th>
<th>Reverse Osmosis</th>
<th>Lime Softening</th>
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</thead>
<tbody>
<tr>
<td>NSF Std.61 Certified for use in potable water</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Chemical Addition</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Liquid Waste Generated</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Changes in Other Water Quality Parameters</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Type of Operation</td>
<td>Passive</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
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<tr>
<td>Disposal of Radium</td>
<td>Licensed Disposal Facility</td>
<td>Sewer</td>
<td>Sewer</td>
<td>Sewer</td>
<td>Land / Landfill</td>
</tr>
<tr>
<td>Combined Radium in Residuals (13 pCi/L in source water)</td>
<td>500 - 2,000 pCi/g</td>
<td>100 - 2,000 pCi/L</td>
<td>5,000 - 15,000 pCi/g</td>
<td>25 - 150 pCi/L</td>
<td>10 - 20 pCi/g of sludge</td>
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<td>Media Ownership</td>
<td>WRT</td>
<td>Utility</td>
<td>Utility</td>
<td>Utility</td>
<td>Utility</td>
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<td>Radioactive Material License</td>
<td>WRT</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
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<tr>
<td>Guaranteed Performance</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

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DISPOSAL OPTIONS
USEPA Recommendations – Disposal of Water Treatment Residuals

- < 5 pCi/g  
  Unrestricted disposal
- 5 to 100 pCi/g  
  Possible burial in local landfill with restrictions
- 50 to 2,000 pCi/L  
  Burial in NORM facility
- > 2,000 pCi/L  
  Burial in LLRW disposal site
Radionuclide Source to Discharge
No Treatment

Raw Water
Ra = 11 pCi/L
Ra = 20 pCi/L

Customers

Non-Radionuclide Influent

Ra = 11 pCi/L
Ra = 20 pCi/L

Waste Water Treatment Plant

40%
60%

Waste Water
Ra = 2.8 pCi/L
Ra = 8.0 pCi/L

Waterways

Radionuclide + Sludge
Ra = 48 pCi/g
Ra = 138 pCi/g

Land Application

Note: Assumes a 50% dilution of waste water with non-radium bearing water.
Radionuclide Source to Discharge
HMO Treatment

Raw Water
Ra = 11 pCi/L

HMO
Ra = <5 pCi/L

Customers

High Ra Solid
Ra = 15,600 pCi/g

Non-Radionuclide
Influent

Waste Water
Ra = 0.7 pCi/L

Waste Water Treatment Plant
10%

90%

Radionuclide + Sludge

Particles: Ra = 15,600 pCi/g
Average Sludge: Ra = 73 pCi/g

Land Application

Note: Assumes a 50% dilution of waste water with non-radium bearing water.

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Radionuclide Source to Discharge
Radionuclide-Selective Media Treatment

Raw Water
Ra = 11 pCi/L
Ra = 20 pCi/L

Ra = ~2,000 pCi/g

Waste Water
Ra = 1.29 pCi/L
Unchanged

Waste Water Treatment Plant

Customers

Non-Radionuclide Influent

Radionuclide + Sludge
Ra = 22 pCi/g
Unchanged

Low Level Disposal

Land Application

Waterways

Note: Assumes a 50% dilution of waste water with non-radium bearing water.
Why not send radioactive treatment residuals to the sewer?

- Solids settle out in sewer pipes creating radioactive dead zones
- Contamination of surrounding land due to leakage
- Contaminated pipes
  - Worker exposure risk during maintenance and repairs
  - Future pipe replacement will present worker exposure and disposal of contaminated pipes issues
- Extends exposure and contamination risks to the wastewater treatment plant
- Potential cleanup costs are expensive
  - 12 Sewer/POTW contamination incidents since 1984
  - Ohio cleanup cost was in excess of $2,000,000
- Land application
  - May restrict land use for agriculture
  - May impact future land development
  - Extends exposure and contamination risks to the application sites
Disposal of Treatment Residues

- Removal of radionuclides in any process generates a radioactive by-product.
- Most treatment methods dispose of radionuclide waste to the sanitary sewer.
- WRT’s Radionuclide Removal Process generates a solid, granular, low level TENORM* waste.
- All handling, exchange, transportation and disposal of media is facilitated by WRT.
- Disposal by WRT to a licensed facility.

* Technically Enhanced Naturally Occurring Radioactive Material.